CA FINAL — ADVANCED FINANCIAL MANAGEMENT

Question Bank: Questions & Solutions (Chapters 1–15)

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Our Rankers

AIR 1

Noor Singla

CA Final May-26

AIR 1

Diksha Goyal

CA Final Jan-26

AIR 49

Hamsa Gayatri

CA Final Sep-25

AIR 27

Sudeepta Benya

CA Final Nov-24

CHAPTER 1 — FINANCIAL POLICY AND CORPORATE STRATEGY

Question 1 — The Growth-Gap Diagnostic

VeloMech Ltd. has tabled an ambitious plan to grow sales by 20% next year. The CFO, before signing off on the plan, has asked you to do a diagnostic. The following data is extracted from the latest financials (₹ in crore):

Item	Amount
Current Sales	3,000
Total Assets	2,400
Shareholders' Funds (Equity + Reserves)	800
Interest-bearing Debt	1,200
Spontaneous Liabilities (Payables)	400

Operating parameters: Net Profit Margin = 5%, Asset Turnover = 1.25, Equity Multiplier = 3.00, Dividend Payout Ratio = 40%.

The Board has communicated two binding policies: (i) no fresh equity issue is contemplated in the planning horizon, and (ii) Debt-to-Equity Ratio must not exceed 1.50.

Required:

(i) Compute the firm's current Sustainable Growth Rate (SGR) and identify the "growth gap" against the target.

(ii) Compute the External Funds Requirement (EFR) for the 20% target growth using the formula approach.

(iii) Assuming the EFR is funded entirely through fresh debt (consistent with the "no fresh equity" policy), examine whether the Board's DER ceiling is respected.

(iv) For each of the four levers in the DuPont decomposition of SGR — net margin, asset turnover, equity multiplier, retention — compute the value the lever must take (holding the other three at current levels) to push SGR to 20%. Comment on the feasibility of each.

(v) Based on (c) and (d), advise the CFO on whether the 20% growth target is achievable within the stated Board policies, and what concrete trade-offs are required.

Solution

(a) Current SGR and Growth Gap

By DuPont decomposition:

ROE = NPM × Asset Turnover × Equity Multiplier = 0.05 × 1.25 × 3.00 = 18.75%

SGR = ROE × Retention = 18.75% × 0.60 = 11.25%

Growth Gap = Target Growth − SGR = 20% − 11.25% = 8.75 percentage points.

(b) External Funds Requirement

EFR = (TA / Sales) × ΔS − (Payables / Sales) × ΔS − m × S_1 × (1 − d)

Where ΔS = 0.20 × 3,000 = ₹600 crore; S_1 = ₹3,600 crore.

EFR = (2,400/3,000)(600) − (400/3,000)(600) − 0.05 × 3,600 × 0.60

= 480 − 80 − 108 = ₹292 crore

(c) DER Check if EFR is Funded Entirely by Fresh Debt

Item	₹ Crore
New Shareholders' Funds (800 + Retained Earnings of 108)	908.00
New Interest-bearing Debt (1,200 + 292)	1,492.00
New DER	**1.643**

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The ceiling is 1.50; the projected DER is 1.643. The 20% growth, financed exclusively by fresh debt, breaches the Board policy by a clear margin.

(d) Single-Lever Sensitivity to Achieve SGR = 20%

Setting NPM × AT × EM × b = 0.20 and solving for one lever at a time:

Lever Held Variable	Required Value	Current Value	Feasibility
Net Profit Margin (NPM)	8.89%	5.00%	Requires ~390 bps margin expansion. Ambitious but conceivable through pricing, mix, cost programmes.
Asset Turnover (AT)	2.222×	1.25×	Requires nearly 78% improvement. Possible only through aggressive working capital release or asset-light models; rarely achievable in one year.
Equity Multiplier (EM)	5.333×	3.00×	Implies DER ≈ 4.33, breaching the 1.50 cap by a wide margin. Infeasible under stated policy.
Retention Ratio (b)	1.067	0.60	Retention cannot exceed 1.0 by definition. Mathematically impossible.

(e) Advisory to the CFO

The diagnostic reveals that the 20% target is not simultaneously achievable under both Board policies and current operating parameters. The CFO must escalate the following trade-offs to the Board:

(i) Operating productivity must do the heavy lifting — only the NPM lever (and to a lesser extent, AT) offers any realistic single-lever path. A blended improvement is likely needed: e.g., NPM lifted to ~6.5% and AT lifted to ~1.50× would together raise SGR to roughly 17.5%, closing most of the gap.

(ii) One Board policy must yield. Even with operational improvements, the residual gap will demand either (i) a temporary relaxation of the DER ceiling to ~1.65, or (ii) admission of fresh equity. The cleaner answer financially is a modest equity infusion of ~₹55 crore, which keeps DER intact at 1.50 and avoids the long-tail risk of higher leverage.

(iii) If neither yields, the growth target itself must be re-calibrated to align with the firm's true sustainable trajectory of 11.25%, possibly stretched to ~14–15% via operational levers alone.

Question 2 — EFR Under Competing Capital-Structure Constraints

PrimeAuto Components Ltd. is preparing its annual operating plan. The CFO has asked you to determine the financing mix required to support 24% sales growth, given multiple Board-mandated structural ratios.

Balance Sheet as on 31-03-2026 (₹ Crore):

Liabilities	₹	Assets	₹
Equity Share Capital (FV ₹10)	1,000	Fixed Assets	3,500
Reserves & Surplus	1,500	Inventory	1,500
Long-Term Debt	2,000	Receivables	800
Short-Term Debt	600	Cash & Bank	200
Trade Payables	900		
Total	**6,000**	**Total**	**6,000**

Current Sales: ₹7,500 crore. NPM (post-tax): 5%. Dividend Payout: 40%.

Board-mandated policies:

- Current Ratio (Current Assets / Current Liabilities, where CL = ST Debt + Payables) shall not fall below 1.60.
- Fixed Assets : Long-Term Debt ratio shall be maintained at 1.80.
- Debt-to-Equity ratio (Total Debt / Shareholders' Funds) shall not exceed 1.50.

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Assume all operating assets (FA, Inventory, Receivables, Cash) scale proportionately with sales, and trade payables increase spontaneously with sales.

Required:

(i) Compute the External Funds Requirement (EFR) using the formula approach.

(ii) Determine the amount to be raised from (a) Short-Term Debt, (b) Long-Term Debt, and (c) Fresh Equity, ensuring all three Board policies are simultaneously honoured.

(iii) Verify the DER ratio post-financing.

(iv) Sensitivity: If the Board agrees to relax the Current Ratio floor from 1.60 to 1.40, recompute the fresh equity required and comment on which constraint binds first.

Solution

(i) EFR Computation

$\Delta S = 0.24 \times 7{,}500 = ₹1{,}800$ crore. New Sales (S_1) = ₹9,300 crore.

EFR = (6,000/7,500)(1,800) − (900/7,500)(1,800) − 0.05 × 9,300 × 0.60

= 1,440 − 216 − 279 = ₹945 crore

Retained earnings ploughed back = ₹279 crore.

(ii) Allocation of EFR Across the Three Sources

Step 1 — Projected Asset & Spontaneous Liability Positions (₹ Crore):

Item	Existing	Growth Factor	New
Fixed Assets	3,500	1.24	4,340
Inventory	1,500	1.24	1,860
Receivables	800	1.24	992
Cash	200	1.24	248
Total Current Assets	**2,500**		**3,100**
Total Assets	**6,000**		**7,440**
Trade Payables	900	1.24	1,116

Step 2 — Long-Term Debt (FA:LT Debt = 1.80 constraint):

New LT Debt = 4,340 / 1.80 = ₹2,411.11 crore

Additional LT Debt to be raised = 2,411.11 − 2,000 = ₹411.11 crore

Step 3 — Short-Term Debt (Current Ratio ≥ 1.60 constraint):

Maximum permitted CL = 3,100 / 1.60 = ₹1,937.50 crore

Permitted ST Debt = 1,937.50 − 1,116 (Payables) = ₹821.50 crore

Additional ST Debt to be raised = 821.50 − 600 = ₹221.50 crore

Step 4 — Fresh Equity (Residual):

Fresh Equity = EFR − Additional ST Debt − Additional LT Debt

= 945 − 221.50 − 411.11 = ₹312.39 crore

(iii) DER Verification

Component	₹ Crore
New Total Debt (2,411.11 + 821.50)	3,232.61
New Shareholders' Funds (1,000 + 312.39 + 1,500 + 279)	3,091.39
New DER	**1.046**

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DER of 1.046 is well within the ceiling of 1.50. All three Board policies are simultaneously satisfied.

(iv) Sensitivity — Current Ratio Relaxed to 1.40

If CR floor = 1.40:

Maximum permitted CL = 3,100 / 1.40 = ₹2,214.29 crore

Permitted ST Debt = 2,214.29 − 1,116 = ₹1,098.29 crore

Additional ST Debt = 1,098.29 − 600 = ₹498.29 crore

Fresh Equity required = 945 − 498.29 − 411.11 = ₹35.60 crore

DER under relaxed scenario:

Total Debt = 2,411.11 + 1,098.29 = ₹3,509.40 crore

SHF = 1,000 + 35.60 + 1,500 + 279 = ₹2,814.60 crore

DER = 3,509.40 / 2,814.60 = 1.247 (within 1.50 ceiling).

Insight: Relaxing the Current Ratio from 1.60 to 1.40 reduces fresh equity requirement by nearly ₹277 crore (from ₹312.39 to ₹35.60), and the DER constraint still does not bind. This demonstrates that the Current Ratio is the dominant binding constraint in this firm's policy stack — not DER. A discussion with the Board on the right CR floor is therefore more value-accretive than tinkering with leverage limits.

Question 3 — The Modern CFO's Financing Choice

GreenCircle Industries Ltd. is a listed mid-cap manufacturer of industrial chemicals with FY26 revenue of ₹4,200 crore. The Board has approved a capital expenditure of ₹1,800 crore over three years to transition 60% of its production base from petroleum-derived to bio-based feedstock. The transition is expected to lower greenhouse gas (GHG) emissions by 45% by FY29. Two facts are relevant to the financing decision:

- Margin trajectory: Gross margins will compress by approximately 200 basis points in FY27 and FY28 during the transition, before recovering to pre-transition levels in FY29 and structurally improving thereafter as bio-feedstock costs scale down.
- Customer signal: GreenCircle's top 10 customers (largely European MNCs) have communicated a strong preference for green-supplier certification by FY28, which is expected to translate into 8–10% revenue uplift from "green premium" contracts.

The CFO has three financing options on the table for the ₹1,800 crore:

- Option A — Plain Vanilla NCD: 10-year non-convertible debenture at 9.25% fixed coupon.
- Option B — Sustainability-Linked Bond (SLB): 10-year bond at 8.85% coupon, with a step-up of 75 bps if GHG reduction milestones are missed in any year.
- Option C — Rights Issue: Equity rights issue priced at a 15% discount to current market price.

Required:

(i) Identify and discuss how this scenario reflects the expanded role of the modern CFO as articulated in the ICAI SM, going beyond traditional wealth maximization. Reference all four newly-emphasized dimensions.

(ii) Apply the "Interface of Financial Policy and Strategic Management" framework to evaluate the three financing options. Comment specifically on (a) sources of finance, (b) capital structure, (c) investment & fund allocation, and (d) dividend policy implications of each option.

(iii) Without numerical computation, explain how Option C (equity) would impact the firm's Sustainable Growth Rate (SGR) differently from Options A and B (debt). Identify the lever in the SGR formula that is affected.

(iv) Recommend a financing structure for the ₹1,800 crore with reasoning that integrates the strategic context, the margin trajectory, and the customer signal.

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Solution

(i) Expanded Role of the Modern CFO

The ICAI SM articulates that the post-pandemic CFO's role extends beyond the traditional governance, compliance, and controls function into four advanced areas, each of which is directly engaged in this scenario:

Risk Management: The CFO is custodian of the firm's risk framework. The bio-feedstock transition exposes the firm to feedstock supply risk, technology execution risk, and margin volatility through FY28. The CFO must structure financing such that the firm has sufficient liquidity headroom to absorb the 200 bps margin compression — a debt option with covenants tied to margin levels could trigger acceleration if not carefully negotiated.

Supply Chain: The transition is fundamentally a supply chain reconfiguration. Bio-feedstock procurement requires new supplier relationships and potentially longer working capital cycles. The CFO must assess whether the chosen financing instrument allows for the additional working capital this entails.

M&A and Corporate Restructuring: While not directly an M&A event, the transition may require equity stakes in bio-feedstock suppliers or joint ventures. Financing flexibility for such opportunistic inorganic moves is more readily preserved through equity (Option C) than through committed debt (Options A and B).

ESG Financing: This is the most direct alignment. Option B (SLB) is precisely the instrument the SM references when discussing the shift from "traditional financing to sustainability financing." The CFO must evaluate whether the 40 bps savings (9.25% vs 8.85%) and reputational signalling justify the step-up risk.

(ii) Interface of Financial Policy and Strategic Management — Option-wise Analysis

Dimension	Option A (NCD)	Option B (SLB)	Option C (Rights)
Sources of Finance	Borrowed capital; conventional debt market; ample depth in Indian NCD market.	Borrowed capital with embedded ESG covenant; investor base broader (ESG funds + traditional bond investors); price-discovery advantage.	Ownership capital; existing shareholder base; no covenant burden but dilution.
Capital Structure	Increases DER; introduces fixed interest obligation during the margin-compression window — heightened financial risk in FY27–28.	Same DER impact as Option A but with conditional cost escalation tied to ESG milestones; effective cost is state-contingent.	Reduces DER; expands equity base; restores headroom for future debt-funded growth post-FY29.
Investment & Fund Allocation	Locks the firm into servicing fixed interest regardless of project performance; constrains flexibility for adjacent investments.	Same fixed-interest discipline as Option A, but cost reduces if ESG execution is on track — aligns incentives.	Maximum flexibility; no claim on cash flows; allows opportunistic reallocation if bio-feedstock economics shift.
Dividend Policy	Restricts dividend flexibility during high-leverage period; potential covenants on payout.	Same constraint as Option A; SLB documentation may include sustainability-linked payout restrictions.	Dilutes EPS in the near term; dividend per share pressure; but no covenant restrictions on payout policy.

(iii) SGR Impact

Recall: SGR = NPM × Asset Turnover × Equity Multiplier × Retention Ratio.

- Options A & B (Debt): Asset Turnover and Equity Multiplier both rise. The Equity Multiplier rises directly because Total Assets grow without commensurate equity expansion. This mechanically raises SGR but at the cost of higher financial risk and reduced future debt capacity.

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- Option C (Equity): Equity Multiplier falls (Total Assets ÷ Equity declines as equity expands). This mechanically reduces SGR in the short run, even though it strengthens the balance sheet. NPM may also dilute on a per-share basis.

The key teaching insight: SGR can be flattered by debt-funded growth, but a higher SGR achieved through leverage is not the same as a higher SGR achieved through margin or turnover improvement. The SM's framing of SGR as a capital-structure-respecting growth ceiling is precisely this point.

(iv) Recommendation

A blended structure is advised:

- Option B (SLB) for approximately ₹1,000 crore (~55%) — captures the 40 bps coupon saving, signals ESG commitment to European customers (directly supporting the 8–10% revenue uplift), and aligns financing cost with execution performance.
- Option C (Rights Issue) for approximately ₹600 crore (~33%) — provides equity cushion to absorb the FY27–28 margin compression without breaching covenants, preserves dividend flexibility, and signals promoter confidence (rights issues are interpreted more favourably by markets than dilutive QIPs).
- Option A (Plain NCD) for the residual ~₹200 crore (~11%) — provides cost diversification and is appropriate for the portion of capex with the most predictable cash flows (e.g., utilities, civil works) that may not qualify for SLB ESG-linked metrics.

This structure honours all four expanded CFO dimensions (risk, supply chain, ESG, and M&A flexibility), respects the interface between strategy and finance (no single source dominates), and produces a sustainable growth profile.

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CHAPTER 2 — RISK MANAGEMENT

Question 1 — Three-Asset Portfolio VaR with Stress-Correlation Scenario

Apex Treasury Ltd. manages a proprietary book with three asset positions as on the reporting date:

Asset	Position Value (₹ Crore)	Daily Volatility (σ)
A — Listed Equity Portfolio	100	1.50%
B — Corporate Bond Portfolio	60	0.40%
C — Gold ETF (commodity proxy)	40	1.10%

The pairwise daily-return correlations under normal market conditions:

Pair	Correlation
A — B	+ 0.20
A — C	− 0.40
B — C	+ 0.10

Z-scores from the normal table: 95% confidence = 1.65; 99% confidence = 2.33. Assume returns are normally distributed and the firm uses parametric (variance-covariance) VaR.

Required:

(i) Compute the 1-day 95% VaR of the portfolio.

(ii) Compute the 10-day 99% VaR of the portfolio.

(iii) Compute the sum of standalone VaRs (1-day 95%) of the three assets and quantify the diversification benefit in rupees and as a percentage.

(iv) Stress Scenario: In a market crisis, pairwise correlations between all three assets converge to +0.85. Recompute the 10-day 99% VaR under this stressed correlation matrix. Compare with the base case and comment on the implication for the firm's risk management.

Solution

Step 1 — Position Volatility in Rupees

Asset	Position (₹ Cr) × σ	Daily σ (₹ Cr)
A	100 × 0.015	1.5000
B	60 × 0.004	0.2400
C	40 × 0.011	0.4400

Step 2 — Portfolio Variance (Base Case)

$\sigma^2 p = \sigma A^2 + \sigma B^2 + \sigma C^2 + 2\rho AB \cdot \sigma A \cdot \sigma B + 2\rho AC \cdot \sigma A \cdot \sigma C + 2\rho BC \cdot \sigma B \cdot \sigma C$

Component	Value (₹ Cr²)
$\sigma A^2 = (1.50)^2$	2.2500
$\sigma B^2 = (0.24)^2$	0.0576
$\sigma C^2 = (0.44)^2$	0.1936
2(0.20)(1.50)(0.24)	0.1440
2(−0.40)(1.50)(0.44)	−0.5280
2(0.10)(0.24)(0.44)	0.0211
Portfolio Variance $\sigma^2 p$	**2.1383**

Portfolio standard deviation σp = √2.1383 = ₹1.4623 crore (daily).

(a) 1-Day 95% VaR

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= σp × Z(95%) = 1.4623 × 1.65 = ₹2.413 crore

***(b) 10-Day 99% VaR* = σp × Z(99%) × √10 = 1.4623 × 2.33 × 3.1623 = ₹10.770 crore**

(c) Standalone VaRs and Diversification Benefit (1-day 95%)

Asset	1-Day 95% Standalone VaR (₹ Cr)
A	1.50 × 1.65 = 2.475
B	0.24 × 1.65 = 0.396
C	0.44 × 1.65 = 0.726
Sum of Standalone VaRs	**3.597**
Portfolio VaR	**2.413**
Diversification Benefit	**1.184 (or 32.92%)**

(d) Stress Scenario — All Correlations at +0.85

Component	Value (₹ Cr²)
σA^2	2.2500
σB^2	0.0576
σC^2	0.1936
2(0.85)(1.50)(0.24)	0.6120
2(0.85)(1.50)(0.44)	1.1220
2(0.85)(0.24)(0.44)	0.1795
Stressed Portfolio Variance	**4.4147**

σp (stressed) = √4.4147 = ₹2.1011 crore.

Stressed 10-day 99% VaR = 2.1011 × 2.33 × 3.1623 = ₹15.481 crore.

Comparison & Insight:

Metric	Base Case	Stressed
10-Day 99% VaR	₹10.770 Cr	₹15.481 Cr
Increase	—	+43.7%

The stressed VaR is nearly 44% higher than the base case, driven entirely by correlation re-pricing — position sizes and individual volatilities are unchanged. The natural hedge between Equity (A) and Gold (C), which contributed a negative correlation term of ₹−0.528 crore² in base case, vanishes under stress.

This illustrates the well-documented "correlation breakdown" or "diversification failure" phenomenon in crisis periods (2008 GFC, March 2020 Covid sell-off). Conventional VaR, calibrated on benign-period correlations, systematically underestimates tail risk. Risk managers must therefore complement VaR with stress testing and reverse stress testing — running VaR under multiple "what-if" correlation matrices, not just the historical sample.

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Question 2 — Cross-Asset Class VaR with Hedging Decision

TechBridge Industries Ltd. has the following risk exposures:

Exposure	Position	Daily Volatility
Listed Indian Equity Portfolio	₹50 crore	1.60%
USD Receivable due in 30 days (exporter; $8 million; spot ₹84.50/$)	INR equivalent ₹67.60 crore	0.65% (of INR/USD rate)

The historical daily-return correlation between the equity portfolio and the INR-value of the USD receivable is −0.20 (when FII flows reverse, equity falls and the rupee weakens, which boosts the INR-value of the USD receivable — an embedded natural hedge).

The Board has approved a 1-day 99% Value-at-Risk limit of ₹1.50 crore for the combined book. Z(99%) = 2.33. The CFO has asked you to assess compliance and, if breached, recommend a hedging plan.

Required:

(i) Identify the two principal types of financial risk present in this exposure under the ICAI taxonomy.

(ii) Compute the standalone 1-day 99% VaR for each exposure.

(iii) Compute the combined 1-day 99% VaR for the portfolio.

(iv) Assess whether the Board's ₹1.50 crore VaR limit is breached.

(v) Recommend two distinct hedging options that would bring VaR within the limit, with a quantified comparison. Comment on which is more cost-effective in spirit (no need to compute hedging costs in rupees).

Solution

(a) Risk Identification (per ICAI SM, Section 1.4)

(i) Market Risk via Equity Price Risk — The equity portfolio is subject to daily price fluctuations driven by market-wide and stock-specific factors. (Falls under the broader umbrella of Financial Risk; ICAI SM treats this as a manifestation of market price variability.)

(ii) Currency Risk (ICAI SM Para 1.4.4) — The INR realisation on the USD receivable will vary with INR/USD rate movements over the 30-day collection period.

(b) Standalone 1-Day 99% VaR

Daily σ in rupees:

- Equity: $\sigma E = 50 \times 0.016 = ₹0.80$ crore
- FX (USD receivable INR-value): $\sigma F = 67.60 \times 0.0065 = ₹0.4394$ crore

Standalone 1-Day 99% VaR:

- Equity: $0.80 \times 2.33 = ₹1.864$ crore
- FX: $0.4394 \times 2.33 = ₹1.024$ crore

(c) Combined Portfolio VaR

$\sigma^2 p = \sigma E^2 + \sigma F^2 + 2\rho EF \cdot \sigma E \cdot \sigma F$

$= (0.80)^2 + (0.4394)^2 + 2(-0.20)(0.80)(0.4394)$

$= 0.6400 + 0.1931 - 0.1406 = 0.6925$

$\sigma p = \sqrt{0.6925} = ₹0.8322$ crore

Combined 1-Day 99% VaR = 0.8322 × 2.33 = ₹1.939 crore

(d) Board Limit Compliance Check

- Sum of Standalone VaRs = ₹2.888 crore
- Combined VaR (after natural hedge benefit) = ₹1.939 crore
- Diversification benefit = ₹0.949 crore (~33%)
- Board Limit = ₹1.50 crore

The combined VaR of ₹1.939 crore exceeds the ₹1.50 crore limit by ₹0.439 crore (29% breach). Action is required.

(e) Hedging Options

Option I — Full Currency Hedge via Forward Contract

Hedge $8 million via a 30-day USD/INR forward. This eliminates σF (FX volatility falls to ~0).

σp (after hedge) = $\sqrt{(\sigma E^2)}$ = ₹0.80 crore

1-Day 99% VaR = 0.80 × 2.33 = ₹1.864 crore

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Result: Still above the ₹1.50 crore cap. Equity volatility alone breaches the limit. Currency-only hedging is insufficient.

Option II — Reduce Equity Exposure (FX Unhedged)

Propose a 30% reduction in the equity position, from ₹50 crore to ₹35 crore. Verify whether this brings VaR within the ₹1.50 crore cap.

New $\sigma E = 35 \times 0.016 = ₹0.560$ crore

$\sigma p^2 = (0.560)^2 + (0.4394)^2 + 2(-0.20)(0.560)(0.4394)$

$= 0.3136 + 0.1931 - 0.0984 = 0.4083$

$\sigma p = \sqrt{0.4083} = ₹0.639$ crore

1-Day 99% VaR = 0.639 × 2.33 = ₹1.489 crore ✓ (just within the ₹1.50 cap)

The 30% reduction in equity exposure brings VaR to ₹1.489 crore — within the cap but with a thin margin of safety (only ₹11 lakh of headroom). The implicit cost is heavy: the firm sacrifices 30% of its equity-driven returns to comply.

Option III — Combined: Partial Equity Reduction + Partial FX Hedge

Reduce equity to ₹40 crore and hedge 70% of the USD receivable via forward.

New $\sigma E = 40 \times 0.016 = 0.640$

New $\sigma F = 0.4394 \times 0.30 = 0.1318$ (only 30% unhedged)

$\sigma p^2 = (0.640)^2 + (0.1318)^2 + 2(-0.20)(0.640)(0.1318) = 0.4096 + 0.0174 - 0.0337 = 0.3933$

$\sigma p = \sqrt{0.3933} = 0.627$

1-Day 99% VaR = 0.627 × 2.33 = ₹1.461 crore ✓ (within limit)

Comparison & Recommendation:

Option	VaR Outcome	Operational Cost	Strategic Implication
I (Full FX Hedge only)	₹1.864 Cr — Fails	Low forward cost only	Loses natural hedge benefit; equity risk remains dominant and unmanaged
II (30% Equity reduction)	₹1.489 Cr — Achieves with thin margin	High implicit cost — foregone equity returns	Sacrifices the portfolio's primary return engine
III (Combined approach)	₹1.461 Cr — Achieves with better cushion	Moderate — partial forward cost + smaller equity reduction	Preserves 80% of equity upside; uses forwards selectively

Recommendation: Option III. It demonstrates the principle articulated in the ICAI SM that effective risk management is rarely about applying a single instrument — it is about combining multiple levers proportionate to each risk type. Option I demonstrates the trap of hedging only the visible risk (FX) while the dominant risk (equity vol of ₹1.864 crore standalone VaR) sits unmanaged.

Question 3 — Multi-Risk Case Scenario (Risk Identification + Management)

Bharat Pharma Ltd. is a Mumbai-listed generic pharmaceutical manufacturer with annual revenue of ₹6,400 crore. The following picture emerges from a recent risk-committee briefing:

Business Profile

- Annual exports to Russia: $80 million (15% of total revenue)
- Trade receivables outstanding from Russia: $25 million across four distributors
- Manufacturing facility in Punjab; ~40% of active pharmaceutical ingredients (APIs) imported from China
- Funded primarily by INR debt of ₹2,000 crore at MCLR + 50 bps (floating rate, semi-annual reset)
- Holds RUB-denominated working balances of approximately RUB 200 million used for local Russian operating expenses

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Recent Developments

(i) Western sanctions on Russia have led to SWIFT exclusion of several major Russian banks.

(ii) The RBI has notified a special INR-RUB Vostro account mechanism for rupee trade settlement.

(iii) Two of the four Russian distributors have been added to the US OFAC sanctions list since the last reporting period.

(iv) The Indian Ministry of Commerce is considering invoking strategic trade controls on certain pharmaceutical exports to sanctioned jurisdictions.

(v) The Chinese API supplier has raised prices by 8% citing USD strength.

(vi) The RBI is expected to raise the repo rate by 50 bps in the next monetary policy review.

(vii) A leaked internal audit notes a cash-management lapse: a junior treasury executive routed a $1.2 million payment to a wrong beneficiary; recovery is ongoing.

Required:

(i) Classify each of the above seven developments under the appropriate ICAI risk category (Strategic / Compliance / Operational / Financial — and within Financial, the appropriate sub-category). Where a single development triggers more than one risk, identify all that apply.

(ii) For each Financial risk identified, suggest the appropriate management approach, drawing on ICAI SM Section 4.

(iii) Recommend a prioritised three-tier risk response — what should the Board address in (a) the next 30 days, (b) the next 90 days, and (c) the next 12 months — with reasoning rooted in the severity-and-immediacy of each risk.

Solution

(i) Risk Classification

#	Development	Risk Classification	ICAI SM Reference
1	SWIFT exclusion of Russian banks	Financial Risk → Counter-Party Risk (payment settlement breakdown) and Political Risk (sanctions-driven restriction on remittance)	Para 1.4.1 and 1.4.2
2	RBI INR-RUB Vostro mechanism	This is a mitigating development, not a risk; introduces operational and compliance considerations around its use	—
3	OFAC listing of two distributors	Counter-Party Risk (potential inability to collect $25M receivables); Compliance Risk (continuing to deal with OFAC-sanctioned entities exposes Bharat Pharma to secondary sanctions)	Para 1.4.1 and 1.2
4	Indian strategic trade controls under consideration	Strategic Risk (potential loss of access to Russia revenue stream — 15% of total) and Compliance Risk (new regulatory regime to navigate)	Para 1.1 and 1.2
5	Chinese API supplier 8% price hike	Strategic Risk (margin compression undermines competitive position) with an embedded Currency Risk (the hike is itself a function of USD strength against CNY → INR cost rises)	Para 1.1 and 1.4.4
6	RBI 50 bps repo hike expected	Interest Rate Risk — the ₹2,000 crore MCLR-linked debt will reset upward, raising annual interest cost by approximately ₹10 crore	Para 1.4.3
7	Wrong-beneficiary payment of $1.2M	Operational Risk ("people" and "process" failure — exactly the SM's illustration of an employee paying ₹1 lakh instead of ₹10,000); residual Counter-Party Risk if recovery fails	Para 1.3 and 1.4.1

(ii) Management Approach for Each Financial Risk

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Financial Risk	Management Approach
Counter-Party Risk (Items 1, 3, 7)	(a) Segregate exposures by sanctioned vs non-sanctioned distributors; cease shipments to OFAC-listed entities immediately; (b) Use OFAC- and SDN-list screening as a permanent treasury control; (c) Strengthen KYC/credit-check protocols and require advance payment or letter-of-credit terms from remaining Russian distributors; (d) For Item 7, document the failure mode, implement four-eye approval for payments above a threshold, and pursue civil recovery with legal counsel.
Political Risk (Item 1)	(a) Reduce concentration in Russia via accelerated diversification into other emerging markets (LATAM, SE Asia); (b) Utilise the RBI INR-RUB Vostro mechanism for new transactions to bypass SWIFT-dependent rails; (c) Consider political risk insurance (e.g., ECGC cover) for residual exposure.
Currency Risk (Item 5, plus the USD/RUB receivables)	(a) Hedge USD receivables via forward contracts; (b) For RUB exposure, given limited forward market, consider natural hedging by keeping payables and receivables in matching currency; (c) For Chinese API imports, consider USD payables hedging or negotiate longer payment terms to reduce volatility window.
Interest Rate Risk (Item 6)	(a) Convert a portion of ₹2,000 crore floating-rate debt to fixed via Interest Rate Swap; (b) Consider issuing fixed-rate NCDs to refinance part of the floating exposure; (c) Build an interest reserve to absorb the ~₹10 crore impact over the next 12 months.

(iii) Prioritised Three-Tier Risk Response

Within 30 Days — Crisis Containment

(i) Freeze all new shipments to OFAC-sanctioned distributors and engage external counsel on compliance posture for past dealings.

(ii) Implement four-eye approval and automated SWIFT-message validation for all cross-border payments — closing the operational hole revealed in Item 7.

(iii) Initiate dialogue with the two non-sanctioned Russian distributors to re-route settlements through the INR-RUB Vostro mechanism.

Within 90 Days — Structural Risk Reduction

(i) Execute interest rate swap on ₹800–1,000 crore (40-50%) of the floating-rate debt to lock in current rates ahead of the anticipated repo hike.

(ii) Hedge open USD receivables (~$25M minus the sanctioned portion) via forward contracts to lock in INR realisation.

(iii) Diversify API sourcing to reduce China-supplier dependency below 30%.

Within 12 Months — Strategic Re-positioning

(i) Reduce Russia revenue concentration below 8% of total revenue (from 15%) through accelerated business development in LATAM and SE Asia.

(ii) Establish a permanent Board-level Risk Management Committee with monthly review of geopolitical exposure, currency exposure, and counter-party concentration.

(iii) Review the entire treasury policy and approval framework end-to-end, given the operational lapse exposed in Item 7.

Reasoning behind prioritisation: Items in the 30-day tier are those where non-action compounds risk daily (continuing to ship to sanctioned entities is an accelerating compliance violation; another payment lapse could occur tomorrow). The 90-day tier addresses risks whose timing is more predictable (the repo hike, the receivable collection cycle). The 12-month tier is structural — these are not crisis items, but their cumulative impact on the firm's strategic position is the largest.

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Question 4 — VaR Risk-Budgeting and Position Sizing

ApexFin AMC offers two PMS strategies to high-net-worth clients:

Strategy	Asset Class	Daily Volatility (per ₹ of position)
Strategy A	Concentrated Equity	1.50%
Strategy B	Investment-Grade Fixed Income	0.40%

The historical daily-return correlation between Strategy A and Strategy B is +0.15.

The Board has imposed a firm-wide 1-day 99% VaR limit of ₹5 crore on the aggregate AUM of these two strategies combined. Z(99%) = 2.33.

The CIO is debating capital allocation.

Required:

(i) Determine the maximum AUM the firm can carry if 100% is allocated to Strategy A alone.

(ii) Determine the maximum AUM the firm can carry if 100% is allocated to Strategy B alone.

(iii) Determine the maximum total AUM the firm can carry if the allocation is 60% to Strategy A and 40% to Strategy B, with the firm-wide ₹5 crore VaR cap binding.

(iv) Compute the sum of standalone VaRs under the (c) allocation and quantify the "risk-budgeting gain" — the extra AUM permitted under the combined VaR cap of ₹5 crore versus the more restrictive constraint that the sum of standalone VaRs must equal ₹5 crore.

(v) Stressed correlation scenario: If the A–B correlation rises to +0.70 in a market crisis (typical of de-risking episodes when both equity and bonds sell off together), what is the new maximum AUM under the 60:40 mix?

Solution

(a) 100% in Strategy A

Position size × 0.015 × 2.33 = 5

Position size = 5 / 0.03495 = ₹143.06 crore

(b) 100% in Strategy B

Position size × 0.004 × 2.33 = 5

Position size = 5 / 0.00932 = ₹536.48 crore

(c) 60% A, 40% B Combined AUM

Let W = total AUM. Position in A = 0.6W; Position in B = 0.4W.

Daily σ in rupees:

- σA = 0.6W × 0.015 = 0.009W
- σB = 0.4W × 0.004 = 0.0016W

Portfolio variance:

$\sigma^2 p = (0.009W)^2 + (0.0016W)^2 + 2(0.15)(0.009W)(0.0016W)$

$= W^2 \times [0.0000810 + 0.0000026 + 0.0000043] = W^2 \times 0.0000879$

$\sigma p = W \times 0.009374$

VaR = σp × 2.33 = W × 0.021841 = 5

W = 5 / 0.021841 = ₹228.96 crore

Within this: Strategy A = ₹137.4 crore; Strategy B = ₹91.6 crore.

(d) Sum of Standalone VaRs and Risk-Budgeting Gain

At W = ₹228.96 crore (the combined-cap allocation):

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- Standalone VaR_A = 137.4 × 0.015 × 2.33 = ₹4.802 crore
- Standalone VaR_B = 91.6 × 0.004 × 2.33 = ₹0.854 crore
- Sum of Standalone VaRs = ₹5.656 crore

The combined portfolio VaR (₹5.00 crore) is lower than the sum of standalone VaRs (₹5.656 crore) by ₹0.656 crore (~11.6%) — this is the diversification benefit reflected in the VaR aggregation.

To find the "risk-budgeting gain," compare against the more restrictive constraint of sum of standalone VaRs ≤ ₹5 crore:

$W \times 0.6 \times 0.015 \times 2.33 + W \times 0.4 \times 0.004 \times 2.33 = 5$

$W \times (0.020970 + 0.003728) = 5$

$W \times 0.024698 = 5$

W = ₹202.45 crore

Constraint	Max AUM (₹ Cr)
Sum of standalone VaRs ≤ ₹5 Cr	202.45
Combined portfolio VaR ≤ ₹5 Cr	228.96
Risk-Budgeting Gain	**26.51 (or 13.1% more AUM)**

In practical terms: the firm earns 13% more in management fees by using the diversification correctly in its risk budget rather than imposing a naïve standalone-VaR cap on each strategy.

(e) Stressed Correlation Scenario (ρ = +0.70)

$\sigma^2 p = (0.009W)^2 + (0.0016W)^2 + 2(0.70)(0.009W)(0.0016W)$

$= W^2 \times [0.0000810 + 0.0000026 + 0.0000202] = W^2 \times 0.0001037$

$\sigma p = W \times 0.010184$

$VaR = W \times 0.010184 \times 2.33 = W \times 0.023729 = 5$

W = 5 / 0.023729 = ₹210.71 crore

Under stressed correlation, the firm's AUM capacity falls from ₹228.96 crore to ₹210.71 crore — a reduction of ₹18.25 crore (8.0%). This is the "tail-correlation drag" the firm must build into its risk-appetite framework.

Strategic Insight: A naive risk budget that allocates the firm-wide VaR cap proportionally to standalone VaRs leaves capital permanently under-utilised. A correlation-aware risk budget unlocks more AUM but creates fragility in stress — both effects must be sized and disclosed to investment committees.

Question 5 — Evaluation of Financial Risk from Three Perspectives (NBFC Case)

Bharat Capital Finance Ltd. (BCFL) is a listed mid-sized Non-Banking Financial Company (NBFC). The following data has been compiled from its latest annual report (₹ Crore):

Particulars	₹ Crore
Total Assets	15,000
Loan Portfolio (Net)	12,500
of which Real-Estate Developer Loans	10,000 (80%)
of which Personal Loans	2,500 (20%)
Total Borrowings	11,500
of which Short-Term Commercial Paper	6,900 (60%)
of which Term Loans from Banks	4,600 (40%)
Net Worth (Shareholders' Funds)	2,500
Net Profit After Tax (FY26)	450
Total Interest Expense (FY26)	920

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Particulars	₹ Crore
Profit Before Tax (FY26)	600
Gross NPA	3.80%
Net NPA	1.90%

Key contextual facts:

- 92% of real-estate developer loans are exposed to Tier-2 and Tier-3 cities; the segment is currently undergoing a slowdown.
- The average tenure of real-estate developer loans is 4–5 years; the average tenure of CP funding is 90–120 days.
- Industry peers (CRISIL AA-rated NBFCs) typically maintain a debt-to-equity of 3.5x and a CP-to-total-borrowings ratio below 35%.
- The RBI has, in recent months, signalled tighter scrutiny of NBFC asset-liability mismatches and concentration risk, citing IL&FS (2018) and DHFL (2019) as cautionary precedents.

Required:

(i) Compute the key risk-evaluation metrics: Debt-to-Equity (Gearing), Interest Coverage Ratio, and the implied CP rollover concentration. Comment briefly on each relative to industry peers.

(ii) Evaluate the financial risk of BCFL using the ICAI SM Section 2 framework — from the perspectives of (a) Equity Shareholders, (b) Lenders, and (c) Government / Regulator. For each perspective, identify the specific risks of concern and the indicators they would track.

(iii) Identify the two most critical financial risk sub-categories (per ICAI SM Para 1.4) at play in BCFL's situation, and recommend management actions for each.

(iv) Conclude with a brief view: is BCFL a sustainable NBFC, a "watch-list" entity, or a candidate for a future systemic event? Justify in two-three lines.

Solution

(i) Key Risk-Evaluation Metrics

Metric	Formula	BCFL	Industry Benchmark	Inference
Debt-to-Equity (Gearing)	11,500 / 2,500	4.60×	3.5×	Highly leveraged — well above peer median; aggressive
Interest Coverage Ratio	(PBT + Interest) / Interest = (600 + 920) / 920	1.65×	2.0× and above	Tight — limited cushion for interest cost shocks
CP-to-Total-Borrowings	6,900 / 11,500	60.0%	< 35%	Severe ALM mismatch — long-tenor assets funded by short-tenor liabilities
Real-Estate Concentration	10,000 / 12,500	80.0%	Diversified mix typical	Concentration risk — single sector dominance
GNPA / NNPA	—	3.80% / 1.90%	Sector ~2.5% / 1.0%	Asset quality below sector standards

(ii) Three-Perspective Risk Evaluation

(a) From the Equity Shareholder's Perspective (ICAI SM Para 2(a))

The SM emphasises that equity holders view financial gearing as risk because, in winding up, they are last in priority. For BCFL:

- Gearing of 4.6× implies that in a stress event where loan book impairment exceeds 21% (i.e., 2,500/12,500), equity is fully wiped out.

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- However, ROE = 450 / 2,500 = 18% — superficially attractive, but this is leverage-amplified return; on a debt-equity-adjusted basis (ROA = 450/15,000 = 3.0%), the underlying business is unremarkable.
- Real-estate concentration creates equity-cycle exposure: an industry downturn translates directly into NPA stress and equity erosion.

Indicators the equity investor would track: GNPA trajectory, real estate sector indicators (RERA approvals, inventory months, builder cash flow), ROA (not ROE), and equity-to-AUM ratio.

(b) From the Lender's Perspective (ICAI SM Para 2(a) — second sub-point — and Para 2(b))

The SM notes that even for a lender, existing gearing is a risk because a highly-geared company faces a higher probability of default on interest and principal:

- The 1.65× interest coverage offers little buffer if NPAs accelerate. A 100 bps rise in funding cost (₹115 crore) on top of any provisioning increase could push coverage below 1.0×.
- The 60% CP funding represents acute rollover risk — every 90–120 days, BCFL must refinance ₹6,900 crore. A loss of investor confidence (rating downgrade, peer default contagion) could trigger a funding squeeze instantly, as it did with DHFL in 2019.
- Bank lenders (₹4,600 crore term loans) are most exposed because their loans are typically secured by general charge, but CP holders rank pari passu and may withdraw faster.

Indicators the lender would track: CP rollover spreads, rating actions, mutual fund redemption pressure on debt schemes, and quarterly ALM gap reports.

(c) From the Government's / Regulator's Perspective (ICAI SM Para 2(c))

The SM frames this as the failure of any bank or financial institution leading to a spread of distrust in society at large — explicitly invoking Lehman Brothers as the precedent. For BCFL:

- BCFL has ₹4,600 crore of bank loans outstanding — a default would impair multiple banking-system balance sheets simultaneously.
- The 60% CP exposure connects BCFL to debt mutual funds, whose retail investors face mark-to-market losses; a default would trigger redemption panic across the NBFC debt fund category.
- Real estate concentration links BCFL distress to a broader real-estate slowdown — already a sectoral concern.
- The IL&FS (2018) and DHFL (2019) precedents demonstrate exactly how an NBFC's failure can cascade into the banking system, the debt mutual fund industry, and ultimately the real economy via construction-sector employment.

Indicators the RBI would track: systemic interconnectedness scores, LCR (liquidity coverage ratio), behavioural ALM gaps, large exposure to real-estate sector concentration limits.

(iii) Two Most Critical Financial Risk Sub-Categories (per ICAI SM Para 1.4)

Critical Risk 1 — Liquidity Risk (ICAI SM Para 1.4.5)

The SM specifically calls out that liquidity risk arises from mismatch in cash flow generation patterns and is most prevalent in banking-style businesses. BCFL is a textbook case: 4–5 year asset tenors funded by 90–120 day liabilities. The gap between asset maturity and liability maturity is the single most existential risk to BCFL.

Management Actions:

- Reduce CP share from 60% to below 35% by termming-out funding via NCDs of 3–5 year maturity.
- Establish committed bank lines for emergency liquidity.
- Build a Liquidity Coverage Ratio (LCR) buffer of 100% of next-90-day outflows.
- Implement daily behavioural ALM gap monitoring with hard limits at the ALCO level.

Critical Risk 2 — Counter-Party Risk (ICAI SM Para 1.4.1)

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The 80% real-estate developer concentration translates directly to counter-party risk: BCFL's borrowers are real-estate developers, and the SM identifies counter-party risk hints including "failure to obtain necessary resources to complete the project" (Para 4.1(a)) — precisely the situation of distressed real-estate developers today.

Management Actions:

- Cap real-estate developer concentration at 50% of loan book; build personal-loan and SME-loan portfolios.
- Tighten developer credit appraisal: minimum RERA registration, escrow account control on receivables, restrictive project-cost coverage covenants.
- Move provisioning policy from regulatory minimum to expected-credit-loss methodology with sector overlay.
- Establish a stressed-borrower workout team to manage the existing portfolio actively.

(iv) Concluding View

BCFL is a watch-list entity bordering on systemic-risk relevance. The fundamentals (ROA of 3%, GNPA of 3.8%) are not yet alarming, but the structural fragility — 4.6× gearing, 60% CP funding, 80% real estate concentration, and 1.65× interest coverage — collectively means a single trigger event (a peer default, a rating downgrade, a major developer bankruptcy) could escalate into a DHFL-style funding crisis within weeks. The next 12–18 months will determine whether BCFL recapitalises and restructures, or joins the cautionary list.

Question 6

Suppose that the change in the value of a portfolio over a one-day time period is normal with a mean of zero and a standard deviation of $2 million; what is (a) the one-day 97.5% VaR, (b) the five-day 97.5% VaR, and (c) the five-day 99% VaR?

(Risk Management and Financial Institutions, John C Hull)

Answer 6: 2 × 1.96 = $3.92 million, (b) √ 5 × 2 × 1.96 = $8.77 million, (c) √ 5 × 2 × 2.33 = 10.40 million

Question 7

Suppose that each of two investments has a 4% chance of a loss of $10 million, a 2% chance of a loss of $1 million, and a 94% chance of a profit of $1 million. They are independent of each other.

(a) What is the VaR for one of the investments when the confidence level is 95%?

(b) What is the expected shortfall when the confidence level is 95%?

(Risk Management and Financial Institutions, John C Hull)

Answer7:

a) A loss of $1 million extends from the 94 percentile point of the loss distribution to the 96-percentile point. The 95% VaR is therefore $1 million.

(b) The expected shortfall for one of the investments is the expected loss conditional that the loss is in the 5 percent tail. Given that we are in the tail there is a 20% chance that the loss is $1million and an 80% chance that the loss is $10 million. The expected loss is therefore $8.2 million. This is the expected shortfall.

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CHAPTER 3 — ADVANCED CAPITAL BUDGETING DECISIONS

Question 1 — Multi-Variable Sensitivity with Break-Even Analysis

PrimeTech Ltd. is launching a new product. The base-case projections are (₹ in lakh):

Parameter	Value
Initial Investment	2,000
Project Life	5 years
Annual Sales Volume	5,00,000 units
Selling Price per Unit	₹400
Variable Cost per Unit	₹240
Annual Fixed Cost (excluding depreciation)	₹100 lakh
Depreciation (Straight-line on initial outlay)	₹400 lakh per annum
Tax Rate	30%
Cost of Capital	12%

PVAF (12%, 5) = 3.605.

Required:

(i) Compute the base-case NPV.

(ii) Compute the break-even sensitivity (the percentage adverse change at which NPV = 0) for each of the following variables, holding all others constant: (a) Initial Investment (b) Selling Price per Unit (c) Variable Cost per Unit (d) Sales Volume (e) Annual Fixed Cost.

(iii) Rank the variables from most sensitive to least sensitive.

(iv) Advise management on which variables warrant the most rigorous monitoring during project execution.

Solution

(i) Base-Case NPV

Item	Computation	₹ Lakh
Revenue	5,00,000 × 400	2,000
Variable Cost	5,00,000 × 240	1,200
Contribution	2,000 − 1,200	800
Less: Fixed Cost		100
EBITDA		700
Less: Depreciation		400
EBT		300
Less: Tax @ 30%		90
EAT		210
Add: Depreciation		400
Annual Cash Flow		**610**
PV of Annual CF	610 × 3.605	2,199.05
Less: Initial Investment		2,000
Base-Case NPV		**₹199.05 lakh**

(ii) Break-Even Sensitivity for Each Variable

For NPV to equal zero, PV of CF must equal ₹2,000 lakh, i.e., break-even CF = 2,000 / 3.605 = ₹554.79 lakh. The reduction needed in CF = 610 − 554.79 = ₹55.21 lakh.

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(a) Initial Investment:

At unchanged CF of 610, PV of CF = 2,199.05. NPV becomes zero when investment rises to 2,199.05.

% Sensitivity = (2,199.05 – 2,000) / 2,000 = 9.95%

(b) Selling Price per Unit:

Let break-even price = P. CF = (5P − 1,700) × 0.70 + 400 = 3.5P − 790

Setting CF = 554.79: 3.5P = 1,344.79 → P = ₹384.23

% Sensitivity = (400 – 384.23) / 400 = 3.94%

(c) Variable Cost per Unit:

Let break-even VC = Vc. CF = (1,500 − 5Vc) × 0.70 + 400 = 1,450 − 3.5Vc

Setting CF = 554.79: 3.5Vc = 895.21 → Vc = ₹255.78

% Sensitivity = (255.78 – 240) / 240 = 6.57%

(d) Sales Volume:

Let break-even volume = V lakh units. CF = (160V − 500) × 0.70 + 400 = 112V + 50

Setting CF = 554.79: 112V = 504.79 → V = 4.507 lakh units

% Sensitivity = (5 – 4.507) / 5 = 9.86%

(e) Annual Fixed Cost:

Let break-even FC = F. CF = (400 − F) × 0.70 + 400 = 680 − 0.7F

Setting CF = 554.79: 0.7F = 125.21 → F = ₹178.87 lakh

% Sensitivity = (178.87 – 100) / 100 = 78.87%

(iii) Sensitivity Ranking

Rank	Variable	% Adverse Change to Wipe Out NPV
1 (Most sensitive)	Selling Price per Unit	3.94%
2	Variable Cost per Unit	6.57%
3	Sales Volume	9.86%
4	Initial Investment	9.95%
5 (Least sensitive)	Annual Fixed Cost	78.87%

(iv) Management Advisory

The project's profitability is most fragile to selling price erosion — a mere 3.94% price cut wipes out the entire NPV. Variable cost is the second most critical variable, followed closely by volume and initial outlay. Fixed costs offer enormous cushion (almost 79% buffer).

Management should therefore prioritise:

- **(i)** Pricing discipline — establish minimum sale price guardrails, monitor competitive pricing daily, and avoid promotional discounts beyond 2–3%.
- **(ii)** Variable cost control — lock-in supplier contracts for raw materials, hedge any commodity exposure, and maintain visibility on per-unit cost movements.
- **(iii)** Volume protection — invest in distribution, demand generation, and channel relationships.

Fixed costs (the easy lever) can be considered the last place to cut — the project can absorb almost 80% increase in fixed costs before turning negative.

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Question 2 — Scenario Analysis with CV-based Risk-Adjusted Discount Rate

GreenLogix Ltd. is evaluating a solar EPC project. The expected outcomes depend on demand:

Scenario	Probability	Annual Cash Flow (₹ Lakh)
Low Demand	0.25	220
Base Demand	0.50	320
High Demand	0.25	420

Project details: Initial investment ₹800 lakh, life 4 years, no salvage, base cost of capital 10%.

The company applies a risk-adjusted discount rate based on the project's coefficient of variation (CV). The table below is used:

CV of NPV	Risk-Adjusted Discount Rate	PVAF (4 yr)
0.0	8%	3.312
0.4	10%	3.170
0.8	12%	3.037
1.2	14%	2.914
1.6	16%	2.798
2.0	18%	2.690

Convention: When the computed CV falls between two table rows, select the next higher row (conservative approach).

Required:

(i) Compute the NPV under each scenario at the base cost of capital of 10%.

(ii) Compute the expected NPV (E[NPV]).

(iii) Compute the standard deviation and coefficient of variation of NPV.

(iv) Identify the appropriate risk-adjusted discount rate.

(v) Recompute the expected NPV using the risk-adjusted discount rate.

(vi) Decide whether the project should be accepted.

Solution

(i) Scenario-wise NPVs at 10% Discount Rate

PVAF (10%, 4) = 3.170.

Scenario	Annual CF	PV of CF	NPV
Low	220	220 × 3.170 = 697.40	697.40 − 800 = −102.60
Base	320	320 × 3.170 = 1,014.40	1,014.40 − 800 = +214.40
High	420	420 × 3.170 = 1,331.40	1,331.40 − 800 = +531.40

(ii) Expected NPV

E[NPV] = 0.25 × (−102.60) + 0.50 × (214.40) + 0.25 × (531.40)

= −25.65 + 107.20 + 132.85 = ₹214.40 lakh

(iii) Standard Deviation and CV

Scenario	Probability	NPV − E[NPV]	(NPV − E[NPV])²	Prob × (Dev)²
Low	0.25	−317.00	1,00,489	25,122.25
Base	0.50	0	0	0
High	0.25	+317.00	1,00,489	25,122.25
			Variance	**50,244.50**

SD = √50,244.50 = ₹224.15 lakh

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CV = SD / E[NPV] = 224.15 / 214.40 = 1.0455

(iv) Risk-Adjusted Discount Rate Selection

CV of 1.0455 falls between table rows 0.8 and 1.2. Applying the conservative convention, the next higher row (CV = 1.2) is selected:

- Risk-Adjusted Discount Rate = 14%
- PVAF (14%, 4) = 2.914

(v) Recomputed Expected NPV at 14%

Expected Annual CF = 0.25(220) + 0.50(320) + 0.25(420) = 55 + 160 + 105 = ₹320 lakh

E[NPV] at 14% = 320 × 2.914 − 800 = 932.48 − 800 = ₹132.48 lakh

(vi) Decision

The project's expected NPV at the risk-adjusted discount rate of 14% is ₹132.48 lakh — positive even after the risk premium of 400 bps above the base cost of capital has been applied. The project should be accepted.

A secondary insight: at the base 10% discount rate, the NPV was ₹214.40 lakh; after risk adjustment, it falls by ₹81.92 lakh (about 38%). This is the implicit "price of risk" — the amount of value sacrificed by being conservative. If the firm can take actions to reduce CV (e.g., long-term offtake contracts to make cash flows more certain), it can recapture some of this lost value.

Question 3 — Optimum Replacement Cycle (5-Year Horizon)

PowerGen Ltd. operates industrial compressors that must be replaced periodically. The following data has been compiled (₹ in lakh):

Year of Age	Maintenance Cost	Repair Cost	Salvage Value (end of year)
1	4	0	38
2	5	1	32
3	7	2	26
4	10	5	14
5	14	8	6

The purchase price of a new compressor is ₹50 lakh. Maintenance and repair costs are incurred at year-end. The company's cost of capital is 12%.

PVF at 12%: Y1 = 0.893, Y2 = 0.797, Y3 = 0.712, Y4 = 0.636, Y5 = 0.567.

PVAF at 12%: 1-year = 0.893, 2-year = 1.690, 3-year = 2.402, 4-year = 3.038, 5-year = 3.605.

Required:

(i) Compute the Equivalent Annual Cost (EAC) for replacement cycles of 1, 2, 3, 4, and 5 years.

(ii) Recommend the optimum replacement cycle.

(iii) Comment on the sensitivity of the recommendation — i.e., how confident is the choice?

Solution

Step 1 — Net Annual Cash Flow (₹ Lakh)

Annual maintenance + repair cost (M+R):

- Y1: 4 + 0 = 4
- Y2: 5 + 1 = 6
- Y3: 7 + 2 = 9
- Y4: 10 + 5 = 15

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- Y5: 14 + 8 = 22

Step 2 — Net PV of Outflow for Each Replacement Cycle (₹ Lakh)

For each cycle ending in Year n: Net PV = Purchase + Σ (M+R)t × PVFt − Salvage Yn × PVFn

Cycle (years)	Initial	PV of M+R	PV of Salvage	Net PV Outflow
1	50	4 × 0.893 = 3.572	38 × 0.893 = 33.934	50 + 3.572 − 33.934 = 19.638
2	50	4×0.893 + 6×0.797 = 8.354	32 × 0.797 = 25.504	50 + 8.354 − 25.504 = 32.850
3	50	8.354 + 9×0.712 = 14.762	26 × 0.712 = 18.512	50 + 14.762 − 18.512 = 46.250
4	50	14.762 + 15×0.636 = 24.302	14 × 0.636 = 8.904	50 + 24.302 − 8.904 = 65.398
5	50	24.302 + 22×0.567 = 36.776	6 × 0.567 = 3.402	50 + 36.776 − 3.402 = 83.374

Step 3 — Equivalent Annual Cost (EAC)

EAC = Net PV Outflow / PVAF (n years)

Cycle	Net PV Outflow	PVAF	EAC (₹ Lakh)
1 year	19.638	0.893	21.99
2 years	32.850	1.690	19.44
3 years	**46.250**	**2.402**	**19.25 (Minimum)**
4 years	65.398	3.038	21.53
5 years	83.374	3.605	23.13

(ii) Optimum Replacement Cycle

The lowest EAC of ₹19.25 lakh is achieved at the 3-year replacement cycle. The compressor should therefore be replaced every 3 years.

(iii) Sensitivity of the Recommendation

The EAC profile is U-shaped: it falls from Year 1 to Year 3, then rises sharply. The choice between Year 2 (EAC ₹19.44) and Year 3 (EAC ₹19.25) is marginal — only ₹0.19 lakh per year difference (~1%). By contrast, the EAC jumps by ₹2.28 lakh moving from Year 3 to Year 4, a clear discontinuity.

Three observations:

(i) The 2-year and 3-year cycles are economically very close. If operational disruption from replacement is a concern (downtime cost, training cost), the 3-year cycle offers identical economics with one-third fewer changeovers.

(ii) Replacement beyond Year 3 deteriorates rapidly. The compressor faces a cliff between Years 3 and 4 — the M+R cost jumps from ₹9 to ₹15 lakh while salvage falls from ₹26 to ₹14 lakh. This cliff is what makes Year 3 the unambiguous "last good year."

(iii) Sensitivity analysis: If cost of capital rises to say 15%, the PVFs change, but the relative ordering would likely preserve (because the cost cliff is sharp). However, if salvage values prove to be 10% lower than estimated (e.g., due to secondary market weakness), the Year 1 and Year 2 cycles become more attractive — worth a stress test.

Question 4 — Adjusted Present Value (APV) Method

NeoMobility Ltd. is evaluating an electric vehicle component manufacturing project with the following details (₹ in crore):

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Parameter	Value
Initial Investment	500
Project Life	5 years
Annual EBIT (after depreciation)	150
Tax Rate	25%
Annual Depreciation (Straight-line)	100
Salvage Value at End of Year 5	Nil
Unlevered Cost of Equity (K_u)	15%

Financing Plan:

- Debt: ₹300 crore at 9% interest, with bullet principal repayment at end of Year 5 (interest paid annually throughout)
- Equity: ₹200 crore

PVAF (15%, 5) = 3.352; PVAF (9%, 5) = 3.890.

Required:

(i) Compute the Base-Case NPV assuming the project is all-equity financed (using the Unlevered Cost of Equity).

(ii) Compute the PV of Tax Shield on interest payments.

(iii) Compute the Adjusted Present Value (APV).

(iv) Discuss why APV is preferred over the traditional WACC method in financing situations where the debt structure is not a constant proportion of project value.

Solution

(i) Base-Case NPV (Unlevered)

Annual operating cash flow:

Item	₹ Crore
EBIT (after depreciation)	150.0
Less: Tax @ 25%	37.5
Profit After Tax	112.5
Add: Depreciation	100.0
Operating Cash Flow	**212.5**

PV of operating cash flows = 212.5 × 3.352 = ₹712.30 crore

Base-Case NPV = 712.30 − 500 = ₹212.30 crore

(ii) PV of Interest Tax Shield

Annual interest = ₹300 crore × 9% = ₹27 crore (constant, since principal is bullet)

Annual tax shield on interest = 27 × 0.25 = ₹6.75 crore

PV of tax shield = 6.75 × PVAF (9%, 5) = 6.75 × 3.890 = ₹26.26 crore

(The interest tax shield is discounted at the pre-tax cost of debt, since the tax shield risk profile aligns with the debt itself.)

(iii) Adjusted Present Value

Component	₹ Crore
Base-Case NPV (Unlevered)	212.30
Add: PV of Interest Tax Shield	26.26
Adjusted Present Value (APV)	**238.56**

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(iv) Why APV is Preferred Over WACC in This Scenario

The traditional WACC method makes a critical assumption: that the debt-to-value ratio remains constant throughout the project life. This holds in textbook examples where the firm is in steady state and rebalances its capital structure to a target leverage. However, in this scenario:

(i) Debt level is constant in absolute terms (₹300 crore), not as a proportion. As the project generates cash flows, the project value declines over time (since remaining future cash flows shrink). With debt held at ₹300 crore, the D/V ratio rises mechanically toward Year 5 — violating the WACC assumption.

(ii) APV elegantly separates the two decisions. The investment decision (is the project worth doing on its own merits?) is evaluated at the unlevered cost of equity, isolated from how it's funded. The financing decision (how should we capitalise it?) is then valued separately as the PV of tax shields. This separation is what gives APV its name — "adjusted" by the financing-specific effects.

(iii) APV is robust to non-standard debt structures. When projects have unusual debt features — bullet repayments, sculpted amortization, interest moratoria, government subsidies, project-specific financing — WACC misprices because it can't disentangle these. APV simply adds another term for each financing feature.

(iv) In ICAI's framework, the APV formula in this chapter is the simple form: Base Case NPV + PV of Tax Shield on Interest. The full APV model (in IFM Chapter, Section 1.5) extends with PV of Interest Subsidies and adjustments for blocked funds in international projects.

Question 5 — Real-Terms NPV Methodology

BharatPharma Ltd. is evaluating a new sterile manufacturing line. The CFO wants the NPV computed using the real-terms approach (real cash flows discounted at the real cost of capital), with explicit treatment of the nominal depreciation tax shield.

Project details (₹ in lakh):

Item	Value
Cost of Plant & Machinery	120
Working Capital Requirement (unchanged through life)	30
Project Life	5 years
Salvage Value	Nil
Annual Operating Income before Tax (real terms)	55
Tax Rate	30%
Inflation Rate	5% p.a.
Real Cost of Capital	12% p.a.
Depreciation Method	Straight-line on initial plant cost

Note: Operating income is given in real (today's price) terms. Working capital is set up at the start and released in full at the end of Year 5 at its original ₹30 lakh nominal value (no inflation revision).

PVF at 12% (real discount rate): Y1 = 0.893, Y2 = 0.797, Y3 = 0.712, Y4 = 0.636, Y5 = 0.567. PVAF (12%, 5) = 3.605.

PVF at 5% (used for deflation to real terms): Y1 = 0.952, Y2 = 0.907, Y3 = 0.864, Y4 = 0.823, Y5 = 0.784.

Required:

(i) Compute the NPV using the REAL-TERMS approach. Show the deflation of the nominal depreciation tax shield and the working capital release before discounting.

(ii) Verify the result using the NOMINAL-TERMS approach (nominal cash flows discounted at the nominal cost of capital).

(iii) Advise the company whether the project should be accepted.

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(iv) Briefly explain why the depreciation tax shield must be deflated to real terms when using the real-terms approach.

Solution

(i) Real-Terms NPV Approach

Step 1 — Initial Outlay

Cash outflow at Year 0 = Plant + WC = 120 + 30 = ₹150 lakh

Step 2 — Present Value of Real CFAT (Operating Income After Tax)

Real CFAT per year = 55 × (1 − 0.30) = ₹38.50 lakh (constant in real terms throughout the 5 years)

PV of real CFAT = 38.50 × PVAF(12%, 5) = 38.50 × 3.605 = ₹138.79 lakh

Step 3 — Present Value of Depreciation Tax Shield

Nominal depreciation per year = 120 / 5 = ₹24 lakh (constant in nominal terms — based on historical cost)

Nominal tax saving per year = 24 × 0.30 = ₹7.20 lakh

This nominal saving must be deflated to real terms (since the discount rate is real) by multiplying with the PVF at the inflation rate of 5%.

Year	Nominal Tax Saving (₹ Lakh)	Inflation Factor @ 5%	Real Tax Saving (₹ Lakh)	PVF @ 12%	PV (₹ Lakh)
1	7.20	0.952	6.854	0.893	6.121
2	7.20	0.907	6.530	0.797	5.205
3	7.20	0.864	6.221	0.712	4.429
4	7.20	0.823	5.926	0.636	3.769
5	7.20	0.784	5.645	0.567	3.201
				PV of Tax Shield	**22.725**

Step 4 — Present Value of Working Capital Release

WC released at end of Year 5 (nominal terms, unchanged): ₹30 lakh

Real WC release at Year 5: 30 × 0.784 (PVF @ 5%) = ₹23.52 lakh

PV at real 12%: 23.52 × 0.567 = ₹13.34 lakh

Step 5 — NPV Computation

Particulars	₹ Lakh
Initial Outlay	(150.00)
PV of Real CFAT (Operating)	138.79
PV of Depreciation Tax Shield (deflated)	22.73
PV of Working Capital Release (deflated)	13.34
Net Present Value (NPV)	**+24.86**

(ii) Verification using Nominal-Terms Approach

Nominal cost of capital = (1 + Real Rate)(1 + Inflation) − 1 = (1.12)(1.05) − 1 = 17.60%

Operating income (nominal) inflates at 5% each year. After-tax: multiply by 0.70. Then add the (constant nominal) ₹7.20 lakh depreciation tax shield.

Year	Nominal Op Income	After Tax (×0.70)	+ Dep Tax Shield	Total Nominal CF
1	55 × 1.05 = 57.75	40.425	7.20	47.625
2	55 × 1.1025 = 60.638	42.446	7.20	49.646
3	55 × 1.1576 = 63.669	44.569	7.20	51.769

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Year	Nominal Op Income	After Tax (×0.70)	+ Dep Tax Shield	Total Nominal CF
4	55 × 1.2155 = 66.853	46.797	7.20	53.997
5	55 × 1.2763 = 70.196	49.137	7.20	56.337

PVF at nominal 17.60%: Y1 = 0.8503, Y2 = 0.7231, Y3 = 0.6149, Y4 = 0.5228, Y5 = 0.4446.

Year	Nominal CF	PVF @ 17.60%	PV (₹ Lakh)
1	47.625	0.8503	40.50
2	49.646	0.7231	35.90
3	51.769	0.6149	31.83
4	53.997	0.5228	28.23
5	56.337	0.4446	25.05
5 (WC release)	30.000	0.4446	13.34
		Total PV	**174.85**

NPV (Nominal Method) = 174.85 − 150.00 = +₹24.85 lakh

The two methods produce identical NPV (within rounding). This confirms the equivalence: real cash flows discounted at the real rate, and nominal cash flows discounted at the nominal rate, will always yield the same NPV.

(iii) Recommendation

The project should be accepted. NPV is positive at ₹24.86 lakh under both methodologies.

(iv) Why the Depreciation Tax Shield Must Be Deflated

The depreciation tax shield is a nominal cash flow — it is fixed at ₹7.20 lakh per year in rupee terms throughout the project life because depreciation is computed on historical (un-inflated) cost. Over five years of 5% inflation, the real purchasing power of this ₹7.20 lakh declines progressively.

If the analyst were to discount the nominal ₹7.20 lakh at the real rate of 12%, the tax shield would be over-valued. Conversely, if everything else is in real terms but the tax shield is left in nominal terms, the apples-and-oranges mismatch produces a biased NPV.

The correct treatment is therefore: deflate the nominal tax shield to real terms (multiply by PVF at the inflation rate), then discount at the real cost of capital. This is exactly the ICAI methodology demonstrated in the May 2025 BC Ltd. suggested answer.

Question 6 — Back-Solve for Maximum Plant Investment

Catalyst Industries Ltd. is evaluating a pharmaceutical contract manufacturing plant. The Board has asked the CFO to determine the maximum plant cost the company can incur such that the project breaks even on an NPV basis (i.e., NPV = 0).

Project parameters (₹ in lakh):

Item	Value
Project Life	5 years
Salvage Value at end of Year 5	Nil
Tax Rate	30%
Cost of Capital	12%
Depreciation Method	Straight-line (20% of plant cost per year)

Sales and expense projections:

Year	Expected Sales (₹ Lakh)	Operating Expenses (60% of Sales) (₹ Lakh)
1	200	120
2	240	144

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Year	Expected Sales (₹ Lakh)	Operating Expenses (60% of Sales) (₹ Lakh)
3	280	168
4	320	192
5	360	216

PVF at 12%: Y1 = 0.893, Y2 = 0.797, Y3 = 0.712, Y4 = 0.636, Y5 = 0.567. PVAF (12%, 5) = 3.605.

Required:

(i) Let P denote the maximum plant cost. Express each year's after-tax cash flow as a function of P.

(ii) Compute the present value of these cash flows and determine P such that NPV = 0 (using DISCOUNTED cash flows at 12%).

(iii) Compute the value of P using the UNDISCOUNTED method (sum of all undiscounted cash flows = plant cost), as ICAI sometimes presents the alternative.

(iv) Compare the two values of P and explain the gap. Which method should be used in a rigorous capital budgeting exercise?

Solution

(i) Cash Flow Expressed as a Function of P

Annual depreciation = 0.20P (Straight-line)

Profit before tax (PBT) = Sales − Operating Expenses − Depreciation = (Sales − Exp) − 0.20P

Profit after tax (PAT) = PBT × (1 − 0.30) = 0.70 × PBT

Cash Flow = PAT + Depreciation (since depreciation is non-cash)

After algebraic simplification: CF = 0.70 × (Sales − Exp) + 0.06P

(The 0.06P term is the depreciation tax shield: 0.20P × 0.30 = 0.06P)

Year	Sales − Exp (₹ Lakh)	0.70 × (Sales − Exp)	Dep Tax Shield	Annual CF (₹ Lakh)
1	80	56.0	0.06P	56.0 + 0.06P
2	96	67.2	0.06P	67.2 + 0.06P
3	112	78.4	0.06P	78.4 + 0.06P
4	128	89.6	0.06P	89.6 + 0.06P
5	144	100.8	0.06P	100.8 + 0.06P
Total	**560**	**392.0**	**0.30P**	**392.0 + 0.30P**

(ii) Discounted Cash Flow Method (Rigorous Approach)

Year	Annual CF	PVF @ 12%	PV (₹ Lakh)
1	56.0 + 0.06P	0.893	50.008 + 0.05358P
2	67.2 + 0.06P	0.797	53.558 + 0.04782P
3	78.4 + 0.06P	0.712	55.821 + 0.04272P
4	89.6 + 0.06P	0.636	56.986 + 0.03816P
5	100.8 + 0.06P	0.567	57.154 + 0.03402P
Total PV			**273.527 + 0.21630P**

Setting NPV = 0: Total PV of inflows = Plant cost

273.527 + 0.21630P = P

273.527 = P − 0.21630P = 0.78370P

P = 273.527 / 0.78370 = ₹349.02 lakh

Maximum plant investment (discounted method): ₹349.02 lakh — rounded to ₹349 lakh.

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(iii) Undiscounted Method (Alternative)

If we ignore the time value of money (as the ICAI Nov 2024 PQ Ltd. answer does in its primary solution), the equation becomes:

Sum of all undiscounted cash flows = Plant cost

392.0 + 0.30P = P

392.0 = P − 0.30P = 0.70P

P = 392.0 / 0.70 = ₹560.00 lakh

(iv) Comparison and Recommendation

Method	Maximum P (₹ Lakh)	Difference from Discounted (₹ Lakh)
Discounted at 12%	349.02	—
Undiscounted	560.00	+210.98

The undiscounted method overstates the permissible investment by ₹210.98 lakh — a 60% inflation of the rigorous answer. The reason: undiscounted summation treats a rupee in Year 5 as equivalent to a rupee in Year 1, ignoring the opportunity cost of capital.

The discounted method (₹349.02 lakh) is the rigorous answer for any commercial capital budgeting decision, since:

(i) Capital has an opportunity cost. ₹560 lakh deployed today could earn 12% elsewhere — the discounted analysis accounts for this, the undiscounted does not.

(ii) If the company invests ₹560 lakh based on the undiscounted method, the project will have a substantially NEGATIVE NPV (approximately −₹148 lakh, computed as 273.527 + 0.21630 × 560 − 560 = 273.527 + 121.13 − 560 = −165.34 lakh). The project would destroy shareholder value.

(iii) ICAI itself notes in the Nov 2024 suggested answer that the discounted version (using 10% in their case) is the alternative-but-correct approach. The undiscounted version is shown only because the original question did not specify a discount rate.

Final Recommendation: Maximum permissible plant investment = ₹349 lakh (discounted method at 12%).

Question 7 — Hillier's Model for NPV Variability

Apex Pharma Ltd. is evaluating a 3-year R&D project with uncertain cash flows in each year. The CFO has asked for a risk assessment using Hillier's model, which computes the standard deviation of NPV under two distinct assumptions about how cash flows are related across time.

Project details (₹ in lakh):

Item	Value
Initial Investment (Year 0)	100
Project Life	3 years
Salvage Value	Nil
Risk-Free Discount Rate	10%

Probability distributions of annual cash flows (₹ in lakh):

Year 1		Year 2		Year 3	
Cash Flow	Probability	Cash Flow	Probability	Cash Flow	Probability
30	0.30	30	0.20	40	0.10
50	0.50	60	0.50	70	0.60
70	0.20	90	0.30	100	0.30

PVF at 10%: Y1 = 0.909, Y2 = 0.826, Y3 = 0.751.

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PVF squared (i.e., 1/(1.10)^2t): Y1 = 0.826, Y2 = 0.683, Y3 = 0.564.

Required:

(i) Compute the expected cash flow and standard deviation for each year.

(ii) Compute the expected NPV of the project.

(iii) Compute the standard deviation of NPV assuming cash flows are INDEPENDENT over time (Hillier's independent-flows formula).

(iv) Compute the standard deviation of NPV assuming cash flows are PERFECTLY CORRELATED over time (Hillier's correlated-flows formula).

(v) Compute the coefficient of variation under both assumptions and interpret the difference.

(vi) Comment on which assumption is more realistic and when each applies.

Solution

(i) Expected Cash Flow and Standard Deviation per Year

Year 1:

Mean = 30(0.30) + 50(0.50) + 70(0.20) = 9 + 25 + 14 = ₹48 lakh

Variance = $0.30(30-48)^2 + 0.50(50-48)^2 + 0.20(70-48)^2$

= 0.30(324) + 0.50(4) + 0.20(484) = 97.2 + 2 + 96.8 = 196

SD (Year 1) = √196 = ₹14 lakh

Year 2:

Mean = 30(0.20) + 60(0.50) + 90(0.30) = 6 + 30 + 27 = ₹63 lakh

Variance = $0.20(30-63)^2 + 0.50(60-63)^2 + 0.30(90-63)^2$

= 0.20(1089) + 0.50(9) + 0.30(729) = 217.8 + 4.5 + 218.7 = 441

SD (Year 2) = √441 = ₹21 lakh

Year 3:

Mean = 40(0.10) + 70(0.60) + 100(0.30) = 4 + 42 + 30 = ₹76 lakh

Variance = $0.10(40-76)^2 + 0.60(70-76)^2 + 0.30(100-76)^2$

= 0.10(1296) + 0.60(36) + 0.30(576) = 129.6 + 21.6 + 172.8 = 324

SD (Year 3) = √324 = ₹18 lakh

(ii) Expected NPV

Year	Mean CF (₹ Lakh)	PVF @ 10%	PV of Mean CF (₹ Lakh)
1	48	0.909	43.632
2	63	0.826	52.038
3	76	0.751	57.076
		Total PV	**152.746**

Expected NPV = 152.746 − 100 = ₹52.75 lakh

(iii) SD of NPV — Independent Cash Flows

Hillier's formula for independent cash flows:

$\sigma^2(NPV) = \Sigma\ \sigma_t^2 / (1 + r)^{(2t)}$

Year	σ_t (₹ Lakh)	σ_t^2 (₹² Lakh²)	$1 / (1.10)^{(2t)}$	$\sigma_t^2 \times (PVF)^2$ (₹² Lakh²)
1	14	196	0.826	161.896
2	21	441	0.683	301.203

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Year	σ_t (₹ Lakh)	σ_t² (₹² Lakh²)	1 / (1.10)^(2t)	σ_t² × (PVF)² (₹² Lakh²)
3	18	324	0.564	182.736
			σ²(NPV)	**645.835**

σ(NPV) = √645.835 = ₹25.41 lakh

(iv) SD of NPV — Perfectly Correlated Cash Flows

Hillier's formula for perfectly correlated cash flows:

σ(NPV) = Σ σ_t / (1 + r)^t

Year	σ_t (₹ Lakh)	PVF @ 10%	σ_t × PVF (₹ Lakh)
1	14	0.909	12.726
2	21	0.826	17.346
3	18	0.751	13.518
		σ(NPV)	**43.590**

σ(NPV) = ₹43.59 lakh

(v) Coefficient of Variation Comparison

Assumption	Expected NPV	SD (NPV)	Coefficient of Variation
Independent over time	₹52.75 lakh	₹25.41 lakh	0.482
Perfectly Correlated over time	₹52.75 lakh	₹43.59 lakh	0.826

The perfectly correlated case shows nearly DOUBLE the standard deviation and coefficient of variation. This is because under correlation, a low cash flow in Year 1 cascades into low cash flows in Years 2 and 3 — there is no offsetting effect. Under independence, a poor Year 1 may be balanced by a strong Year 2 or 3 (and vice versa), reducing the overall dispersion of NPV outcomes.

(vi) Which Assumption is More Realistic?

The choice between independent and correlated cash flows depends on the underlying business economics:

(i) INDEPENDENT cash flows are appropriate when each year's outcome is driven by year-specific random factors with no carry-over effect. Examples: monsoon-dependent agricultural projects, ad-hoc government tenders where each year's win is independent of the prior year, seasonal hospitality projects in different micro-markets.

(ii) PERFECTLY CORRELATED cash flows are appropriate when there is strong momentum or path-dependence. Examples: a new pharmaceutical drug (if early reception is strong, subsequent years tend to be strong too — and vice versa); a software-as-a-service product (initial adoption drives subsequent renewals); long-cycle infrastructure projects where macroeconomic exposure is consistent year over year.

(iii) Most real-world projects sit between these two extremes — partial correlation rather than perfect independence or perfect correlation. The two Hillier calculations therefore serve as USEFUL BOUNDS on the true risk: actual SD of NPV will lie somewhere between ₹25.41 lakh and ₹43.59 lakh.

(iv) For risk-management purposes, the prudent approach is to use the perfectly-correlated SD (the higher of the two) as a conservative estimate. This protects against the case where the project's underlying risk drivers turn out to be more synchronised than initially assumed — a common cause of capital project failures.

Question 8 — Monte Carlo Simulation

BlueOrbit Tech Pvt. Ltd. is launching a new SaaS product. Both the annual cash flow and the project life are uncertain. The CFO has asked you to perform a Monte Carlo simulation with 5 runs to estimate the project's NPV distribution.

Project details (₹ in lakh):

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Item	Value
Initial Investment	100
Risk-Free Discount Rate	10%

Probability distribution of Annual Cash Flow:

Annual Cash Flow (₹ Lakh)	Probability	Cumulative Probability	Two-Digit Random Number Range
30	0.20	0.20	00 – 19
40	0.50	0.70	20 – 69
50	0.30	1.00	70 – 99

Probability distribution of Project Life:

Project Life (years)	Probability	Cumulative Probability	Two-Digit Random Number Range
3	0.30	0.30	00 – 29
4	0.50	0.80	30 – 79
5	0.20	1.00	80 – 99

Random number pairs for 5 simulation runs (Annual CF Random No., Project Life Random No.):

Run	RN for Annual CF	RN for Project Life
1	45	72
2	08	91
3	76	34
4	23	18
5	61	84

PVAF at 10%: 3 years = 2.487, 4 years = 3.170, 5 years = 3.791.

Required:

(i) Conduct the 5 simulation runs by mapping each random number to the corresponding cash flow value and project life. Compute the NPV for each run.

(ii) Compute the mean NPV across the 5 runs.

(iii) Compute the standard deviation of NPV across the 5 runs.

(iv) Compute the empirical probability of negative NPV based on the simulation.

(v) State the limitations of simulation analysis as articulated in the ICAI SM.

Solution

(i) Simulation Run Results

Run	RN (CF)	Annual CF (₹ Lakh)	RN (Life)	Project Life (yrs)	PVAF @ 10%	NPV (₹ Lakh)
1	45	40	72	4	3.170	40 × 3.170 − 100 = 26.80
2	08	30	91	5	3.791	30 × 3.791 − 100 = 13.73
3	76	50	34	4	3.170	50 × 3.170 − 100 = 58.50
4	23	40	18	3	2.487	40 × 2.487 − 100 = −0.52
5	61	40	84	5	3.791	40 × 3.791 − 100 = 51.64

Random number mapping (illustrative for Run 1): RN 45 falls in range 20-69 → Annual CF = ₹40 lakh. RN 72 falls in range 30-79 → Project Life = 4 years.

(ii) Mean NPV across the 5 Runs

Sum of NPVs = 26.80 + 13.73 + 58.50 + (−0.52) + 51.64 = ₹150.15 lakh

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Mean NPV = 150.15 / 5 = ₹30.03 lakh

(iii) Standard Deviation of NPV

Run	NPV (₹ Lakh)	Deviation from Mean (₹ Lakh)	Squared Deviation (₹² Lakh²)
1	26.80	−3.23	10.43
2	13.73	−16.30	265.69
3	58.50	+28.47	810.54
4	−0.52	−30.55	933.30
5	51.64	+21.61	467.19
		Sum	**2,487.15**

Variance = 2,487.15 / 5 = 497.43

SD of NPV = √497.43 = ₹22.30 lakh

Coefficient of Variation = 22.30 / 30.03 = 0.743

(iv) Empirical Probability of Negative NPV

Out of 5 runs, only Run 4 produced a negative NPV (−₹0.52 lakh).

Empirical Probability of Negative NPV = 1 / 5 = 20%

Note: This is a small-sample estimate. The ICAI SM example uses 10 runs; production simulations typically use thousands of runs to get reliable probability estimates.

(v) Limitations of Simulation Analysis (per ICAI SM Section 4.3.3.3)

(i) Difficult to model the project realistically and specify the probability distributions of exogenous variables — wrong distributions lead to wrong simulated outcomes.

(ii) Simulation is inherently imprecise — it provides only a rough approximation of the probability distribution of NPV. The approximation may be especially misleading at the tails of the distribution, which is exactly where risk management decisions matter most.

(iii) A realistic simulation model is usually complex and constructed by quantitative experts, not the decision maker. If the decision maker lacks understanding of the model, they may not use it confidently.

(iv) Simulation typically uses the risk-free discount rate (to avoid double-counting risk that is already captured in the dispersion of NPV outcomes). This derived NPV measure takes on a different meaning from conventional NPV and can be difficult to interpret consistently.

Decision

Based on the 5-run simulation:

- Mean NPV = ₹30.03 lakh (positive)
- SD of NPV = ₹22.30 lakh
- Probability of Negative NPV = 20% (based on small sample)
- CV = 0.743 (moderate dispersion)

The project has a positive expected NPV, but the 20% probability of a loss and the moderate-to-high CV mean management should approach with eyes open. A larger simulation (50+ runs) would refine these estimates before final commitment.

Question 9 — Decision Tree Analysis

Lumio Diagnostics Ltd. is evaluating a new medical imaging product. The product's success in Year 2 depends critically on its reception in Year 1. The Board has asked you to use a decision tree approach to capture this conditional cash flow structure.

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Project details (₹ in lakh):

Item	Value
Initial Investment (Year 0)	100
Project Life	2 years
Discount Rate	10%

Year 1 Cash Flow distribution:

Year 1 Outcome	Cash Flow (₹ Lakh)	Probability
Strong Reception	70	0.40
Weak Reception	50	0.60

Year 2 Cash Flow distribution, CONDITIONAL on Year 1 outcome:

Conditional on Year 1	Year 2 Cash Flow (₹ Lakh)	Conditional Probability
If Year 1 was Strong (₹70)	100	0.50
	80	0.30
	60	0.20
If Year 1 was Weak (₹50)	70	0.30
	50	0.50
	30	0.20

PVF at 10%: Y1 = 0.909, Y2 = 0.826.

Required:

(i) Describe the decision tree structure (decision nodes, chance nodes, branches).

(ii) Compute the NPV for each of the six possible paths.

(iii) Compute the joint probability for each path.

(iv) Compute the Expected NPV of the project.

(v) Identify the best-case and worst-case NPVs with their respective probabilities.

(vi) Compute the overall probability that the project will yield a NEGATIVE NPV.

(vii) State your recommendation.

Solution

(i) Decision Tree Structure

The decision tree has the following structure:

- ROOT (Year 0): A single decision node — Invest ₹100 lakh.
- AFTER YEAR 1: A chance node with two branches — Strong Reception (₹70 with prob 0.40) and Weak Reception (₹50 with prob 0.60).
- AFTER YEAR 2: Each Year 1 branch leads to a chance node with three sub-branches. Strong → three Year 2 outcomes (100, 80, 60 with probs 0.50, 0.30, 0.20). Weak → three Year 2 outcomes (70, 50, 30 with probs 0.30, 0.50, 0.20).
- Total: 6 paths emerge from Year 0 to Year 2, each with a joint probability and a path NPV.

(ii) and (iii) Path NPVs and Joint Probabilities

Path	Year 1 CF	Year 2 CF	Joint Probability	NPV Computation	NPV (₹ Lakh)
1	70	100	0.40 × 0.50 = 0.20	−100 + 70(0.909) + 100(0.826)	+46.23
2	70	80	0.40 × 0.30 = 0.12	−100 + 70(0.909) + 80(0.826)	+29.71
3	70	60	0.40 × 0.20 = 0.08	−100 + 70(0.909) + 60(0.826)	+13.19

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Path	Year 1 CF	Year 2 CF	Joint Probability	NPV Computation	NPV (₹ Lakh)
4	50	70	0.60 × 0.30 = 0.18	−100 + 50(0.909) + 70(0.826)	+3.27
5	50	50	0.60 × 0.50 = 0.30	−100 + 50(0.909) + 50(0.826)	−13.25
6	50	30	0.60 × 0.20 = 0.12	−100 + 50(0.909) + 30(0.826)	−29.77
Total			**1.00**		

Worked Path 1 (Best Case) — Detailed Computation

Year 1 CF = ₹70 lakh; Year 2 CF = ₹100 lakh

PV of Year 1 CF = 70 × 0.909 = ₹63.63 lakh

PV of Year 2 CF = 100 × 0.826 = ₹82.60 lakh

NPV = −100 + 63.63 + 82.60 = +₹46.23 lakh

Joint Probability = 0.40 × 0.50 = 0.20 (i.e., 20% chance of this path occurring)

(iv) Expected NPV

Path	NPV (₹ Lakh)	Joint Probability	Expected Value (₹ Lakh)
1	+46.23	0.20	9.246
2	+29.71	0.12	3.565
3	+13.19	0.08	1.055
4	+3.27	0.18	0.589
5	−13.25	0.30	−3.975
6	−29.77	0.12	−3.572
		Expected NPV	**+6.908**

Expected NPV = +₹6.91 lakh

(v) Best-Case and Worst-Case Outcomes

Scenario	NPV (₹ Lakh)	Joint Probability
Best Case (Path 1: Strong Y1 + Strong Y2)	+46.23	20%
Worst Case (Path 6: Weak Y1 + Weak Y2)	−29.77	12%

(vi) Probability of Negative NPV

Paths with negative NPV: Path 5 (−₹13.25 lakh, prob 0.30) and Path 6 (−₹29.77 lakh, prob 0.12).

Probability of Negative NPV = 0.30 + 0.12 = 0.42 (i.e., 42%)

Conversely, Probability of Positive NPV = 0.58 (58%).

(vii) Recommendation

The expected NPV of +₹6.91 lakh is positive, which supports project acceptance on a strict NPV-rule basis. However, the decision is not clear-cut:

(i) There is a 42% probability that the project will yield a negative NPV. This is materially high — almost coin-toss territory.

(ii) The expected value of ₹6.91 lakh is modest in relation to the ₹100 lakh initial investment (about 7% in present-value terms). The risk-adjusted return is therefore low.

(iii) The worst-case loss of ₹29.77 lakh has a 12% probability — significant downside.

(iv) Management's appetite for this risk-return profile depends on the firm's broader portfolio. If the firm has many such projects, the diversified expected NPV is what matters. If this is a stand-alone bet, the 42% downside probability warrants either restructuring (to improve Y2 cash flows if Y1 is weak), seeking additional risk mitigation, or rejecting the project.

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Conditional Recommendation: Accept the project if the firm has portfolio diversification and a moderate-to-high risk appetite. Reject (or restructure) if this is a stand-alone investment for a risk-averse organisation.

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CHAPTER 4 — SECURITY ANALYSIS

Question 1 — Dow Theory: Averages Confirmation and Reversal Signals

A senior fund manager at a Mumbai-based mutual fund is reviewing quarterly index behaviour to assess whether the primary market trend has reversed. She applies Dow Theory's classical framework, adapted to Indian equities: Charles Dow's original construct used the Dow Jones Industrial Average confirmed by the Dow Jones Transportation Average. In the Indian context, Nifty 50 serves as the broad market proxy, while Nifty Auto (a heavy consumer of raw materials and a reliable indicator of underlying economic activity) serves as the confirmation index.

Quarterly index changes, volume metrics, and market breadth over the past four quarters:

Quarter	Nifty 50 % Change	Nifty Auto % Change	NSE Cash Volume (Y-o-Y)	Advance / Decline Ratio
Q1	+8.0%	+9.0%	+18%	1.80
Q2	+6.0%	+7.5%	+22%	1.70
Q3	+5.0%	−3.0%	+5%	1.20
Q4	+2.5%	−8.0%	−12%	0.70

Required:

(i) Apply the "averages must confirm each other" principle to each quarter and identify when the confirmation broke down.

(ii) Analyse volume confirmation across the four quarters and identify the classic Dow Theory divergence signal.

(iii) Assess the significance of the Advance/Decline ratio deterioration in confirming a primary trend reversal.

(iv) State when Dow Theory would formally signal a primary trend reversal and justify the timing.

(v) Recommend portfolio positioning for a growth-oriented equity fund manager operating within a mandate that permits equity allocation between 40% and 70%.

Solution

(i) Averages Confirmation Analysis

Per Dow Theory, a primary trend is validated only when both the broad market average and the confirmation average move in the same direction. Divergence between the two is the first classical warning signal.

Quarter	Nifty 50	Nifty Auto	Confirmation Status
Q1	+8.0%	+9.0%	CONFIRMED — Both averages rising in tandem
Q2	+6.0%	+7.5%	CONFIRMED — Primary uptrend continues
Q3	+5.0%	−3.0%	DIVERGENCE — First warning signal
Q4	+2.5%	−8.0%	DIVERGENCE PERSISTS AND WIDENS — Reversal signal

The confirmation broke down decisively at Q3 and was reinforced in Q4. Per Dow's own writings, a single quarter of divergence is a caution flag; two consecutive quarters constitute a confirmed reversal signal.

(ii) Volume Confirmation Analysis

Dow's third theorem: volume must confirm the trend. Rising prices on rising volume signals genuine demand; rising prices on falling volume signals distribution.

Quarter	Nifty 50	Volume Y-o-Y	Volume Reading
Q1	+8.0%	+18%	Healthy — Volume confirms price
Q2	+6.0%	+22%	Healthy — Institutional participation strong
Q3	+5.0%	+5%	Warning — Volume growth decelerating faster than price
Q4	+2.5%	−12%	BEARISH DIVERGENCE — Price still rising on FALLING volume

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The Q4 signal is textbook distribution phase behaviour: informed institutional sellers are quietly unloading their positions to less-informed retail buyers, keeping prices elevated on artificially thin volume. This is the pattern that precedes almost every major market top.

(iii) Advance/Decline Ratio Analysis

The A/D ratio measures market breadth — the proportion of stocks participating in the trend. A robust bull market has broad participation (many stocks rising); a weak bull market driven by a handful of large-caps produces a narrowing A/D.

Quarter	A/D Ratio	Interpretation
Q1	1.80	Broad participation — approximately 64% of stocks advancing
Q2	1.70	Still healthy — broad-based rally
Q3	1.20	Narrowing rally — fewer stocks participating
Q4	0.70	Negative breadth — more stocks declining than advancing while Nifty still rises

The Q4 reading is particularly significant: Nifty 50 rose 2.5% while the A/D was 0.70, meaning MORE stocks declined than advanced. This means the Nifty's rise was driven by only a small subset of very large-cap stocks — a classic "narrow rally" that precedes market tops.

(iv) Reversal Signal Confirmation

Dow Theory requires reversal signals to be confirmed by MULTIPLE independent tests. The formal reversal is confirmed at the END OF Q4 because all three classical tests fail simultaneously:

(i) Averages Test: Nifty 50 up but Nifty Auto down — confirmation breakdown persists.

(ii) Volume Test: Prices rising on falling volume — bearish divergence.

(iii) Breadth Test: A/D ratio below 1.0 confirms narrow, unhealthy rally.

The primary bull trend is confirmed to have ended. The market is now transitioning from the distribution phase to the first leg of a primary bear trend.

(v) Portfolio Positioning Recommendation

For a growth-oriented equity fund manager operating under a 40%–70% equity mandate:

(i) Reduce equity allocation from likely current levels of 65-70% toward the lower end of mandate (40-45%). This is a tactical de-risking, not a permanent shift.

(ii) Rotate within equity from cyclicals (Auto, Realty, Metals, Infrastructure) to defensives (FMCG, Pharma, IT Services). Historical drawdown analysis shows defensives contain losses at 40-60% of the market decline during primary bear phases.

(iii) Increase cash and short-duration debt allocation to 15-25%. This provides both risk reduction and dry powder for redeployment during the correction.

(iv) Consider portfolio hedging via Nifty index puts or short futures for the equity book that must be held (depending of course on what is permitted by the regulations).

(v) Communicate the positioning shift proactively to trustees and unitholders. Reversal-timing calls carry career risk for fund managers; documenting the analytical basis (Dow Theory framework, breadth deterioration, volume divergence) provides defensibility.

Question 2 — Serial Correlation Test for Weak-Form EMH

A quantitative analyst at a Bengaluru-based hedge fund is testing whether daily returns on Meridian Auto Ltd. exhibit serial correlation. Under the weak-form Efficient Market Hypothesis, successive daily returns should be independent (statistically uncorrelated). Statistically significant serial correlation would indicate that past returns predict future returns in a systematic manner exploitable by traders — contradicting weak-form efficiency.

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Daily returns (%) observed over 7 consecutive trading days:

Day	Daily Return (%)
1	+3.0
2	−2.0
3	+2.0
4	−1.0
5	+3.0
6	−2.0
7	+2.0

Critical t-values (at 4 degrees of freedom):

- At 5% level of significance: ± 2.776
- At 1% level of significance: ± 4.604

Required:

(i) Form the 6 pairs of (return_t−1, return_t) required for the serial correlation test.

(ii) Compute the Pearson correlation coefficient (r) using the shortcut formula.

(iii) State your conclusion regarding weak-form EMH for Meridian Auto Ltd.

(iv) Discuss the practical implications for a systematic trading strategy and comment on sample-size considerations.

Solution

(i) Formation of Return Pairs

Let x denote the return on Day (t−1), and y denote the return on Day t. Each pair captures the relationship between one day's return and the next.

Pair No.	Day (t−1)	x (Return t−1)	Day (t)	y (Return t)
1	1	+3.0	2	−2.0
2	2	−2.0	3	+2.0
3	3	+2.0	4	−1.0
4	4	−1.0	5	+3.0
5	5	+3.0	6	−2.0
6	6	−2.0	7	+2.0

Sample size: n = 6 pairs.

(ii) Correlation Coefficient Computation

Using Pearson's shortcut formula

$r = [n \cdot \Sigma xy - \Sigma x \cdot \Sigma y] / \sqrt{[n \cdot \Sigma x^2 - (\Sigma x)^2] \times [n \cdot \Sigma y^2 - (\Sigma y)^2]}$

Computing the summations:

Pair	X	y	xy	x^2	y^2
1	3.0	−2.0	−6.00	9.00	4.00
2	−2.0	2.0	−4.00	4.00	4.00
3	2.0	−1.0	−2.00	4.00	1.00
4	−1.0	3.0	−3.00	1.00	9.00
5	3.0	−2.0	−6.00	9.00	4.00
6	−2.0	2.0	−4.00	4.00	4.00
Σ	**3.0**	**2.0**	**−25.00**	**31.00**	**26.00**

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Substituting into the formula:

Numerator = [6 × (−25) − 3 × 2] = −150 − 6 = −156

Denominator = √{[6 × 31 − 9] × [6 × 26 − 4]} = √[177 × 152] = √26,904 = 164.03

r = −156 / 164.03 = −0.951

The coefficient r = −0.951 indicates STRONG NEGATIVE serial correlation. Positive-return days are systematically followed by negative-return days, and vice versa — a mean-reverting pattern.

(iii) Conclusion on Weak-Form EMH

The strong negative serial correlation (r = −0.951) indicates a systematic mean-reversion pattern in Meridian Auto's daily returns — positive-return days are reliably followed by negative-return days.

Conclusion: The Weak-Form Efficient Market Hypothesis is REJECTED for Meridian Auto Ltd. based on this sample. Past prices contain information that predicts future prices in a statistically significant, systematic manner.

(iv) Practical Implications for a Systematic Trading Strategy

The observed mean-reversion pattern suggests a "contrarian" strategy: sell after positive-return days, buy after negative-return days. However, converting this statistical finding into a viable trading strategy requires careful practitioner judgement:

(i) Sample size limitation: n = 7 days (6 pairs) is materially small for robust statistical inference. Institutional testing standards require 250 trading days minimum, with rolling-window analysis to test stability over time.

(ii) Transaction cost drag: A contrarian strategy trading every day accumulates 40-50 bps of round-trip costs per trade. If the observed daily return amplitude is 2-3%, the strategy needs a hit rate above 60% just to break even after costs.

(iii) Pattern persistence: Serial correlation patterns are prone to "decay" once discovered and exploited. In institutional practice, mean-reversion patterns typically weaken as high-frequency market makers arbitrage them away within milliseconds.

(iv) Regime dependence: Mean reversion may hold during range-bound markets but break down during trending markets. Rigorous back-testing across bull, bear, and sideways regimes is essential.

(v) Market microstructure: The observed pattern may reflect market-maker inventory rebalancing rather than genuine mispricing, in which case it cannot be captured by end-investors without paying the market-maker spread.

A rigorous practitioner would treat this test result as a candidate hypothesis warranting further investigation — not as an actionable strategy signal.

Question 3 — Filter Rules Test for Weak-Form EMH

An equity research analyst at a Mumbai brokerage tests whether a mechanical filter-based trading rule can outperform a passive buy-and-hold strategy on ABC Auto Ltd. Under the weak-form EMH, no mechanical rule based purely on past prices should generate abnormal returns after transaction costs. If the filter rule outperforms buy-and-hold on a risk-adjusted basis net of transaction costs, the weak-form EMH is falsified for that security.

Filter Rule Specification:

- BUY signal: When price rises more than 5% from a recent local low
- SELL signal: When price falls by more than 5% from a recent local high
- Transaction cost: 0.5% per transaction (each way)

ABC Auto Ltd. closing prices over 8 consecutive trading days:

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Day	Closing Price (₹)
1	100
2	108
3	104
4	96
5	92
6	100
7	105
8	110

Required:

(i) Identify the specific buy and sell signals generated by the 5% filter rule during the 8-day period.

(ii) Compute the net return from the filter rule strategy after transaction costs.

(iii) Compute the buy-and-hold return over the same period, net of transaction costs.

(iv) Compare the two strategies and state the conclusion regarding weak-form EMH.

(v) Discuss the critical role of transaction costs in filter rule tests, and reference the Fama-Blume study that established the empirical foundation of filter rule testing.

Solution

(i) Signal Identification

Starting position on Day 1: No holding. Watch for signals.

Day	Price (₹)	Change from Reference	Filter Signal
1	100	Starting price (local reference)	No position
2	108	+8.0% from Day 1 low of 100	BUY TRIGGERED at ₹108
3	104	−3.7% from Day 2 peak of 108	Below 5% sell filter → HOLD
4	96	−11.1% from Day 2 peak of 108	SELL TRIGGERED at ₹96
5	92	New local low	Watch for buy signal
6	100	+8.7% from Day 5 low of 92	BUY TRIGGERED at ₹100
7	105	+5.0% from Day 6 entry	Continues uptrend → HOLD
8	110	End of trading window	CLOSE POSITION at ₹110

Summary: Two complete trading cycles.

- Trade 1: Buy Day 2 @ ₹108, Sell Day 4 @ ₹96
- Trade 2: Buy Day 6 @ ₹100, Sell Day 8 @ ₹110

(ii) Filter Strategy Return (Net of Transaction Costs)

Trade 1 (Buy at 108, Sell at 96):

Effective buy price = 108 × 1.005 = ₹108.54 (including 0.5% buy cost)

Effective sell price = 96 × 0.995 = ₹95.52 (net of 0.5% sell cost)

Return on Trade 1 = (95.52 − 108.54) / 108.54 = −13.02 / 108.54 = −12.00%

Trade 2 (Buy at 100, Sell at 110):

Effective buy price = 100 × 1.005 = ₹100.50

Effective sell price = 110 × 0.995 = ₹109.45

Return on Trade 2 = (109.45 − 100.50) / 100.50 = +8.90%

Cumulative Compounded Return:

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(1 + Trade 1 return) × (1 + Trade 2 return) − 1

= (1 − 0.12) × (1 + 0.089) − 1

= 0.88 × 1.089 − 1

= 0.9583 − 1

Filter Strategy Net Return = −4.17%

(iii) Buy-and-Hold Return (Net of Transaction Costs)

Buy at Day 1 @ ₹100, Sell at Day 8 @ ₹110.

Effective buy price = 100 × 1.005 = ₹100.50

Effective sell price = 110 × 0.995 = ₹109.45

Return = (109.45 − 100.50) / 100.50 = +8.95 / 100.50

Buy-and-Hold Net Return = +8.90%

(iv) Strategy Comparison and Weak-Form EMH Conclusion

Strategy	Net Return	No. of Transactions	Total Transaction Cost
Filter Rule (5%)	−4.17%	4 (2 buy + 2 sell)	2.0% of turnover
Buy-and-Hold	+8.90%	2 (1 buy + 1 sell)	1.0% of turnover
Performance Gap	**Buy-and-Hold outperforms by 13.07 pp**		

Per ICAI SM Section 4.4: "If the returns from filter rule are significantly higher than buy-and-hold strategy after adjusting for transaction costs, the market is not weak-form efficient."

Our finding is the OPPOSITE: the filter rule materially underperforms buy-and-hold by 13.07 percentage points over the 8-day period. This is consistent with the weak-form EMH.

Conclusion: The Weak-Form EMH is SUPPORTED for ABC Auto Ltd. The 5% filter rule cannot generate abnormal returns and in fact destroys value relative to a passive buy-and-hold strategy.

(v) Transaction Costs: The Silent Killer of Filter Rule Strategies

Transaction costs are the central battleground of filter rule testing. Understanding why they matter is essential to interpreting these tests correctly.

(i) Cost drag scales linearly with trading frequency: The filter rule generated 4 transactions vs 2 for buy-and-hold, doubling the transaction cost burden (2.0% vs 1.0%). Higher-frequency filters (2-3% instead of 5%) would trigger more signals and would face proportionately higher cost drag.

(ii) Gross-of-cost vs net-of-cost distinction: A filter rule may appear profitable on gross returns but destroy value on net returns. The correct test is always net-of-cost.

(iii) Hidden costs beyond explicit brokerage: In institutional practice, transaction costs also include (a) bid-ask spread payment (5-15 bps per trade for liquid Indian large-caps, higher for mid-caps), (b) market impact for larger orders (5-50 bps depending on order size relative to average daily volume), (c) opportunity cost of unfilled orders during price movement. The 0.5% cost used in this question represents a reasonable retail approximation but is optimistic for institutional-scale trading.

(iv) Break-even filter width: For a given transaction cost, there exists a minimum filter width below which the strategy cannot possibly break even. With 0.5% round-trip cost per trade, filters below approximately 2% would face cost-dominated returns even before market impact.

The Fama-Blume Study (1966) — Empirical Foundation

Eugene Fama and Marshall Blume tested filter rules ranging from 0.5% to 50% on Dow Jones Industrial Average stocks between 1957 and 1962. Their landmark finding: while very small filters (0.5% to 1.5%) generated positive gross

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returns, ALL filters underperformed buy-and-hold once realistic transaction costs were included. This study is credited with cementing the empirical case for weak-form efficiency in developed markets and remains one of the most-cited papers in finance.

For Indian equities, subsequent studies have found weak-form efficiency in Nifty 50 large-caps but partial inefficiency in less-followed small-caps — consistent with the broader finding that market efficiency is stronger where analyst coverage, institutional participation, and liquidity are higher.

Question 4 — Support and Resistance + Price Pattern Identification

Apex Pharma Ltd. share price has been observed over the past 6 trading weeks. The key price points identified by the technical analyst are summarised below:

Peaks observed:

- Day 5: ₹498
- Day 15: ₹497
- Day 25: ₹497

Troughs observed:

- Day 10: ₹475
- Day 20: ₹477

Breakout observation:

- Day 26: Share closed at ₹502, with trading volume 2.5× the 20-day average daily volume.
- Days 27–30: Share rallied further to ₹515 with sustained above-average volume.

Required:

(i) Identify the resistance and support levels for the share over the observation period.

(ii) Identify the chart pattern formed during the 25-day consolidation phase before the breakout.

(iii) Interpret the Day 26 breakout in the context of technical analysis principles (per ICAI SM Section 2.7 and 2.8).

(iv) Recommend trading action with specific entry, stop-loss, and target levels.

Solution

(i) Support and Resistance Levels

Resistance Level: ₹497–498.

The share approached this level three times (Days 5, 15, 25) and was rejected each time. This is a strong horizontal resistance.

Support Level: ₹475–477.

The share found buying interest at this level twice (Days 10, 20). This is the horizontal support.

The share oscillated within a trading range of approximately ₹22 (between 475–477 and 497–498) for the first 25 days.

(ii) Chart Pattern Identification

The price action between Day 1 and Day 25 displays the characteristics of a Symmetrical / Slightly Ascending Triangle (Range-Bound Consolidation):

Feature	Observation	Inference
Peaks	498, 497, 497 — flat at ~497	Resistance is horizontal
Troughs	475, 477 — rising slightly	Support is gradually rising
Duration	~25 days of oscillation	Period of indecision in the market
Volume during consolidation	Below average	Consistent with consolidation pattern

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The slight rise in troughs (475 → 477) and flat peaks suggest accumulation rather than distribution, indicating that buyers are gradually willing to bid up the support while sellers remain anchored at ₹498.

(iii) Interpretation of Day 26 Breakout

Per ICAI SM Section 2.7, a breach of resistance or support levels indicates a distinct departure from status quo. The Day 26 close at ₹502 has the following characteristics:

(i) Decisive breach: Closing above the ₹498 resistance (not just an intraday touch) confirms genuine buying interest.

(ii) Volume confirmation: Volume at 2.5× the 20-day average is critical. Per ICAI SM Section 2.6, "a rising index/price with increasing volume would signal buy behaviour because the situation reflects an unsatisfied demand in the market." Without volume confirmation, the breakout would be suspect.

(iii) Continuation pattern: Days 27–30 sustaining the rally to ₹515 with above-average volume validates the breakout. A false breakout would typically reverse within 1–2 days.

The breakout is therefore genuine, and the previous resistance of ₹497–498 now becomes the new support level (per technical analysis convention of role reversal).

(iv) Trading Recommendation

Recommendation: BUY on confirmed breakout with the following parameters:

Parameter	Value	Reasoning
Entry	₹510–515 (current levels)	Buy on minor pullbacks within sustained uptrend
Stop-loss	₹497	Below new support; close below invalidates breakout
First Target	₹520	Initial momentum target
Second Target	₹525–530	Measured-move: breakout (498) + height of consolidation (22) = ₹520
Risk-Reward Ratio	0.77 (first target); 1.54 (second target)	Acceptable for breakout trades

Risk Management Note: The recommendation is contingent on the breakout being sustained. If the share closes back below ₹497 within the next 5 trading days, the breakout would be classified as a false breakout, and the trade should be exited at stop-loss.

Question 5 — Dow Theory and Elliot Wave Application

The Indian equity market (Nifty 50) over the past 18 months has displayed the following phases:

Phase 1 (Months 1–6):

Steady upward movement from Nifty 18,000 to 22,000. Trading volume gradually increased. Foreign institutional investors quietly began accumulating large-cap quality stocks. Retail sentiment remained cautious, with most media commentary focused on macroeconomic concerns and global headwinds.

Phase 2 (Months 7–12):

Corporate earnings surprised positively across sectors. The market rose from 22,000 to 25,000 amid widespread media coverage of a "structural bull market." Brokerages raised target prices; quarterly results were broadly above expectations. Mutual fund inflows began picking up.

Phase 3 (Months 13–18):

Speculative activity intensified — small-cap and penny stocks rallied 40–50%. F&O turnover hit record highs. Media headlines projected Nifty crossing 30,000 by year-end. Promoters of several listed companies began discreetly reducing their stakes. A handful of far-sighted institutional investors started rotating from cyclicals to defensives.

Required:

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(i) Map these three phases to the three primary stages of Dow Theory's bull market.

(ii) Identify the current market position (end of Phase 3) within the Dow Theory framework.

(iii) Apply Dow Theory's prediction logic — what is the likely near-term market direction?

(iv) Apply Elliot Wave Theory to interpret this 18-month sequence as a complete cycle.

(v) Recommend portfolio positioning for an investor at the end of Phase 3.

Solution

(i) Mapping to Dow Theory Stages (per ICAI SM Section 2.4.1)

Dow Theory Stage	Description	Scenario Phase	Key Indicators
Stage 1: Accumulation Phase	Caused by accumulation of shares by far-sighted investors	Phase 1 (Months 1–6)	FII quiet accumulation; cautious retail sentiment; macro concerns
Stage 2: Public Participation Phase	Caused by arrival of first reports of good earnings	Phase 2 (Months 7–12)	Earnings surprises; brokerage upgrades; rising MF inflows
Stage 3: Distribution / Excess Phase	Caused by widespread report of financial well-being; rampant speculation	Phase 3 (Months 13–18)	Small/penny stocks rally; F&O records; 30,000 headlines; promoter selling

(ii) Current Market Position

The market is at the end of Stage 3 (Distribution/Excess Phase). The classic markers of late bull-market topping are all present:

- Rampant speculation in low-quality stocks
- Record derivatives activity (typically a contrarian indicator)
- Sensational price targets in mainstream media
- Promoter and insider selling (smart money exit)
- Discreet rotation by sophisticated investors to defensives

(iii) Dow Theory's Prediction

Per ICAI SM: "Towards the end of the third stage, the far-sighted investors, realizing that the high earnings levels may not be sustained, would start selling, starting the first move down of a downtrend, and as the non-sustainability of high earnings is confirmed, the second move down would be initiated and then the third move down would result from distress selling in the market."

Prediction: A primary bearish trend (bear market) is likely to commence shortly. The three stages of the downtrend would be:

(i) First downtrend leg — Smart money selling; market pulls back 10–15% from peak; widely dismissed as a healthy correction

(ii) Second downtrend leg — Earnings disappointments; mutual fund outflows; correction extends to 20–25%

(iii) Third downtrend leg — Distress selling, margin calls, retail panic; correction may extend to 30–40% from peak

(iv) Elliot Wave Interpretation

Per ICAI SM Section 2.4.2, Elliot Wave Theory describes a complete cycle as 5 impulse waves (1, 2, 3, 4, 5) followed by 3 corrective waves (a, b, c):

Elliot Wave	Description	Mapped to Scenario
Wave 1	Initial impulse up (less recognized)	Months 1–4 of Phase 1
Wave 2	First corrective dip	Month 5 of Phase 1 (brief pullback)
Wave 3	Strongest and longest impulse up	Phase 2 (Months 7–12)
Wave 4	Second corrective dip	Brief consolidation before Phase 3

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Elliot Wave	Description	Mapped to Scenario
Wave 5	Final impulse, often driven by speculation	Phase 3 (Months 13–18) — excess phase

The market has now completed the 5-wave impulsive structure. The next sequence will be the corrective phase (a, b, c):

- Wave a: Initial sharp correction
- Wave b: Counter-trend bounce (bull trap)
- Wave c: Final corrective leg, often steeper and longer than Wave a

The Elliot Wave prediction is consistent with Dow Theory's three-stage downtrend.

(v) Portfolio Positioning Recommendation

For an investor at the end of Phase 3 (anticipating a bear market):

(i) Reduce equity allocation — Trim from typical 65–70% to 40–50%, depending on risk tolerance and investment horizon.

(ii) Rotate to defensive sectors — FMCG, pharmaceuticals, IT services, utilities have lower beta and historically outperform in bear markets.

(iii) Exit speculative positions — Small-cap and penny stocks acquired in Phase 3 should be liquidated. The first leg of the bear market typically punishes these most severely.

(iv) Build cash reserves — Increase cash/liquid fund allocation to 20–25%. Cash becomes the optionality that allows re-entry at lower levels during Wave c.

(v) Hedge equity portfolio with index puts or short futures — For sophisticated investors, options/futures hedging can protect the equity book without tax-triggering sales.

(vi) Hold quality blue-chips through the cycle — Blue-chip stocks with strong fundamentals should be held; the correction provides opportunity to add at lower prices during Wave c.

Question 6 — Empirical Tests of Market Efficiency Across Three Forms

A senior portfolio manager at an Indian asset management company is reviewing five recent observations from Indian equity markets to inform the firm's active management strategy:

Observation 1:

Multiple academic studies have shown that daily and weekly price changes on the NSE Nifty 50 do not exhibit statistically significant serial correlation. Run tests and filter rule tests have consistently produced random-walk-supporting results.

Observation 2:

A backtest by the firm's research team found that buying small-cap stocks ranked in the lowest decile by P/E ratio yielded 6% higher annualised returns than the Nifty 500 index over a 5-year holding period, even after adjusting for beta risk.

Observation 3:

When SEBI announced "Restricted Trading Window" rules for insiders in mid-2019, blue-chip stocks corrected by an average of 8% within 3 trading days. The full price adjustment was complete within 5 trading days.

Observation 4:

A study of mutual fund manager performance over 5 years found that 65% of actively managed equity funds underperformed their benchmark indices on a net-of-fees basis.

Observation 5:

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Stock market returns on Mondays in Indian markets have been observed to be statistically lower than returns on other weekdays, over the past decade.

Required:

(i) For each observation, identify which form of EMH (Weak, Semi-strong, or Strong) is relevant, and state whether the observation SUPPORTS or CONTRADICTS that form.

(ii) Based on all five observations, characterise the overall efficiency profile of the Indian equity market.

(iii) What investment strategies are RATIONAL given this efficiency profile?

(iv) Comment on the roles of fundamental analysis vs technical analysis vs passive investing in such a market.

Solution

(i) Observation-by-Observation EMH Mapping

Observation	Relevant EMH Form	Supports / Contradicts	Rationale
1. No serial correlation in price changes	Weak Form	Supports	If past prices contain no information about future prices, weak form is supported. Run/Filter Rule tests failing to find patterns is direct evidence (ICAI SM Section 4.4).
2. Low-P/E small-cap anomaly (6% excess return)	Semi-strong Form	Contradicts	P/E is publicly available. Abnormal returns from public information violate semi-strong efficiency. Low P/E multiple anomaly (ICAI SM Section 4.5).
3. Rapid price adjustment to SEBI announcement	Semi-strong Form	Supports	Rapid (within days) full incorporation of public news is consistent with semi-strong efficiency.
4. 65% of active managers underperform	Semi-strong Form	Supports	Sophisticated investors cannot beat the index — public information is broadly priced in.
5. Monday returns lower than other weekdays	Semi-strong Form	Contradicts	Calendar anomaly (Monday effect, ICAI SM Section 4.5).

(ii) Overall Efficiency Profile

Form of EMH	Assessment for Indian Equity Market	Evidence
Weak Form	Largely SATISFIED	Observation 1
Semi-strong Form	PARTIALLY SATISFIED — supports in some areas (Obs 3, 4), contradicts in others (Obs 2, 5)	Mixed evidence
Strong Form	Likely NOT SATISFIED	Insider information universally yields abnormal returns

The Indian equity market appears to be WEAK-FORM EFFICIENT but only PARTIALLY SEMI-STRONG EFFICIENT. There exist persistent, publicly-observable anomalies (low P/E effect, Monday effect, small-firm effect) that skilled investors can exploit, even though most active managers fail to capture this opportunity systematically.

(iii) Rational Investment Strategies

(i) Technical analysis alone is unlikely to add value — weak-form efficiency implies past price patterns do not predict future prices.

(ii) Fundamental analysis on neglected segments may add value — the low-P/E small-cap anomaly suggests that careful research on under-followed stocks can produce alpha.

(iii) Calendar-effect trading may yield small but positive alpha — strategies exploiting known calendar patterns may yield modest excess returns, though transaction costs must be considered.

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(iv) Passive investing is rational for most investors — given that 65% of active managers underperform after fees, the average investor is better served by low-cost index funds.

(v) Quality + Value strategies — combining fundamental quality metrics with value indicators (low P/E, low P/B) appears to offer the best risk-adjusted return potential.

(iv) Comparative Role of FA, TA, and Passive Investing

Approach	Likely Effectiveness	Best Use Case
Technical Analysis	Limited — weak form is largely satisfied	Short-term trading, market timing for institutional execution
Fundamental Analysis	Moderately effective, especially in small/mid-cap and under-followed names	Stock selection in semi-strong-inefficient pockets; long-term wealth creation
Passive Investing	Highly effective for average investor — large cap segment is broadly efficient	Core portfolio (60–70%); cost-efficient market exposure
Smart Beta / Factor Investing	Emerging — combines factor-based fundamental signals with passive structure	Strategic portfolio tilts toward documented factors (value, quality, low vol)

The portfolio manager's strategy should be a core-satellite approach: passive index funds as the core (60–70% allocation), supplemented by satellite active strategies in fundamentally-informed small/mid-cap selection and disciplined factor tilts.

Question 7 — Integration Case: Fundamental vs Technical + Equity Research Tools

You are an equity research analyst at a mid-sized Indian asset management company. You have been asked to evaluate Stellar Pharma Ltd., a specialty pharmaceutical company with a US FDA-approved manufacturing facility and a growing oncology portfolio.

Current Market Snapshot:

Particular	Value
Current Market Price (CMP)	₹650
Current EPS (trailing)	₹40
Trailing P/E	16.25x
Pharma Industry Average Trailing P/E	25x
ROE	22%
Dividend Payout Ratio	30%
Forward EPS (consensus, FY28)	₹52
Forward P/E (consensus)	12.5x
Industry Forward P/E	22x
DDM-based Intrinsic Value (conservative)	₹780–820
Recent News (2 weeks ago)	EU EMA approval for key oncology drug

Technical Picture:

Particular	Value
1-month price action	Down 5% (vs Nifty +3%)
50-day Moving Average	₹680
200-day Moving Average	₹695
Current Price vs 50-DMA	Below
Current Price vs 200-DMA	Below
Volume (past 10 days)	Below 20-day average
Chart Pattern	Forming a Double Bottom near ₹620–625

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Equity Research Tool Outputs:

Tool / Indicator	Reading
Bloomberg consensus rating (12 analysts)	8 BUY, 3 HOLD, 1 SELL
Stockopedia QualityScore	88 / 100
Insider activity (last 60 days)	Promoter increased stake by 2%

Required:

(i) Summarise the fundamental view of Stellar Pharma.

(ii) Summarise the technical view.

(iii) Reconcile the apparent conflict between FA and TA signals.

(iv) Recommend a specific course of action with entry, stop-loss, and target levels.

(v) Identify which equity research tools (per ICAI SM Section 5) the analyst should use for ongoing monitoring, and what specific data each tool would provide.

Solution

(i) Fundamental View Summary

Metric	Stellar Pharma	Industry	Read
Trailing P/E	16.25x	25x	35% discount to industry
Forward P/E	12.5x	22x	43% discount to industry
ROE	22%	—	Strong return on equity
EPS growth (trailing to forward)	(52−40)/40 = 30%	—	Strong growth
DDM Intrinsic Value	₹780–820	—	20–26% upside to CMP
Recent catalyst	EU EMA approval	—	Material positive, expands TAM

Fundamental Verdict: Stellar Pharma is materially UNDERVALUED.

Multiple valuation approaches (P/E, forward P/E, DDM) converge on the conclusion that the stock trades 20–35% below fair value. The EU EMA approval is a material positive catalyst that should drive earnings upgrades.

(ii) Technical View Summary

Indicator	Reading	Interpretation
Price below 50-DMA (680)	Bearish near-term	Short-term momentum weak
Price below 200-DMA (695)	Bearish medium-term	Longer-term trend has turned negative
Price down 5% vs market up 3%	Relative weakness	Underperformance vs Nifty
Volume below average	Lack of conviction	Selling pressure on light volume — not panic
Double bottom near 620–625	Reversal pattern	Classic bullish reversal pattern in formation

Technical Verdict: Mixed but tilting bullish.

While price is below both key moving averages (typically a sell signal), the light volume of recent selling and the double bottom pattern at ₹620–625 suggest that downside is exhaustion-driven rather than driven by fundamental deterioration. A reversal is likely once the double bottom completes.

(iii) Reconciliation of Conflicting Signals

(i) Time-horizon mismatch: Fundamental analysis works over multi-quarter and multi-year horizons. Technical analysis primarily captures short-term sentiment. The 5% weakness over the past month does not invalidate a 20–35% undervaluation that has been building over several quarters.

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(ii) The EU EMA approval may not yet be fully priced — Per ICAI SM Section 4.5, semi-strong efficiency means stock prices should adjust rapidly to public announcements. The 2-week-old EMA approval should have lifted the price; instead, the stock has weakened, suggesting either (a) the market is treating the approval as already-priced-in, or (b) the market is temporarily inefficient (a buying opportunity).

(iii) Insider buying is a powerful signal — Promoter increasing stake by 2% in the last 60 days indicates those with the most intimate knowledge of the business see the current price as attractive. ICAI SM Section 4.6 notes that corporate insiders consistently earn abnormal returns.

(iv) Light-volume selling is materially different from heavy-volume distribution. The technical weakness is exhaustion-driven; once selling pressure dries up, the fundamental drivers will reassert.

(v) Analyst consensus is overwhelmingly bullish (8 BUY, 3 HOLD, 1 SELL) — Aggregating diverse expert opinions, the weight of professional analysis aligns with the fundamental view.

Reconciled View: The stock is fundamentally attractive with a short-term technical air pocket. The technical weakness is creating an OPPORTUNITY rather than a warning. The double bottom forming near ₹620 is a textbook accumulation pattern at the support level.

(iv) Specific Recommendation

Recommendation: STRONG BUY with a 6–12 month investment horizon.

Trade Parameter	Value	Reasoning
Action	Accumulate in 3 tranches	Average down risk; capture potential further dip
First Tranche (50%)	At current ₹650	Initial position based on fundamental conviction
Second Tranche (30%)	At ₹625–630	At the double-bottom support level
Third Tranche (20%)	On confirmed breakout above ₹680 (50-DMA)	Momentum confirmation
Stop-Loss	₹600	Below double bottom; would invalidate the technical setup
First Target	₹780	DDM intrinsic value lower bound (20% upside)
Second Target	₹820	DDM intrinsic value upper bound (26% upside)
Third Target	₹950	Re-rating; partial closure of gap to industry multiple
Holding Period	6–12 months	Sufficient time for fundamental thesis to play out
Risk-Reward	(780 − 650)/(650 − 600) = 2.6x	Excellent risk-reward

(v) Equity Research Tools for Ongoing Monitoring

Per ICAI SM Section 5 (Equity Research and Tools Available), the analyst should use the following tools:

Tool	Specific Use for Stellar Pharma Monitoring
Bloomberg Terminal	Daily analyst rating revisions, consensus estimate changes, real-time news (FDA/EMA filings, contract wins, regulatory updates)
Refinitiv EIKON	Alternative to Bloomberg; comparative valuation analysis across pharma peers; ownership structure changes (FII / DII / Promoter holdings)
Stockopedia	Continuous tracking of the QualityScore (currently 88) and ValueRank; alerts on any deterioration in quality metrics
Finbox.io	Multiple valuation models (DCF, DDM, comparables) updated automatically with consensus estimates; sensitivity analysis on key inputs
GuruFocus	Insider transaction monitoring (promoter activity is a key data point in our case); ownership by quality long-term institutional investors
Benzinga Pro	Real-time news and earnings call alerts; useful for fast-moving regulatory news in pharma sector

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Tool	Specific Use for Stellar Pharma Monitoring
YCharts	Visualising fundamental trends (EPS growth trajectory, margin trends) across multiple quarters

Note: Per ICAI SM, students should be familiar with these tools at the level of "knowing what each tool provides" — not at the level of "subscribing and operating each tool." The exam expectation is conceptual familiarity.

Question 8 — Exponential Moving Average and Buy/Sell Signals

A technical analyst is tracking Nifty 50 closing levels over an 8-day trading period. The previous day's Exponential Moving Average (EMA) was 22,000. The smoothing exponent (α) for the analyst's chosen EMA period is 0.20.

The closing values are:

Day	Closing Nifty
1	22,200
2	22,400
3	22,300
4	22,500
5	22,800
6	23,000
7	23,200
8	23,400

EMA Formula (per ICAI SM Section 2.9):

EMA_today = EMA_previous + α × (Price_today − EMA_previous)

Required:

(i) Compute the EMA for each of the 8 days.

(ii) Compare the closing price line with the EMA line on each day.

(iii) Based on the ICAI SM's buy and sell signal rules, identify whether any signals are generated during the period.

(iv) Provide a trading recommendation as of the end of Day 8.

Solution

(i) EMA Computation

Day	Closing Price (1)	EMA Previous (2)	Diff (1–2)	α × Diff (×0.20)	EMA (2 + α×Diff)
1	22,200	22,000.00	200.00	40.00	22,040.00
2	22,400	22,040.00	360.00	72.00	22,112.00
3	22,300	22,112.00	188.00	37.60	22,149.60
4	22,500	22,149.60	350.40	70.08	22,219.68
5	22,800	22,219.68	580.32	116.06	22,335.74
6	23,000	22,335.74	664.26	132.85	22,468.59
7	23,200	22,468.59	731.41	146.28	22,614.87
8	23,400	22,614.87	785.13	157.03	22,771.90

(ii) Price vs EMA Comparison

On every day from Day 1 through Day 8, the closing Nifty price is consistently ABOVE the EMA, and the gap between price and EMA is widening (from ₹160 on Day 1 to ₹628 on Day 8). The EMA itself is rising steadily — from 22,000 to 22,772, a 3.5% rise over the period.

(iii) Signal Identification

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Per ICAI SM Section 2.9:

- Buy signal: Stock price line rises through the moving average line when the moving average is flattening, OR stock price line falls below moving average which is rising, then recovers.
- Sell signal: Stock price line falls through moving average line, OR stock price rises above falling moving average.

In our 8-day data, the price has been above the rising EMA throughout the period. This is a sustained uptrend — neither a buy-trigger nor a sell-trigger has emerged within the observation window. The signal generated before Day 1 (when price crossed above EMA) is still in effect.

(iv) Trading Recommendation

Observation	Interpretation
Price > EMA on all 8 days	Confirmed uptrend
EMA itself is rising (22,000 → 22,772)	Trend strength is genuine, not just a temporary spike
Gap between price and EMA is widening	Bullish momentum is accelerating
Price gain over 8 days: 5.4% (22,200 → 23,400)	Strong directional move

Recommendation: HOLD existing long positions; CAUTIOUS ACCUMULATION at small dips toward the EMA. Avoid aggressive new entries at the current widening-gap stage, as such gaps often precede short-term mean reversion toward the EMA. Wait for a partial retracement to closer to 22,800–23,000 levels for a more favourable risk-reward entry.

Question 9 — Run Test for Weak-Form EMH

A technical analyst at a Kolkata-based brokerage is testing the weak-form Efficient Market Hypothesis for Bharat Steel Ltd. using the non-parametric Run Test. Under weak-form EMH, successive price changes should occur in a random sequence; a systematic pattern of clustering (too few runs, indicating trending) or excessive alternation (too many runs, indicating mean reversion) would contradict randomness and hence weak-form efficiency.

Bharat Steel Ltd. — Closing prices (in ₹) over 21 consecutive trading days:

Day	Price (₹)	Day	Price (₹)	Day	Price (₹)
1	100	8	102	15	104
2	102	9	104	16	102
3	104	10	106	17	100
4	106	11	108	18	102
5	104	12	110	19	104
6	102	13	108	20	106
7	100	14	106	21	108

Critical t-values (two-tailed):

- Value of t at 5% is 2.093 at 19 degrees of freedom
- Value of t at 10% is 1.729 at 19 degrees of freedom

Required:

(i) Convert the daily prices into a sequence of price changes and classify each change as positive (+) or negative (−).

(ii) Count n_1 (number of positive changes), n_2 (number of negative changes), and R (observed number of runs).

(iii) Compute the expected mean number of runs (μ) and the standard deviation (σ) under the null hypothesis of randomness.

(iv) Test the observed R against the 5% and 10% confidence intervals using the t-distribution at df = $(n_1 + n_2) - 1$, and state your conclusion regarding weak-form EMH.

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(v) Explain the economic intuition of the Run Test result and comment on the practitioner interpretation of "too few runs" versus "too many runs".

Solution

(i) Daily Price Changes and Sign Classification

Each daily change is the current close minus the previous close. A rise is coded as (+); a fall as (−). Since there are 21 daily prices, there are 20 successive price changes.

Day	Price (₹)	Change (₹)	Sign
1	100	—	—
2	102	+2	+
3	104	+2	+
4	106	+2	+
5	104	−2	−
6	102	−2	−
7	100	−2	−
8	102	+2	+
9	104	+2	+
10	106	+2	+
11	108	+2	+
12	110	+2	+
13	108	−2	−
14	106	−2	−
15	104	−2	−
16	102	−2	−
17	100	−2	−
18	102	+2	+
19	104	+2	+
20	106	+2	+
21	108	+2	+

(ii) Counting n_1, n_2, and R

The full sequence of sign changes (in chronological order) is:

+++ −−− +++++ −−−−− +++ +

A "run" is defined as an unbroken sequence of identical signs. Reading the sequence from left to right, a new run begins whenever the sign changes.

Run No.	Sign	Length (Days)	Days Covered
1	+	3	Days 2 to 4
2	−	3	Days 5 to 7
3	+	5	Days 8 to 12
4	−	5	Days 13 to 17
5	+	4	Days 18 to 21

Summary of Counts:

- n_1 (positive changes) = 3 + 5 + 4 = 12
- n_2 (negative changes) = 3 + 5 = 8
- Total price changes: $n_1 + n_2$ = 12 + 8 = 20

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- R (observed number of runs) = 5
- Degrees of freedom: df = $(n_1 + n_2) - 1 = 20 - 1 = 19$

(iii) Expected Mean and Standard Deviation Under H_o

Under the null hypothesis H_o of randomness (i.e., successive price changes are independent), the expected mean and standard deviation of the number of runs are:

Expected Mean:

$\mu = [2 \times n_1 \times n_2 / (n_1 + n_2)] + 1$

$\mu = [2 \times 12 \times 8 / (12 + 8)] + 1$

$\mu = [192 / 20] + 1$

$\mu = 9.6 + 1$

$\mu = 10.6$

Standard Deviation:

$\sigma = \sqrt{[2 \times n_1 \times n_2 \times (2 \times n_1 \times n_2 - n_1 - n_2)] / [(n_1 + n_2)^2 \times (n_1 + n_2 - 1)]}$

$\sigma = \sqrt{[2 \times 12 \times 8 \times (2 \times 12 \times 8 - 12 - 8)] / [(20)^2 \times (20 - 1)]}$

$\sigma = \sqrt{[192 \times (192 - 20)] / [400 \times 19]}$

$\sigma = \sqrt{[192 \times 172] / 7,600}$

$\sigma = \sqrt{33,024 / 7,600}$

$\sigma = \sqrt{4.3453}$

$\sigma = 2.0845$

(iv) Confidence Interval Test using t-Distribution

Per the ICAI SM convention, the confidence interval is constructed using critical t-values at $df = (n_1 + n_2) - 1 = 19$.

At 5% Level of Significance (t = 2.093, df = 19):

Lower limit $= \mu - t \times \sigma = 10.6 - 2.093 \times 2.0845 = 10.6 - 4.363 = 6.237$

Upper limit $= \mu + t \times \sigma = 10.6 + 2.093 \times 2.0845 = 10.6 + 4.363 = 14.963$

5% Confidence Interval = [6.237, 14.963]

At 10% Level of Significance (t = 1.729, df = 19):

Lower limit $= \mu - t \times \sigma = 10.6 - 1.729 \times 2.0845 = 10.6 - 3.604 = 6.996$

Upper limit $= \mu + t \times \sigma = 10.6 + 1.729 \times 2.0845 = 10.6 + 3.604 = 14.204$

10% Confidence Interval = [6.996, 14.204]

Level of Significance	Critical t (df = 19)	Acceptance Range for R	Observed R	Decision
5%	± 2.093	[6.24, 14.96]	5	5 < 6.24 → REJECT H_o
10%	± 1.729	[7.00, 14.20]	5	5 < 7.00 → REJECT H_o

Conclusion:

The observed number of runs (R = 5) falls below the lower bound of the acceptance region at BOTH the 5% and 10% levels of significance. The null hypothesis of randomness is decisively rejected. The Weak-Form Efficient Market Hypothesis is therefore rejected for Bharat Steel Ltd. based on this sample of 21 trading days.

(v) Economic Intuition and Practitioner Interpretation

The Run Test statistic captures an economically meaningful pattern in price behaviour, not merely a mechanical arithmetic outcome.

Too Few Runs (R < μ): Trending / Momentum Behaviour

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A very low number of runs, as observed here (R = 5 versus expected 10.6), signals that price changes are clustering into long unbroken sequences of the same sign. Positive changes are followed by more positive changes; negative changes by more negative changes. This is the statistical signature of trending or momentum behaviour. In practical terms, if this pattern is stable and identifiable ex ante, a momentum-based trading strategy — buy when the price starts rising, hold while it continues rising — could in principle generate abnormal returns, which is inconsistent with weak-form efficiency.

Too Many Runs (R > μ): Mean-Reverting Behaviour

A very high number of runs would signal that price changes are systematically alternating in sign more often than randomness would predict — an up-day tends to be followed by a down-day, and vice versa. This is the signature of mean-reverting behaviour. A contrarian trading strategy — sell after up-days, buy after down-days — could in principle exploit this pattern.

Randomness (R ≈ μ): Weak-Form Efficiency

When R lies within the expected range, price changes are statistically indistinguishable from a random sequence. Past prices contain no exploitable pattern, no simple trading rule based on past prices can generate abnormal returns, and weak-form efficiency holds.

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CHAPTER 5A — SECURITY VALUATION (EQUITY INSTRUMENTS)

Question 1 — Three-Stage H-Model

InnovaPharma Ltd. is a specialty pharmaceutical company with a strong domestic oncology franchise and an emerging US generic portfolio. The equity research analyst expects the dividend growth rate to start at an elevated 18% p.a., decline linearly over the next six years, and stabilise at 6% p.a. in perpetuity as the firm matures and US generic competition intensifies. Half-life of transition (H) is therefore 3 years. Current dividend (D_0) is ₹5 per share and the required rate of return (K_e) is 12% p.a.

H-Model Formula

$P_0 = [D_0 \times (1 + g_n)] / (K_e - g_n) + [D_0 \times H \times (g_a - g_n)] / (K_e - g_n)$

Where: g_a = initial high growth rate; g_n = terminal stable growth rate; H = half-life of the transition period (in years).

Required:

(i) Compute the intrinsic value using the H-Model.

(ii) Decompose the intrinsic value into the "stable growth component" and the "transition adjustment component" and comment on the economic significance of each.

(iii) Sensitivity: If the transition period were faster (H = 2 years instead of 3), what would be the revised intrinsic value?

(iv) Explain when the H-Model is analytically preferred over the two-stage DDM.

Solution

(i) Intrinsic Value via H-Model

Stable Growth Component:

$= [D_0 \times (1 + g_n)] / (K_e - g_n)$

$= [5 \times 1.06] / (0.12 - 0.06)$

$= 5.30 / 0.06 = ₹88.33$

Transition Adjustment Component:

$= [D_0 \times H \times (g_a - g_n)] / (K_e - g_n)$

$= [5 \times 3 \times (0.18 - 0.06)] / (0.12 - 0.06)$

$= [5 \times 3 \times 0.12] / 0.06$

$= 1.80 / 0.06 = ₹30.00$

Intrinsic Value = ₹88.33 + ₹30.00 = ₹118.33 per share

(ii) Economic Decomposition

Component	Value (₹)	% of Total	Economic Interpretation
Stable Growth Component	88.33	74.6%	Value if the firm grew at only the terminal 6% rate from Year 1 onwards
Transition Adjustment	30.00	25.4%	Additional value from the elevated growth during the transition period
Total Intrinsic Value	118.33	100.0%	

The transition adjustment of ₹30 per share (25% of total value) represents the incremental value that InnovaPharma generates because of its multi-year super-normal growth trajectory. If the analyst were to use a naive Gordon model

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with only the 6% terminal rate, the firm would be systematically undervalued by 25 percent — a material error in stock recommendation.

(iii) Sensitivity: H = 2 (Faster Transition)

If the transition period compresses to H = 2 years (i.e., 4-year total transition), the analysis becomes:

Transition Adjustment = [5 × 2 × 0.12] / 0.06 = 1.20 / 0.06 = ₹20.00

Revised Intrinsic Value = 88.33 + 20.00 = ₹108.33 per share

A one-year compression in the transition period reduces intrinsic value by ₹10 per share, or approximately 8 percent. This shows that the length of the super-normal phase materially affects fair value — a key judgement call for the analyst that requires industry-specific insight.

(iv) When the H-Model is Preferred

(i) When the growth trajectory is monotonically declining over a predictable transition period. Pharmaceutical firms losing patent exclusivity, technology firms facing platform saturation, and specialty industrial firms in maturing niches typically follow this pattern.

(ii) When the analyst wants to avoid the artificial "cliff" of the two-stage model. The two-stage model creates a sharp discontinuity — 20% growth in Year 2 and 10% growth in Year 3 — which does not reflect economic reality. The H-Model smooths this transition mathematically.

(iii) When rough directional accuracy is more important than granular precision. The H-Model achieves reasonable accuracy with only three inputs (g_a, g_n, H), making it well-suited to preliminary screening across large watchlists. For detailed valuation of a single stock, a full three-stage explicit forecast is generally preferred.

Question 2 — FCFE Valuation and Comparison with DDM

BharatTech Ltd. is a mid-cap technology firm listed on the NSE. The Chief Investment Officer of a diversified equity mutual fund has asked you to value the company using both the Free Cash Flow to Equity (FCFE) approach and the Dividend Discount Model (DDM), and to explain any divergence between the two intrinsic value estimates.

BharatTech Ltd. — Financial Snapshot for FY26 (₹ crore):

Item	Amount
Net Profit After Tax	200
Depreciation and Amortisation	50
Capital Expenditure	80
Increase in Working Capital	20
New Debt Issued	40
Debt Repayment	25
Preference Dividend Paid	10
Dividend Paid to Equity Shareholders	60

Additional Assumptions:

- Number of equity shares outstanding: 10 crore
- Sustainable growth rate for both FCFE and dividends: 6% p.a. in perpetuity
- Cost of equity (K_e), derived from CAPM: 13% p.a.

Required:

(i) Compute the Free Cash Flow to Equity (FCFE) and FCFE per share.

(ii) Compute the intrinsic value per share using the FCFE-based Constant Growth Model.

(iii) Compute the intrinsic value per share using the DDM-based Constant Growth Model.

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(iv) Explain the gap between the two intrinsic value estimates and identify which is analytically more appropriate for BharatTech Ltd.

(v) Discuss the type of Indian companies for which the FCFE approach would systematically dominate the DDM in professional equity research practice.

Solution

(i) FCFE Computation

FCFE captures the cash flow available to equity shareholders after all operating expenses, capital investment, working capital changes, and debt service (both principal and interest post-tax) have been met. Preference dividends are also subtracted because they are a mandatory cash outflow prior to equity distributions.

Item	₹ Crore
Net Profit After Tax	200
Add: Depreciation (non-cash)	50
Less: Increase in Working Capital	(20)
Less: Capital Expenditure	(80)
Add: New Debt Issued	40
Less: Debt Repaid	(25)
Less: Preference Dividend	(10)
Free Cash Flow to Equity (FCFE)	**155**

FCFE per Share = ₹155 crore / 10 crore shares = ₹15.50

(ii) FCFE-based Intrinsic Value

Applying the constant growth model to FCFE per share:

$FCFE_1$ per share = 15.50 × 1.06 = ₹16.43

IV (FCFE) = $FCFE_1$ / (K_e − g) = 16.43 / (0.13 − 0.06) = 16.43 / 0.07

IV (FCFE) = ₹234.71 per share

(iii) DDM-based Intrinsic Value

Current DPS = ₹60 crore / 10 crore shares = ₹6.00

D_1 = 6.00 × 1.06 = ₹6.36

IV (DDM) = D_1 / (K_e − g) = 6.36 / (0.13 − 0.06) = 6.36 / 0.07

IV (DDM) = ₹90.86 per share

(iv) Explaining the Gap

Method	Intrinsic Value (₹)	% of FCFE-based Value
FCFE Model	234.71	100.0%
DDM	90.86	38.7%
Value Missed by DDM	143.85	61.3%

The DDM captures only 38.7 percent of the intrinsic value indicated by the FCFE model. The gap of ₹143.85 per share reflects retained earnings that BharatTech is reinvesting rather than distributing as dividends. The firm generates ₹15.50 per share of distributable cash flow but pays out only ₹6.00 — a payout ratio of just 38.7 percent.

Per ICAI SM when payout ratio is materially below 100 percent, the DDM systematically understates value because it treats retained cash as if it were destroyed rather than reinvested at the firm's return on equity. The FCFE model correctly captures the full economic value regardless of dividend policy.

For BharatTech Ltd., the FCFE-based intrinsic value of ₹234.71 is the analytically appropriate estimate. The DDM understates value by 61 percent and would produce a materially wrong stock recommendation.

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(v) When FCFE Systematically Dominates DDM in Indian Practice

(i) High-growth firms with low payout ratios. Indian IT services firms typically retain 40-60% of earnings for global capacity expansion; Indian pharmaceutical firms retain 50-70% for R&D and capacity building. DDM systematically undervalues these firms.

(ii) Firms that pay no dividends. Many mid-cap and small-cap Indian firms, particularly in emerging technology, consumer internet, and specialty manufacturing, pay zero or nominal dividends. DDM is structurally silent on their value; FCFE is the only DCF-based option.

(iii) Firms with volatile or policy-driven dividend patterns. Some Indian firms use dividend policy for signalling rather than economic distribution — declaring generous dividends to attract retail investors, or cutting dividends to fund acquisitions. In these cases DDM confuses signalling behaviour with economic value; FCFE cuts through to the underlying cash generation.

(iv) Firms subject to changing capital structures. When leverage is being materially altered — for example, during LBO-type transactions or debt refinancing cycles — the FCFE model directly captures the value impact through the debt-issuance and debt-repayment lines. DDM cannot see these effects.

Question 3 — FCFF Two-Stage Valuation

MeridianAuto Ltd. is a Tier-1 Indian auto components supplier with a strong export order book. The Head of Corporate Finance is evaluating an equity investment in the company and has asked you to value the firm using the Free Cash Flow to Firm (FCFF) two-stage model. The FCFF approach values the entire enterprise (equity plus debt plus preference capital) by discounting operating cash flows at the Weighted Average Cost of Capital (WACC), then subtracts non-equity claims to arrive at equity value.

MeridianAuto Ltd. — Explicit Forecast Period FCFF (₹ crore):

Year	FCFF
Year 1	100
Year 2	115
Year 3	130
Year 4 onwards	Stable growth phase

Additional Assumptions:

- Stable growth rate (g) from Year 4 onwards: 5% p.a.
- Weighted Average Cost of Capital (WACC): 11% p.a.
- Debt outstanding (market value): ₹400 crore
- Preference share capital (market value): ₹100 crore
- Equity shares outstanding: 50 crore
- PVF @ 11%: Year 1 = 0.901, Year 2 = 0.812, Year 3 = 0.731

Required:

(i) Compute the present value of FCFF during the explicit forecast period (Years 1 to 3).

(ii) Compute the horizon value (Terminal Value) at the end of Year 3 using the stable-growth Gordon model applied to $FCFF_4$.

(iii) Discount the horizon value back to today.

(iv) Compute the total Enterprise Value.

(v) Derive the equity value and the intrinsic value per equity share.

(vi) Comment on the relative merits of FCFF valuation versus FCFE valuation in professional equity research practice.

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Solution

(i) Present Value of Explicit Period FCFF

Year	FCFF (₹ crore)	PVF @ 11%	PV of FCFF (₹ crore)
1	100	0.901	90.10
2	115	0.812	93.38
3	130	0.731	95.03
		PV of Explicit Period	**278.51**

(ii) Horizon Value (Terminal Value) at End of Year 3

$FCFF_4 = FCFF_3 \times (1 + g) = 130 \times 1.05 = ₹136.50$ crore

Terminal Value at end of Year 3 = $FCFF_4$ / (WACC − g) = 136.50 / (0.11 − 0.05) = 136.50 / 0.06

Terminal Value at end of Year 3 = ₹2,275.00 crore

(iii) Present Value of Horizon Value

PV of Terminal Value = 2,275.00 × 0.731

PV of Terminal Value = ₹1,663.03 crore

(iv) Total Enterprise Value

Component	₹ Crore
PV of Explicit Period FCFF (Years 1-3)	278.51
PV of Terminal Value	1,663.03
Enterprise Value (EV)	**1,941.54**

The Terminal Value contributes 85.6 percent of Enterprise Value, which is typical for firms in stable industries. This concentration underscores why the terminal growth assumption and WACC accuracy are the two most consequential inputs in any FCFF valuation.

(v) Equity Value and Intrinsic Value per Share

Item	₹ Crore
Enterprise Value	1,941.54
Less: Market Value of Debt	(400.00)
Less: Market Value of Preference Capital	**(100.00)**
Equity Value	**1,441.54**

Intrinsic Value per Equity Share = ₹1,441.54 crore / 50 crore shares = ₹28.83

(vi) FCFF vs FCFE — Merits in Practice

(i) FCFF is capital-structure neutral. Because FCFF is computed before debt service, changes in leverage do not directly alter the FCFF stream — only the WACC changes. This makes FCFF the natural choice when valuing firms in the middle of capital structure transitions (post-IPO deleveraging, LBO refinancing, acquisitions financed through mixed sources).

(ii) FCFE is more intuitive for pure equity investors. The FCFE stream is directly what accrues to shareholders. In sell-side research, FCFE-based per-share value often communicates more clearly to portfolio managers because it maps directly to shareholder cash flows.

(iii) FCFF is preferred when debt is volatile or complex. Firms with meaningful convertible debt, warrants, or hybrid securities are difficult to value via FCFE because the debt-issuance line becomes ambiguous. FCFF sidesteps this by valuing the entire enterprise first, then subtracting all non-equity claims.

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(iv) For consistent-leverage firms, the two methods produce equivalent equity values when applied rigorously. Convergence between FCFF and FCFE should be treated as an internal validation check in any full equity research model.

Question 4 — Relative Valuation using P/E Multiples with Peer Adjustments

ConsumerSnacks Ltd., a listed mid-cap FMCG player operating in the branded packaged foods segment, is being evaluated for potential inclusion in an equity mutual fund's portfolio. The buy-side analyst has been asked to derive intrinsic value using the P/E multiple approach, with specific adjustments for the company's distinctive fundamentals relative to industry peers, and to cross-check the result against the Gordon Growth Model.

Company data:

Parameter	Value
Trailing EPS	₹15
Return on Equity (ROE)	18%
Dividend Payout Ratio	40%
Cost of Equity (K_e)	13%

Peer Group and Adjustment Judgements:

- Industry Average Trailing P/E: 22.0x
- Peer average ROE: 14 percent (ConsumerSnacks superior by 400 bps) — analyst applies a 10% P/E premium for higher return quality
- Peer average Debt/Equity: 0.5x (ConsumerSnacks at 1.0x, materially higher) — analyst applies a 5% P/E discount for elevated financial risk

Required:

(i) Compute the peer-adjusted P/E multiple for ConsumerSnacks Ltd.

(ii) Derive the intrinsic value per share via the P/E multiple approach.

(iii) Cross-check using Gordon's Constant Growth Model, deriving the sustainable growth rate from ROE and retention ratio.

(iv) Reconcile the two intrinsic value estimates and articulate the final research recommendation range.

(v) Discuss the general limitations of relative valuation approaches and when they are preferred over DCF-based methods in professional practice.

Solution

(i) Peer-Adjusted P/E Multiple

The industry P/E of 22.0x reflects the market's collective view of comparable firms. ConsumerSnacks warrants adjustments for its distinctive fundamentals:

Adjusted P/E = Industry P/E × (1 + ROE Premium − Leverage Discount)

= 22.0 × (1 + 0.10 − 0.05)

= 22.0 × 1.05

= 23.10x

(ii) Intrinsic Value via P/E Multiple

IV (P/E Multiple) = Trailing EPS × Adjusted P/E

= 15 × 23.10

= ₹346.50 per share

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(iii) Cross-Check via Gordon's Growth Model

Sustainable growth rate (g) = ROE × Retention Ratio

= 0.18 × (1 − 0.40) = 0.18 × 0.60 = 10.8%

Current DPS (D_0) = EPS × Payout Ratio = 15 × 0.40 = ₹6.00

D_1 = 6.00 × 1.108 = ₹6.648

IV (Gordon) = D_1 / (K_e − g) = 6.648 / (0.13 − 0.108) = 6.648 / 0.022

IV (Gordon) = ₹302.18 per share

(iv) Reconciliation and Recommendation Range

Method	Intrinsic Value (₹)	% Difference from Midpoint
Relative Valuation (P/E Multiple)	346.50	+6.8%
Gordon's Growth Model	302.18	−6.8%
Midpoint (Fair Value Anchor)	**324.34**	—

The two methods yield estimates that differ by approximately 15 percent, reflecting the different assumptions embedded in each. The relative valuation approach implicitly incorporates the market's aggregate expectations about the industry (which may include growth rates higher than ConsumerSnacks' own 10.8 percent). The Gordon model uses only firm-specific inputs and produces a more conservative estimate.

Research Recommendation: Fair value range of ₹302 to ₹347 per share, with a central estimate of ₹324. The recommendation depends on the current market price:

- If CMP < ₹302: BUY (undervalued on both methods)
- If CMP ₹302 to ₹347: HOLD (within fair value range)
- If CMP > ₹347: SELL / TRIM (overvalued on both methods)

(v) Limitations of Relative Valuation and When It Is Preferred

Limitations:

(i) Circular reasoning risk. Relative valuation assumes that peer firms are correctly priced by the market. If the entire sector is over- or under-valued, relative valuation propagates that mispricing to the target firm.

(ii) Adjustment subjectivity. The 10% ROE premium and 5% leverage discount applied here are judgemental. Two analysts applying the same framework can arrive at materially different adjusted multiples.

(iii) Ignores company-specific structural differences. Firms in the same industry can have profoundly different economics (e.g., asset-light franchisee model versus capital-heavy manufacturing). Peer multiples may not adequately capture these differences.

(iv) Static in nature. P/E multiples reflect the current state; they do not incorporate expected changes in growth, profitability, or capital structure the way explicit DCF forecasts do.

When Preferred:

(i) Early-stage firms with limited forecast visibility. When explicit multi-year forecasts are speculative, benchmarking against comparables provides a defensible anchor.

(ii) Sell-side coverage initiation. When an analyst is initiating coverage with limited proprietary insight, relative valuation is faster to deploy and easier to defend against critique.

(iii) Cross-checking DCF outputs. Even when DCF is the primary technique, relative valuation is used as a sanity check. Large divergences between DCF and relative valuation are early warning signals that one of the models has a flawed input.

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Question 5 — CAPM-Derived Cost of Equity Integrated with Gordon's Model

OceanShipping Ltd. is a listed Indian shipping company operating tanker and container vessels on international trade routes. The stock is currently trading at ₹65 on the BSE. As part of a broader portfolio review, the equity strategist has asked you to derive the required rate of return using the Capital Asset Pricing Model (CAPM), value the stock using Gordon's Growth Model, and evaluate whether the current market price offers an attractive risk-adjusted entry point.

Available inputs:

Parameter	Value
Risk-free Rate (Rf, 10-year G-Sec yield)	7.0%
Market Risk Premium (Rm − Rf)	6.0%
Equity Beta (β)	1.4
Current Dividend per Share (D_o)	₹3.00
Expected Sustainable Growth Rate (g)	8.0%
Current Market Price	₹65.00

Required:

(i) Compute the required rate of return on equity (K_e) using CAPM.

(ii) Compute the intrinsic value per share using Gordon's Growth Model.

(iii) Compare intrinsic value with current market price and state whether the stock is over- or under-valued and by what magnitude. Provide a specific investment recommendation.

(iv) Sensitivity: If the company undertakes a debt-funded fleet expansion that increases its equity beta from 1.4 to 1.6, recompute K_e and the resulting intrinsic value. Comment on the implications for the investment decision.

(v) Discuss the theoretical and practical limitations of CAPM as a discount rate framework in Indian equity valuation.

Solution

(i) Cost of Equity via CAPM

$K_e = Rf + \beta \times (Rm - Rf)$

$= 0.07 + 1.4 \times 0.06$

$= 0.07 + 0.084$

K_e = 15.4%

(ii) Intrinsic Value via Gordon's Growth Model

$D_1 = D_o \times (1 + g) = 3.00 \times 1.08 = ₹3.24$

$IV = D_1 / (K_e - g) = 3.24 / (0.154 - 0.08) = 3.24 / 0.074$

Intrinsic Value = ₹43.78 per share

(iii) Valuation Assessment and Recommendation

Metric	Value
Intrinsic Value (Gordon Model)	₹43.78
Current Market Price	**₹65.00**
Overvaluation (₹)	**₹21.22**
Overvaluation (%)	**48.5%**

Recommendation: SELL. The stock trades at a 48.5 percent premium to intrinsic value — well beyond any reasonable margin of error. The current market price implies expectations that the analyst's own fundamentals do not support.

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A prudent portfolio manager would exit any existing position and would not initiate a new long position at these levels. The stock could be considered again only if either (a) the market price corrects toward the intrinsic value estimate, or (b) new information emerges to justify a higher growth expectation or lower discount rate.

(iv) Sensitivity: Higher Beta Scenario

If leverage-driven fleet expansion raises equity beta to 1.6:

Revised K_e = 0.07 + 1.6 × 0.06 = 0.07 + 0.096 = 16.6%

Revised IV = 3.24 / (0.166 − 0.08) = 3.24 / 0.086 = ₹37.67 per share

Scenario	β	K_e	Intrinsic Value (₹)	Overvaluation (%)
Base Case	1.40	15.4%	43.78	48.5%
Post-Expansion	1.60	16.6%	37.67	72.5%

The higher beta scenario deepens the overvaluation to 72.5 percent because the additional financial risk from debt-funded expansion raises the discount rate faster than the growth benefit materialises. This is a critical practitioner insight: expansion strategies that increase equity risk without proportionately improving cash flows destroy shareholder value.

If OceanShipping proceeds with the fleet expansion as currently planned, the SELL recommendation strengthens further. Investors should watch for management's capital structure commentary on the upcoming earnings call as a key catalyst.

(v) Limitations of CAPM in Indian Equity Valuation

(i) Beta estimation instability. Beta is measured statistically over historical data and is highly sensitive to the estimation window (2-year vs 5-year), the frequency (daily vs weekly), and the choice of market proxy (Nifty 50 vs Nifty 500). Estimates for the same stock can vary by 0.3–0.5 across methodologies.

(ii) Market risk premium ambiguity. The 6.0 percent MRP used above is the practitioner consensus, but academic estimates for India range from 5.5 to 8.5 percent depending on the methodology. This range translates to 60-250 bps of variability in K_e and correspondingly large swings in intrinsic value.

(iii) Single-factor assumption. CAPM assumes that systematic risk (beta) fully captures the risk premium. In practice, factors such as size, value, momentum, and quality have been shown empirically to command additional risk premiums (Fama-French three-factor and five-factor models). Pure CAPM systematically understates the required return for small-cap and value stocks.

(iv) Country risk in emerging markets. For Indian firms with substantial global exposure, the domestic risk-free rate and MRP may not fully capture emerging market risk. Some practitioners add a country risk premium to K_e to account for this.

(v) Structural changes. Beta is backward-looking; it reflects the firm's historical risk profile. If a firm is undergoing a strategic transformation (as OceanShipping is in this question), historical beta may materially understate forward-looking risk. Explicit scenario adjustment to beta is warranted.

Question 6 — Market Risk Premium, Equity Risk Premium, and the Build-Up Method for Required Return

RetailMart Ltd. is a listed Indian offline-plus-online retail chain operating in the value fashion segment. The company faces a distinct combination of risks: sector-wide execution challenges as e-commerce reshapes shopping behaviour, elevated capex requirements for store network expansion, regulatory uncertainty around foreign investment rules in multi-brand retail, and macroeconomic sensitivity to consumer discretionary spending.

The Head of Research at your investment firm believes that a pure CAPM-based discount rate would systematically understate the true required return because CAPM captures only systematic (market-wide) risk through the beta and

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the Market Risk Premium. She has asked you to derive the required return using a Build-Up Method that explicitly layers various risk premiums to arrive at the total Equity Risk Premium for the specific security.

Available Inputs

Parameter	Value
10-year Government Security Yield (Rf)	7.25%
Market Risk Premium (MRP) for India (Damodaran estimate)	7.5%
Country Risk Premium (already embedded in domestic MRP above)	N/A separately
Company's Adjusted Beta (vs Nifty 500)	1.10
Industry-Specific Execution Risk Premium (Analyst judgement)	1.5%

Required:

(i) Compute the company-specific required return on equity using the Build-Up methodology, showing the CAPM systematic component and the additional non-systematic premium explicitly.

(ii) Compute the total security-specific Equity Risk Premium (ERP) implied by your answer.

(iii) Justify the choice of the 10-year G-Sec yield as the risk-free rate proxy versus the 91-day T-Bill.

(iv) Articulate the analytical rationale for adding an industry-specific premium on top of the CAPM-derived component.

(v) Compare the Build-Up derived required return against the pure CAPM-derived required return and comment on the difference.

(vi) Discuss when the Build-Up Method is preferred over pure CAPM in professional equity research practice.

Solution

(i) Build-Up Methodology — Layered Construction

The Build-Up Method computes the required return by summing the risk-free rate with progressively-layered risk premiums:

K_e = Rf + (β × MRP) + Execution Risk Premium

Note carefully: beta is multiplied with MRP (the market-wide premium), not with ERP (which is the security-specific total premium we are constructing). This distinction is fundamental.

Substituting the inputs:

Layer	Component	Value
Risk-free rate	Rf	7.25%
CAPM Systematic Premium	β × MRP = 1.10 × 7.5%	8.25%
Non-systematic Adjustment	Execution Risk Premium	1.50%
Total Required Return (K_e)	**Sum**	**17.00%**

K_e = 7.25% + 8.25% + 1.50% = 17.00%

(ii) Total Security-Specific Equity Risk Premium (ERP)

The security-specific ERP is the total excess return required over the risk-free rate for holding RetailMart shares:

Security-specific ERP = K_e − Rf = 17.00% − 7.25% = 9.75%

Decomposition of the 9.75% ERP:

Component	Value	Description
Systematic component (β × MRP)	8.25%	The CAPM-captured premium reflecting exposure to market risk
Non-systematic component (Execution Risk Premium)	1.50%	The Build-Up addition reflecting firm-specific risks CAPM cannot capture

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Component	Value	Description
Total Security-Specific ERP	**9.75%**	

This decomposition is why the terminology matters: the 7.5% figure in the inputs is the market-level MRP, not the security-specific ERP. Beta multiplies MRP (not ERP) because CAPM measures systematic exposure relative to the aggregate market. The Build-Up Method then adds firm-specific premia to produce the total ERP as an output.

(iii) Risk-Free Rate Choice: 10-year G-Sec versus 91-day T-Bill

Per ICAI SM, the discount rate must be matched to the cash flow duration. The choice between the 10-year G-Sec (currently 7.25%) and the 91-day T-Bill (typically 6.5-6.8%) is not trivial:

- Equity valuations discount cash flows in perpetuity or over very long horizons. The 10-year G-Sec captures the long-term interest rate expectation and inflation outlook.
- The 91-day T-Bill reflects only short-term liquidity preferences and RBI monetary policy stance, which can be quite different from long-term interest rate levels.

For equity valuation, the 10-year G-Sec is the appropriate proxy. The 91-day T-Bill is appropriate only for valuing short-duration instruments such as commercial paper, money market funds, or short-tenor commodity forwards.

(iv) Rationale for Industry-Specific Premium

Pure CAPM captures only systematic (market) risk through beta multiplied by MRP. It does not capture firm-specific or industry-specific risks such as:

(i) Regulatory uncertainty. Multi-brand retail in India has faced episodic policy shifts on foreign investment norms, tax structures, and e-commerce rules. Such regulatory volatility is not captured by historical beta.

(ii) Execution risk in transformation strategies. RetailMart is executing an omnichannel transition — offline physical stores plus e-commerce plus supply chain integration. Execution risk in strategic transformations is empirically material but does not show up in past return correlations.

(iii) Sector-specific technological disruption. E-commerce reshaping traditional retail is a structural shift that beta, calculated from historical data, cannot fully anticipate.

(iv) Concentration risk. RetailMart operates in a single sector; multi-sector conglomerates enjoy natural diversification benefits not available to focused single-sector plays.

The 150 bps execution risk premium captures these residual risks. This is the essence of the Build-Up Method: adding a firm-specific premium on top of the CAPM output to reflect risks that historical beta and market-wide MRP cannot capture.

(v) Build-Up vs Pure CAPM Comparison

Method	Formula	K_e	Security-Specific ERP
Pure CAPM	Rf + (β × MRP)	7.25% + 8.25% = 15.5%	8.25%
Build-Up Method	Rf + (β × MRP) + Execution Risk Premium	17.00%	9.75%
Difference	Additional execution risk premium	**+150 bps**	**+150 bps**

The 150 bps addition is material. For a stock with terminal-value-heavy valuation (where TV constitutes 70-85 percent of enterprise value), a 150 bps increase in discount rate can reduce intrinsic value by 15-25 percent. This is the difference between a BUY and a HOLD recommendation, or between a HOLD and a SELL. The choice of methodology therefore has direct portfolio-implementation consequences.

(vi) When Build-Up Is Preferred

(i) Companies undergoing strategic transformation. When historical beta does not reflect forward risk (RetailMart's omnichannel pivot, a bank shifting from branch to digital, a pharma firm entering biosimilars), Build-Up captures the transformation premium.

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(ii) Firms in early-lifecycle stages. Emerging-market growth firms with limited trading history have unreliable beta estimates. Build-Up provides a defensible alternative.

(iii) Firms in structurally risky industries. Real estate developers, small-cap infrastructure operators, and specialty chemical firms face industry-specific risks that CAPM understates. Build-Up allows explicit adjustment.

(iv) For private company valuation. When there is no listed share price, beta must be estimated from comparable listed peers plus adjustments for size, liquidity, and control. Build-Up is the standard approach in private equity, venture capital, and startup CFO settings.

Question 7 — Three-Stage DDM with H-Model Transition (CFA L2 Adapted for CA Exam)

An equity research analyst is valuing a listed company that exhibits a distinctive three-stage dividend growth profile. The current annual dividend paid is $0.75 per share. The analyst expects dividends to grow at 12% p.a. for the next three years (Phase 1 — super-normal growth), decline linearly from 12% to 4% over the following six years (Phase 2 — transition), and then stabilise at 4% p.a. in perpetuity (Phase 3 — steady state). The required rate of return on equity is 9%.

PVF at 9% (provided):

Year	PVF @ 9%
Year 1	0.9174
Year 2	0.8417
Year 3	0.7722

Required:

(i) Compute the value of the company using a combination of the standard DDM (for Phase 1) and the H-Model (for the combined Phase 2 transition and Phase 3 perpetuity).

(ii) Verify the answer by identifying and explaining the H-Model half-life parameter (H) used in the solution.

Solution: Analytical Approach — Why the H-Model Solves Phases 2 and 3 Together

A naive three-stage explicit-forecast approach would require the analyst to compute six separate dividends during the transition phase (Years 4 through 9), each with a different linearly-declining growth rate, and then a terminal value from Year 10 onwards. This would involve twelve to fifteen distinct arithmetic operations and is unwieldy in an exam setting.

The H-Model provides a mathematically elegant collapse of these two phases (linear transition plus stable perpetuity) into a single closed-form expression. This allows the analyst to:

(i) Compute D_1, D_2, and D_3 explicitly using the Phase 1 growth rate of 12%.

(ii) Compute the value at end of Year 3 (V_3) directly using the H-Model formula, which internally captures both the transition phase and the perpetuity.

(iii) Discount D_1, D_2, and the sum of (D_3 + V_3) back to today at the 9% required return.

The result is a three-cash-flow discounting problem that any CA student can execute manually with a basic calculator using the provided PVFs.

Step 1 — Dividend Forecasts for Phase 1 (Super-Normal Growth)

With D_0 = $0.75 and g_S = 12%:

Year	Formula	Computation	Dividend ($)
1	$D_1 = D_0 \times (1 + g_S)$	0.75 × 1.12	0.8400
2	$D_2 = D_1 \times (1 + g_S)$	0.8400 × 1.12	0.9408
3	$D_3 = D_2 \times (1 + g_S)$	0.9408 × 1.12	1.0537

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Cross-verification for D_3: $D_0 \times (1.12)^3 = 0.75 \times 1.4049 = \$1.0537$. ✓

Step 2 — Value at End of Year 3 via the H-Model

The H-Model captures the entire cash flow stream from Year 4 onwards — that is, the linear transition period plus the stable perpetuity — into a single expression. The formula (ICAI SM) is:

$V_3 = [D_3 \times (1 + g_L)] / (r - g_L) + [D_3 \times H \times (g_S - g_L)] / (r - g_L)$

Where:

- D_3 = Dividend at end of Year 3 = \$1.0537
- g_L = Long-term stable growth rate = 4% = 0.04
- g_S = Short-term high growth rate = 12% = 0.12
- H = Half-life of the transition period = 6 / 2 = 3 years
- r = Required rate of return = 9% = 0.09

The formula has two intuitive components: a stable-growth component (what the firm would be worth if it grew perpetually at 4%) and a transition adjustment (the extra value from the initial high-growth phase that gradually declines).

Component A — Stable Growth Value:

$[D_3 \times (1 + g_L)] / (r - g_L)$

= 1.0537 × 1.04 / (0.09 − 0.04)

= 1.0958 / 0.05

= \$21.9170

Component B — Transition Adjustment:

$[D_3 \times H \times (g_S - g_L)] / (r - g_L)$

= 1.0537 × 3 × (0.12 − 0.04) / (0.09 − 0.04)

= 1.0537 × 3 × 0.08 / 0.05

= 0.2529 / 0.05

= \$5.0578

Value at End of Year 3:

V_3 = 21.9170 + 5.0578 = \$26.9748

Step 3 — Discount Cash Flows to Today

The analyst now has three cash flows to discount: D_1, D_2, and the composite cash flow of Year 3 (which is D_3 received at end of Year 3, plus V_3 representing the value of all future cash flows also at end of Year 3).

Year	Cash Flow ($)	Description	PVF @ 9%	PV ($)
1	0.8400	D_1	0.9174	0.7706
2	0.9408	D_2	0.8417	0.7920
3	28.0285	$D_3 + V_3$ = 1.0537 + 26.9748	0.7722	21.6436
			Intrinsic Value	**\$23.21**

Step 4 — Final Answer

Intrinsic Value of the Share = \$23.21

Note on precision: The CFA Institute's own solution reports \$23.2056 using very high-precision PVFs from a financial calculator. Using the ICAI-convention 4-decimal PVFs provided in the question, the answer rounds to \$23.21. Both are correct within acceptable tolerance; the ICAI examiner would accept any answer within the range \$23.19 to \$23.22.

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Explanation of the H-Model Half-Life Parameter

The parameter H is called the half-life of the transition period. When growth declines linearly from g_S to g_L over T years, H = T / 2 captures the mathematical "centre of mass" of the excess growth above the long-term rate.

In this question, the transition period runs from Year 4 through Year 9 — a span of 6 years. The half-life H = 6 / 2 = 3 years is therefore the correct input to the H-Model formula.

Intuition: Imagine the excess growth (g_S − g_L) as a triangle that decays from 8% at the start of transition to 0% at the end. The H-Model recognises that the present value of this decaying triangle is approximately equal to a rectangle of height (g_S − g_L) and width H — that is, a stable premium growth of 8% for 3 years. This mathematical approximation is what makes the H-Model computationally tractable while remaining reasonably accurate.

Question 8 — Implied Cost of Equity Using the H-Model Inversion (CFA L2 Adapted for CA Exam)

Beluga Fisheries Ltd. is a listed seafood processing company that just paid a current annual dividend of $0.75 per share. The equity research analyst covering the stock estimates that the current dividend growth rate of 10% p.a. will decline linearly to a long-term stable rate of 5% p.a. over the next five years, and then remain at 5% p.a. in perpetuity. The current market price of the share is $30.00.

The Head of Research is not asking you to value the company (which would be the standard H-Model application). Instead, she asks a more sophisticated question: given the market's current price of $30.00, what discount rate is the market implicitly demanding on this stock? This is the technique of computing the implied cost of equity — a powerful analytical tool in institutional equity research and one that Aswath Damodaran uses extensively in his implied equity risk premium framework.

Required:

(i) Derive the H-Model formula in a form that expresses r (required return) as a function of D_0, P_0, g_S, g_L, and H.

(ii) Compute the implied required return for Beluga Fisheries.

(iii) Interpret the answer in terms of the implied equity risk premium the market is pricing.

(iv) Explain how a portfolio manager would use this implied return in a stock-selection decision.

Analytical Approach — Inverting the H-Model

The standard H-Model expresses price as a function of the discount rate:

$P_0 = D_0 \times [(1 + g_L) + H \times (g_S - g_L)] / (r - g_L)$

In standard valuation applications, we substitute known values for D_0, r, g_S, g_L, and H, and solve for P_0. In the implied-return application, the logic reverses: we substitute known values for D_0, P_0, g_S, g_L, and H (all observable market or estimated fundamentals), and solve for r. The algebraic manipulation is straightforward:

Starting equation:

$P_0 = D_0 \times [(1 + g_L) + H \times (g_S - g_L)] / (r - g_L)$

Multiply both sides by (r − g_L):

$P_0 \times (r - g_L) = D_0 \times [(1 + g_L) + H \times (g_S - g_L)]$

Divide both sides by P_0:

$r - g_L = (D_0 / P_0) \times [(1 + g_L) + H \times (g_S - g_L)]$

Add g_L to both sides — the inverted H-Model formula:

$$\mathbf{r = (D_0 / P_0) \times [(1 + g_L) + H \times (g_S - g_L)] + g_L}$$

This is the closed-form solution for the implied discount rate. It has an intuitive interpretation: the required return equals the current dividend yield (D_0/P_0) times a growth-adjustment factor, plus the long-term stable growth rate.

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Step-by-Step Computation

Inputs Summary:

Variable	Value	Description
D_0	$0.75	Current annual dividend paid
P_0	$30.00	Current market price per share
g_S	10% = 0.10	Current (short-term) growth rate
g_L	5% = 0.05	Long-term stable growth rate
Transition period	5 years	Time over which growth declines linearly from g_S to g_L
H	5 / 2 = 2.5	Half-life of the transition period

Sequential Computation (all standard arithmetic operations):

Step	Operation	Result
1	$D_0 / P_0 = 0.75 / 30$	0.025
2	g_S − g_L = 0.10 − 0.05	0.05
3	H × (g_S − g_L) = 2.5 × 0.05	0.125
4	(1 + g_L) + [H × (g_S − g_L)] = 1.05 + 0.125	1.175
5	$(D_0 / P_0) \times 1.175 = 0.025 \times 1.175$	0.029375
6	Add g_L: r = 0.029375 + 0.05	0.079375
Final	**Implied Required Return r**	**7.94%**

Implied Required Return for Beluga Fisheries = 7.94%

Interpretation — What Does 7.94% Actually Mean?

The 7.94% implied required return has a specific economic meaning: it is the total annual return the market is expecting from holding Beluga Fisheries stock over the long run, given the current price of $30.00 and the analyst's assumptions on dividend growth. This 7.94% can be decomposed into two components:

Return Component	Value	Source
Dividend Yield (D_0 / P_0)	2.50%	Current cash income from dividends
Growth Component (Implied)	5.44%	Expected capital appreciation from dividend growth
Total Required Return	**7.94%**	

The growth component of 5.44% is not directly the same as g_L (5%); it is g_L plus the H-Model transition premium the market is implicitly recognising. The market is essentially saying: "To justify paying $30 for this stock, we expect to earn approximately 7.94% per year through a combination of dividend income and share price appreciation."

Comparison with CAPM — The Implied Equity Risk Premium

The real analytical power of the implied return calculation emerges when we compare it with the CAPM-derived required return. This comparison is the foundation of Aswath Damodaran's implied ERP framework used at NYU Stern Business School:

Illustrative comparison scenario:

- Suppose the US 10-year Treasury yield (Rf) is 4.5%.
- Beluga Fisheries' beta, estimated over 5 years, is 0.85.
- Standard US market risk premium (MRP) is assumed at 5.0%.
- CAPM-derived required return = 4.5% + 0.85 × 5.0% = 8.75%

Metric	Value	Reading
Implied Return (from market price)	7.94%	What the market expects
CAPM-Derived Return	8.75%	What fundamentals suggest

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Metric	Value	Reading
Implied – CAPM Gap	**–0.81%**	**Market accepts lower return than fundamentals justify**

A negative gap of 81 bps signals that the market is pricing the stock at a level where returns are below what CAPM would suggest is fair — that is, the stock trades at a premium to fair value. Rational interpretation: either the market believes the analyst's growth assumptions are too conservative, or the stock is genuinely overvalued.

Portfolio Manager Application

A portfolio manager considering an investment in Beluga Fisheries would use the implied return in one of three ways, depending on their investment philosophy:

(i) Fundamental value investor. If the CAPM-implied return (8.75%) exceeds the market-implied return (7.94%), the stock is overpriced relative to fundamentals. The value investor passes, or considers a short position if the mandate permits.

(ii) Growth investor. The value investor's conclusion may be wrong if the analyst's growth assumptions are too conservative. The growth investor asks: what growth rate would justify a fair CAPM-based return? Solving inversely from the H-Model, this rate may be materially higher than 10% and the growth investor may still buy if they believe Beluga can achieve it.

(iii) Momentum investor. Does not directly use implied return but observes it as a market sentiment indicator. A widening negative gap (implied return falling further below CAPM) suggests accelerating bullish sentiment — potentially a positive momentum signal.

Computing implied returns on a portfolio of 30-50 stocks every quarter is one of the most efficient ways to identify candidates for deeper fundamental review. Stocks with the largest positive gaps (implied return > CAPM return) are typically the most attractive risk-adjusted opportunities.

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CHAPTER 5B — SECURITY VALUATION (FIXED INCOME INSTRUMENTS)

Question 1

Shiva Limited issues a partly convertible debenture for Rs. 600, carrying an interest rate of 10 percent. Rs. 200 will get compulsorily converted into two equity shares of Shiva Limited a year from now. The expected price per share of Shiva Limited's equity a year from now would be Rs. 150. The non-convertible portion will be redeemed in two equal instalments of Rs. 200 each at the end of years five and six respectively.

What is the pre-tax rate of return earned by the debenture holders?

Assume that the price per share after a year would be Rs. 120.

(Investment Analysis & Portfolio Management - Prof Prasanna Chandra)

Solution:

Assumed Share Price after 1 year	Pre-tax Rate of Return
₹150 per share	15.47% p.a.
₹120 per share	12.08% p.a.

Question 2

A Rs. 1,000 par value bond carries a coupon of 10 percent (payable annually) and has a remaining maturity of four years. The bond is presently selling for Rs. 1020. The re investment rate applicable to the future cash inflows of the bonds is nine percent per annum. What will be the realised yield to maturity?

(Investment Analysis & Portfolio Management - Prof Prasanna Chandra)

Solution:

Given:

Face Value = ₹1,000

Coupon Rate = 10% p.a.

Annual Coupon = ₹100

Remaining Maturity = 4 years

Purchase Price = ₹1,020

Reinvestment Rate = 9% p.a.

Redemption Value = ₹1,000

Step 1: Compute Maturity Value of Coupons

Coupon received at end of	Amount (₹)	Compounding Factor @ 9%	Value at Maturity (₹)
Year 1	100	(1.09)^3 = 1.2950	129.50
Year 2	100	(1.09)^2 = 1.1881	118.81
Year 3	100	(1.09)^1 = 1.0900	109.00
Year 4	100	(1.09)^0 = 1.0000	100.00
Total Maturity Value of Coupons			457.31

Step 2: Total Maturity Value

$$= \text{Redemption Value} + \text{Accumulated Coupons}$$
$$= \mathbf{1,000 + 457.31}$$
$$= \mathbf{₹1,457.31}$$

Step 3: Compute Realised Yield

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$$1020(1+r)^4 = 1457.31$$
$$\left(1+r\right)^4 = \frac{1457.31}{1020} = 1.42874$$
$$1+r = (1.42874)^{1/4}$$
$$= 1.0932$$
$$r = 9.32\%$$

Question 3

A 10 percent coupon bond has a maturity of 12 years. It pays interest semi-a Its yield to maturity is four percent per half-year period. What is its duration?

(Principles of Corporate Finance , Brealey & Myers)

Solution:

Formula for duration is:

$$\frac{1+y}{y} - \frac{(1+y)+t(c-y)}{C((1+y)^t-1)+y}$$

The bond has five percent semi-annual coupon and 24 payment periods.

Its duration would be:

(1.04 /.04) – (1.04+24(0.05 -0.04))/ (04+ (0.05 [1.0424 -1]

= 15.17 half-years

= 7.58 years

Question 4 — Bond Portfolio Immunization

Mr. Wealth has a specific liability-driven investment obligation: he must accumulate exactly ₹10 lakh at the end of four years from today to fund a family commitment. He wants to protect this obligation against interest rate risk through a bond immunization strategy so that the target ₹10 lakh accumulates regardless of parallel shifts in the yield curve during the holding period.

Two bonds are available in the corporate bond market. Both are AAA-rated with negligible credit risk, allowing the portfolio construction to focus purely on interest rate immunization.

Bond	Coupon	Maturity	YTM	Macaulay Duration	Face Value
Bond X (Short)	7%	3 years	9%	2.81 years	₹100
Bond Y (Long)	8%	6 years	9%	4.85 years	₹100

PVF at 9% (provided):

Year	PVF @ 9%
Year 1	0.9174
Year 2	0.8417
Year 3	0.7722
Year 4	0.7084
Year 5	0.6499
Year 6	0.5963

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PVAF at 9% (provided):

Period	PVAF @ 9%
3-year annuity	2.5313
6-year annuity	4.4859

Required:

(i) Compute the present value of the ₹10 lakh future obligation and determine the investment amount required today.

(ii) Explain why either bond used alone would fail to immunize the 4-year obligation.

(iii) Determine the portfolio weights for Bond X and Bond Y that immunize the obligation through duration matching.

(iv) Compute the current market price of each bond, given its coupon rate and prevailing YTM.

(v) Allocate the total investment amount between the two bonds based on the immunizing weights.

(vi) Compute the number of each bond that Mr. Wealth must purchase.

(vii) Discuss the practical limitations of the immunization framework in real-world portfolio management.

Solution

(i) Present Value of the Future Obligation

The ₹10 lakh is Mr. Wealth's FUTURE obligation at end of Year 4 — not the amount he has available today. To determine the investment required today, we discount the obligation at the prevailing YTM of 9%:

PV of Obligation = Future Obligation × PVF (9%, 4)

= 10,00,000 × 0.7084

= ₹7,08,400

Mr. Wealth must invest ₹7,08,400 today. If yields remain at 9% throughout the 4-year horizon, this investment will accumulate exactly to ₹10 lakh at the end of Year 4. The immunization strategy protects this accumulation against parallel yield shifts.

(ii) Why a Single Bond Cannot Immunize the 4-Year Obligation

Immunization requires that portfolio duration equal the liability horizon, so that reinvestment risk and price risk offset each other for parallel yield shifts.

Bond	Duration	Horizon	Duration Gap	Uncovered Risk
Bond X alone	2.81 years	4 years	−1.19 years	Reinvestment risk — coupons reinvested at unknown future rates for 1.19 years after Bond X matures
Bond Y alone	4.85 years	4 years	+0.85 years	Price risk — Bond Y must be sold at Year 4 at an unknown future price

Neither bond individually matches the horizon. A combined portfolio can achieve exact duration matching by weighted combination.

(iii) Portfolio Weights for Immunization

Setting portfolio duration equal to the 4-year liability horizon:

$w_x \times 2.81 + (1 - w_x) \times 4.85 = 4$

Expanding:

$2.81\ w_x + 4.85 - 4.85\ w_x = 4$

$-2.04\ w_x = 4 - 4.85 = -0.85$

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w_x = 0.85 / 2.04 = 0.4167 (41.67%)

w_y = 1 − 0.4167 = 0.5833 (58.33%)

(iv) Market Price of Each Bond

Since both bonds have YTM (9%) exceeding their respective coupon rates (7% and 8%), both trade at a discount to face value. We compute the market price by discounting each bond's cash flows at 9%.

Bond X — 7% coupon, 3 years, YTM 9%, Face Value ₹100:

Year	Cash Flow (₹)	PVF @ 9%	PV (₹)
1	7 (coupon)	0.9174	6.42
2	7 (coupon)	0.8417	5.89
3	107 (coupon + face)	0.7722	82.63
		Market Price of Bond X	**₹94.94**

Bond Y — 8% coupon, 6 years, YTM 9%, Face Value ₹100:

Using the PVAF and PVF at 9% for the 6-year annuity:

Market Price = Annual Coupon × PVAF(9%, 6) + Face Value × PVF(9%, 6)

= 8 × 4.4859 + 100 × 0.5963

= 35.89 + 59.63

= ₹95.52

Summary of Bond Prices:

Bond	Face Value (₹)	Market Price (₹)	Discount to Face
Bond X	100.00	94.94	5.06% discount
Bond Y	100.00	95.52	4.48% discount

Both bonds trade at discount because YTM (9%) exceeds coupon rates (7% and 8% respectively). This is the classical premium-par-discount relationship covered in Question 8.

(v) Investment Allocation Between the Two Bonds

Apply the immunizing weights to the total investment amount of ₹7,08,400:

Bond	Weight	Investment Allocation (₹)
Bond X	0.4167 (41.67%)	7,08,400 × 0.4167 = 2,95,190
Bond Y	0.5833 (58.33%)	7,08,400 × 0.5833 = 4,13,210
Total	**1.0000 (100%)**	**7,08,400**

(vi) Number of Each Bond to Purchase

This is the critical operational step. Since both bonds trade below their face value of ₹100, the number of bonds is derived by dividing each rupee allocation by the actual market price (not the face value):

Number of Bond X:

= Rupee Allocation to Bond X / Market Price of Bond X

= 2,95,190 / 94.94

= 3,109.23

≈ 3,109 bonds (rounded to nearest whole number)

Number of Bond Y:

= Rupee Allocation to Bond Y / Market Price of Bond Y

= 4,13,210 / 95.52

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= 4,325.90

≈ 4,326 bonds (rounded to nearest whole number)

Portfolio Construction Summary:

Bond	Number of Bonds	Market Price (₹)	Actual Investment (₹)
Bond X	3,109	94.94	3,109 × 94.94 = 2,95,168
Bond Y	4,326	95.52	4,326 × 95.52 = 4,13,220
Total Portfolio	**7,435 bonds**		**7,08,388**

The actual investment of ₹7,08,388 differs from the theoretical requirement of ₹7,08,400 by only ₹12 (0.002%). This tiny difference reflects rounding to whole bonds and is immaterial in practice. Bond mutual funds and larger institutional portfolios that permit fractional bond exposure can achieve the exact allocation, but retail immunization strategies always face this trivial rounding drift.

(vii) Practical Limitations of the Immunization Framework

(i) Parallel shift assumption. Immunization protects only against parallel shifts in the yield curve. Non-parallel shifts — steepening, flattening, or twists — can break the immunization and produce Year 4 accumulations different from the target.

(ii) Continuous rebalancing requirement. Duration is dynamic — it changes with time and yield movements at different rates for different bonds. Real-world immunization portfolios require periodic rebalancing (typically annually or semi-annually) to maintain the duration match. Failing to rebalance creates a growing residual gap.

(iii) Fractional bond rounding drift. As shown above, the requirement to purchase whole bonds creates minor deviations from the target investment. For retail portfolios this is trivial; for institutional-scale immunization, bond mutual fund units or floating rate notes can be used to achieve exact fractional exposure.

(iv) Convexity mismatch. Even if duration is matched, differences in the convexity profiles of the two bonds versus the liability can create residual risk under large yield movements. Advanced portfolio dedication techniques match both duration and convexity to eliminate this residual.

(v) Reinvestment rate assumptions. The immunization result assumes coupon reinvestment at the prevailing YTM. In practice, coupon reinvestment happens at whatever rate is available when the coupon is received, which introduces path-dependent variation.

(vi) Credit risk changes. Immunization addresses only interest rate risk. If either bond's credit standing deteriorates during the holding period, the portfolio's accumulation may fall short of target regardless of the duration match.

Question 5 — Spot Rates, Forward Rates, and Bond Pricing via Yield Curve

The Head of Fixed Income at a Delhi-based asset management company is analysing the Indian G-Sec yield curve to derive implied forward rates and price a new corporate bond issue. The current observable spot rate structure is:

Maturity	Spot Rate
1-year	6.0%
2-year	6.8%
3-year	7.4%

Required:

(i) Compute the 1-year implied forward rate one year from now ($f_{1,1}$).

(ii) Compute the 1-year implied forward rate two years from now ($f_{2,1}$).

(iii) Price a 3-year corporate bond with annual coupon of ₹80 and face value of ₹1,000 using the spot rate curve.

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(iv) Briefly explain the Expectations Theory and the Liquidity Preference Theory of the term structure of interest rates.

Solution

(i) Forward Rate $f_{1,1}$ (One-year Rate, One Year Forward)

The no-arbitrage relationship between spot and forward rates:

$$\mathbf{(1 + s_2)^2 = (1 + s_1) \times (1 + f_{1,1})}$$

Substituting:

$(1.068)^2 = 1.06 \times (1 + f_{1,1})$

$1.1407 = 1.06 \times (1 + f_{1,1})$

$(1 + f_{1,1}) = 1.1407 / 1.06 = 1.07614$

$\mathbf{f_{1,1} = 7.61\%}$

(ii) Forward Rate $f_{2,1}$ (One-year Rate, Two Years Forward)

$$\mathbf{(1 + s_3)^3 = (1 + s_2)^2 \times (1 + f_{2,1})}$$

$(1.074)^3 = (1.068)^2 \times (1 + f_{2,1})$

$1.2388 / 1.1407 = 1 + f_{2,1}$

$1 + f_{2,1} = 1.08596$

$\mathbf{f_{2,1} = 8.60\%}$

Observation: The forward rates (7.61%, 8.60%) are rising. This is consistent with an upward-sloping yield curve — the market expects short rates to rise over time, or at least demands a term premium for longer maturities.

(iii) Bond Pricing Using Spot Rates

Each cash flow is discounted at its own maturity-matched spot rate:

Year	Cash Flow (₹)	Spot Rate	Discount Factor	PV of Cash Flow (₹)
1	80 (coupon)	6.0%	1 / 1.06 = 0.9434	75.47
2	80 (coupon)	6.8%	1 / $(1.068)^2$ = 0.8767	70.13
3	1,080 (coupon + FV)	7.4%	1 / $(1.074)^3$ = 0.8072	871.79
			Bond Price	**₹1,017.39**

Bond Price = ₹1,017.39 (trading slightly above par)

Comment: The bond trades at a modest premium because the 8 percent coupon rate exceeds the average spot rate implied by the yield curve (which lies between 6.0 and 7.4 percent). If we were instead to use a single YTM to discount all cash flows, we would get a slightly different bond price — the spot-rate approach is theoretically more accurate because it recognises that different cash flow maturities face different discount rates.

(iv) Term Structure Theories

Expectations Theory (Pure Expectations Hypothesis):

Long-term rates are simple averages of expected future short-term rates. Forward rates are unbiased predictors of future spot rates. Under this theory:

- An upward-sloping yield curve implies the market expects future short rates to rise.
- A downward-sloping (inverted) yield curve implies the market expects future short rates to fall — historically a recession warning.
- A flat yield curve implies expected stable rates.

Empirical support: Expectations Theory has strong theoretical elegance but limited empirical support. Forward rates have been shown to be biased upward as predictors of future spot rates in most markets.

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Liquidity Preference Theory:

Investors demand a premium (called the liquidity premium or term premium) for locking their funds into longer-maturity bonds instead of rolling short-term instruments. Under this theory:

- Long-term yields = Average of expected future short rates + Liquidity Premium
- The liquidity premium is positive and generally increases with maturity.
- The "normal" yield curve is upward-sloping even when the market expects stable short rates, because of the liquidity premium.
- Only when the market expects a substantial fall in short rates (typically preceding a recession) can the yield curve invert — the falling-rate expectation must overwhelm the positive liquidity premium.

Empirical support: Liquidity Preference Theory has substantially stronger empirical grounding and is the dominant framework in professional practice today.

Question 6 — Valuation of a Rights Issue

TechRise Ltd. is a listed Indian mid-cap technology firm currently trading on the NSE at ₹450 per share. The company has 100 lakh equity shares outstanding. To fund the acquisition of a US-based data analytics subsidiary, the Board has approved a 1:5 rights issue at a subscription price of ₹300 per share. Each existing shareholder will receive the right to subscribe to 1 new share for every 5 shares held.

The rights issue is a common capital raising mechanism in Indian listed markets — it allows the firm to raise fresh equity at a discount to market price while giving existing shareholders the first opportunity to maintain their proportionate ownership. However, the mechanics of rights valuation and the choices facing shareholders (subscribe, renounce, or ignore) contain subtleties that students frequently misunderstand.

Assumption:

- Rights are freely tradable in the secondary market between record date and exercise date.
- Ignore any dividend adjustments and transaction costs.

Required:

(i) Compute the ex-rights (theoretical) share price after the rights issue.

(ii) Compute the value of one right — expressed both per new share (rights entitlement) and per existing share held.

(iii) For a shareholder holding 5,000 shares in TechRise: analyse the wealth position under three scenarios — (a) full subscription to rights, (b) sale of rights in the secondary market (renunciation), and (c) doing nothing (ignoring the rights).

(iv) Compute the impact on ownership percentage under scenarios (a) and (b), assuming the shareholder held 0.005% of the company before the issue.

(v) Comment on the strategic rationale for issuing shares at a discount to market price.

Solution

(i) Ex-rights (Theoretical) Share Price

The ex-rights price reflects the weighted average of the cum-rights price and the subscription price, weighted by the number of existing and new shares respectively.

Ex-rights Price = [(N × Cum-rights Price) + (1 × Subscription Price)] / (N + 1)

Where N = number of existing shares required for 1 new right = 5

= [(5 × 450) + (1 × 300)] / (5 + 1)

= [2,250 + 300] / 6

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= 2,550 / 6

Ex-rights Price = ₹425

(ii) Value of One Right

Value of Right per new share (rights entitlement):

= Ex-rights Price − Subscription Price

= 425 − 300

= ₹125 per rights entitlement

Value of Right per existing share held:

= (Cum-rights Price − Subscription Price) / (N + 1)

= (450 − 300) / (5 + 1)

= 150 / 6

= ₹25 per existing share

Cross-verification: 5 existing shares × ₹25 = ₹125 = Value of 1 new rights entitlement. ✓

(iii) Wealth Analysis for a Shareholder with 5,000 Shares

The shareholder currently holds 5,000 shares. Under the 1:5 rights ratio, they are entitled to 5,000 / 5 = 1,000 rights (each right lets them buy 1 new share at ₹300).

Pre-Rights Wealth Position:

5,000 shares × ₹450 = ₹22,50,000

Scenario A: Full Subscription

Item	Value (₹)
Original 5,000 shares × ₹425 (ex-rights)	21,25,000
1,000 new shares × ₹425 (ex-rights)	4,25,000
Total Portfolio Value	25,50,000
Less: Subscription Payment (1,000 × ₹300)	**(3,00,000)**
Net Wealth Position	**22,50,000**

Net change from pre-rights position: 22,50,000 − 22,50,000 = ₹0. The shareholder is neither better nor worse off in wealth terms; the rights issue is wealth-neutral if fully subscribed.

Scenario B: Renunciation (Sale of Rights in Secondary Market)

Item	Value (₹)
Original 5,000 shares × ₹425 (ex-rights)	21,25,000
Proceeds from selling 1,000 rights × ₹125	**1,25,000**
Net Wealth Position	**22,50,000**

Net change: ₹0. Renunciation preserves wealth. The market value of rights compensates the shareholder for the dilution of their existing holding.

Scenario C: Doing Nothing (Ignoring the Rights)

Item	Value (₹)
Original 5,000 shares × ₹425 (ex-rights)	21,25,000
Rights value forgone (1,000 × ₹125)	**(1,25,000)**
Net Wealth Position	**21,25,000**

Net change: 21,25,000 − 22,50,000 = −₹1,25,000. The shareholder suffers a wealth loss of ₹1,25,000 by ignoring the rights. This is the classic "rights-worth loss" that retail investors frequently incur out of inertia or lack of awareness.

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(iv) Ownership Percentage Impact

Scenario	Shares Held	Total Shares Outstanding	Ownership %
Pre-rights	500	1,00,00,000	0.005%
Scenario A (Subscribe)	600	1,20,00,000	0.005%
Scenario B (Renounce)	500	1,20,00,000	0.00417%

Only under full subscription does the shareholder maintain their proportionate ownership. Renunciation preserves wealth but dilutes ownership by 16.7 percent. For minority shareholders where percentage ownership is not strategically material, renunciation is often the rational choice — capturing wealth without committing additional capital.

(v) Strategic Rationale for the Subscription Discount

Rights issues in Indian listed markets are typically priced at 25 to 40 percent below the prevailing market price. The 33 percent discount in TechRise's issue (300 vs 450) is well within this range. Three strategic reasons drive this discount:

(i) Certainty of subscription. A material discount effectively guarantees full subscription because the rights themselves are valuable — even shareholders who do not wish to inject fresh capital will sell their rights in the market rather than let them expire worthless. This eliminates the risk of an under-subscribed issue, which would signal weakness to the market.

(ii) Market volatility buffer. During the period between announcement and record date (typically 2-4 weeks), the market price can fluctuate materially. A wide discount ensures that even if the market price falls 15-20 percent during this window, the rights subscription remains attractive.

(iii) Retail participation encouragement. A meaningful discount incentivises retail shareholders to actually subscribe (rather than merely renounce), which the promoter often prefers because it maintains a diversified shareholder base and avoids concentration of new equity among institutional traders.

The discount is one of the most negotiated aspects of the transaction. Too small a discount risks under-subscription; too large a discount transfers excessive value from continuing to new shareholders (who buy rights in the secondary market at prices below their theoretical value). The optimal discount balances certainty of subscription with fair value preservation for existing shareholders.

Question 7 — Yield to Call, Yield to Put, and Yield to Worst

Merlin Industries Ltd., a listed BSE 500 corporate, has issued a 10-year bond with the following features. An investor at a Mumbai-based fixed income fund is evaluating whether to purchase this bond in the secondary market and needs to understand the full yield profile before committing capital.

Feature	Value
Face Value	₹1,000
Coupon Rate	10% (annual)
Remaining Maturity	10 years
Current Market Price	₹1,080 (trading at premium)
Callable at ₹1,020 after 3 years	Issuer's option to redeem early
Callable at ₹1,010 after 6 years	Second call date at lower call price
Putable at ₹980 after 4 years	Investor's option to sell back

PVAF and PVF values at multiple discount rates (provided):

Discount Rate	PVAF Y3	PVF Y3	PVAF Y4	PVF Y4	PVAF Y6	PVF Y6	PVAF Y10	PVF Y10
7%	2.6243	0.8163	3.3872	0.7629	—	—	—	—
8%	2.5771	0.7938	3.3121	0.7350	4.6229	0.6302	6.7101	0.4632
9%	—	—	—	—	4.4859	0.5963	6.4177	0.4224

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Required:

(i) Compute the Yield to Maturity (YTM) using the interpolation method, assuming the bond is held to natural maturity.

(ii) Compute the Yield to Call (YTC) for both call dates (3 years and 6 years) using the same interpolation approach.

(iii) Compute the Yield to Put (YTP) at the put date of 4 years using interpolation.

(iv) Determine the Yield to Worst (YTW) from the investor's perspective and identify the scenario that produces it.

(v) Explain from a corporate finance perspective why the issuer includes call features and why the investor demands put features.

(vi) State the effective yield the investor should use for investment decision purposes.

Solution

(i) Yield to Maturity — Interpolation Method

The bond's cash flow stream is ₹100 annual coupon for 10 years plus ₹1,000 face value at Year 10. We discount this stream at two trial rates to bracket the observed market price of ₹1,080.

Trial 1: Discount at 8%

Cash Flow Component	Formula	Amount (₹)
PV of coupons (10 years)	100 × PVAF(8%, 10) = 100 × 6.7101	671.01
PV of face value (Year 10)	1,000 × PVF(8%, 10) = 1,000 × 0.4632	463.20
Total Price at 8%		**1,134.21**

Trial 2: Discount at 9%

Cash Flow Component	Formula	Amount (₹)
PV of coupons (10 years)	100 × PVAF(9%, 10) = 100 × 6.4177	641.77
PV of face value (Year 10)	1,000 × PVF(9%, 10) = 1,000 × 0.4224	422.40
Total Price at 9%		**1,064.17**

Interpolation Between 8% and 9%:

At 8%: Price = ₹1,134.21

At 9%: Price = ₹1,064.17

Target Market Price: ₹1,080.00

The target price of ₹1,080 lies between the two trial prices, confirming that YTM lies between 8% and 9%. Applying linear interpolation:

YTM = Lower Rate + [(Price at Lower Rate − Target Price) / (Price at Lower Rate − Price at Higher Rate)] × (Higher Rate − Lower Rate)

YTM = 8% + [(1,134.21 − 1,080.00) / (1,134.21 − 1,064.17)] × (9% − 8%)

= 8% + [54.21 / 70.04] × 1%

= 8% + 0.7740 × 1%

= 8% + 0.7740%

YTM = 8.77%

(ii-a) Yield to Call at Year 3 — Interpolation Method

If called at Year 3, the bondholder receives ₹100 coupon for 3 years plus the call price of ₹1,020 at Year 3.

Trial 1: Discount at 7%

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Cash Flow Component	Formula	Amount (₹)
PV of coupons (3 years)	100 × PVAF(7%, 3) = 100 × 2.6243	262.43
PV of call price (Year 3)	1,020 × PVF(7%, 3) = 1,020 × 0.8163	832.63
Total Price at 7%		**1,095.06**

Trial 2: Discount at 8%

Cash Flow Component	Formula	Amount (₹)
PV of coupons (3 years)	100 × PVAF(8%, 3) = 100 × 2.5771	257.71
PV of call price (Year 3)	1,020 × PVF(8%, 3) = 1,020 × 0.7938	809.68
Total Price at 8%		**1,067.39**

Interpolation Between 7% and 8%:

YTC = 7% + [(1,095.06 − 1,080.00) / (1,095.06 − 1,067.39)] × (8% − 7%)

= 7% + [15.06 / 27.67] × 1%

= 7% + 0.5443 × 1%

YTC (3-year) = 7.54%

(ii-b) Yield to Call at Year 6 — Interpolation Method

If called at Year 6, the bondholder receives ₹100 coupon for 6 years plus the call price of ₹1,010 at Year 6.

Trial 1: Discount at 8%

Cash Flow Component	Formula	Amount (₹)
PV of coupons (6 years)	100 × PVAF(8%, 6) = 100 × 4.6229	462.29
PV of call price (Year 6)	1,010 × PVF(8%, 6) = 1,010 × 0.6302	636.50
Total Price at 8%		**1,098.79**

Trial 2: Discount at 9%

Cash Flow Component	Formula	Amount (₹)
PV of coupons (6 years)	100 × PVAF(9%, 6) = 100 × 4.4859	448.59
PV of call price (Year 6)	1,010 × PVF(9%, 6) = 1,010 × 0.5963	602.26
Total Price at 9%		**1,050.85**

Interpolation Between 8% and 9%:

YTC = 8% + [(1,098.79 − 1,080.00) / (1,098.79 − 1,050.85)] × (9% − 8%)

= 8% + [18.79 / 47.94] × 1%

= 8% + 0.3920 × 1%

YTC (6-year) = 8.39%

(iii) Yield to Put at Year 4 — Interpolation Method

If the investor exercises the put at Year 4, they receive ₹100 coupon for 4 years plus the put price of ₹980 at Year 4.

Trial 1: Discount at 7%

Cash Flow Component	Formula	Amount (₹)
PV of coupons (4 years)	100 × PVAF(7%, 4) = 100 × 3.3872	338.72
PV of put price (Year 4)	980 × PVF(7%, 4) = 980 × 0.7629	747.64
Total Price at 7%		**1,086.36**

Trial 2: Discount at 8%

Cash Flow Component	Formula	Amount (₹)
PV of coupons (4 years)	100 × PVAF(8%, 4) = 100 × 3.3121	331.21

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Cash Flow Component	Formula	Amount (₹)
PV of put price (Year 4)	980 × PVF(8%, 4) = 980 × 0.7350	720.30
Total Price at 8%		**1,051.51**

Interpolation Between 7% and 8%:

YTP = 7% + [(1,086.36 − 1,080.00) / (1,086.36 − 1,051.51)] × (8% − 7%)

= 7% + [6.36 / 34.85] × 1%

= 7% + 0.1825 × 1%

YTP = 7.18%

(iv) Yield to Worst Determination

Yield to Worst is computed from the investor's perspective, considering all scenarios in which the investor's realised yield is unfavourable:

(i) Call options are the ISSUER'S rights. The issuer will exercise the call whenever it benefits them (i.e., when they can refinance at a lower rate). This is always adverse to the investor, so both YTC values are potentially binding on the investor's yield.

(ii) Put options are the INVESTOR'S rights. The investor exercises the put only when it benefits them (i.e., when YTP exceeds YTM). Here YTP (7.18%) is LESS than YTM (8.77%), so the investor will NOT exercise the put. The put is out-of-the-money and does not enter the Yield to Worst calculation.

Scenario	Yield	Included in YTW?
Held to Natural Maturity	8.77% (YTM)	Yes (base case)
Called at Year 3	7.54% (YTC 3-yr)	Yes (issuer's choice, unfavourable to investor)
Called at Year 6	8.39% (YTC 6-yr)	Yes (issuer's choice, unfavourable to investor)
Put at Year 4	7.18% (YTP)	No (investor won't exercise since YTP < YTM)

Yield to Worst = MIN (YTM, YTC-3yr, YTC-6yr) = MIN (8.77%, 7.54%, 8.39%) = 7.54%

The worst-case outcome for the investor is the bond being called at Year 3 at ₹1,020, producing a realised yield of 7.54%. This is the yield the investor should use for prudent investment decision-making.

(v) Rationale for Call and Put Features

Why the Issuer Includes Call Features:

(i) Interest rate flexibility. If market interest rates fall materially after issuance, the issuer can call the bond and refinance at the lower prevailing rate. This is exactly the scenario where the investor faces adverse yield outcomes.

(ii) Balance sheet management. Callable bonds allow the issuer to restructure capital as business conditions change (for example, after a large asset sale or major acquisition, the issuer may want to reduce debt).

(iii) Rating-triggered refinancing. If the issuer's credit rating improves, they can call the higher-coupon bond and reissue at a lower coupon reflecting their improved credit standing.

Why the Investor Demands Put Features:

(i) Interest rate protection. If interest rates rise materially, the investor can put the bond at the put price (avoiding further mark-to-market losses) and reinvest at the new higher rates.

(ii) Credit protection. If the issuer's credit rating deteriorates, the investor can exit the position at the put price rather than bearing the full credit-driven price decline.

(iii) Portfolio rebalancing flexibility. Puts provide investors with a defined exit at a known price, useful for insurance and pension fund portfolios that must periodically rebalance to target duration or asset allocation.

(vi) Investment Decision Yield

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The investor should evaluate this bond using the Yield to Worst of 7.54%, not the YTM of 8.77%.

This is a critical practitioner discipline. A retail investor or naive analyst who evaluates the bond on YTM basis will believe they are earning 8.77% and be disappointed when the issuer exercises the call at Year 3 and the realised return is only 7.54%. Sophisticated investors always use Yield to Worst as the effective yield for callable bonds trading at premium — precisely because the premium price signals that yields have fallen since issuance, making the call more likely.

Appendix — Comparison Between Interpolation and Approximation Methods

For pedagogical reference, the yields computed by the approximation formula (used in the earlier version of this question) versus the interpolation method:

Yield Measure	Approximation Method	Interpolation Method	Difference (bps)
YTM	8.85%	8.77%	8 bps
YTC (3-year)	7.62%	7.54%	8 bps
YTC (6-year)	8.45%	8.39%	6 bps
YTP	7.28%	7.18%	10 bps
Yield to Worst	**7.62%**	**7.54%**	**8 bps**

The approximation method consistently overstates yields by 6-10 basis points across all four measures because it uses a simple average of face value and current price in the denominator, which is a rough proxy for the true weighted-average investment. The interpolation method uses actual PV computations at both trial rates and produces yields that satisfy the cash-flow-to-price equivalence to within one decimal place of accuracy. For any serious investment decision, the interpolation method is the analytically correct choice.

Question 8 — Positive and Negative Convexity

Kingsley Bank Ltd. holds two 10-year corporate bonds in its trading book. Both bonds have identical coupons and are currently priced at par, but they differ in one critical feature: Bond A has no embedded options while Bond B is callable at ₹1,030 after 2 years from today. The Risk Management Committee is analysing how these two bonds will behave under contrasting interest rate scenarios.

Feature	Bond A (Non-Callable)	Bond B (Callable)
Face Value	₹1,000	₹1,000
Coupon Rate	10% (annual)	10% (annual)
Maturity	10 years	10 years
Current YTM	10%	10%
Current Price	₹1,000 (at par)	₹1,000 (at par)
Call Feature	None	Callable at ₹1,030 after 2 years

Yield Scenarios to Analyse:

- Scenario 1: Yields fall by 200 basis points to 8%
- Scenario 2: Yields rise by 200 basis points to 12%

PVAF and PVF (provided):

Discount Rate	PVAF (10 years)	PVF (10 years)
8%	6.710	0.463
10%	6.145	0.386
12%	5.650	0.322

Required:

(i) Compute the price of Bond A (non-callable) under both yield scenarios.

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(ii) Compute the theoretical price of Bond B (callable) under both scenarios, taking the call feature into account.

(iii) Compute the price change (₹ and %) for each bond under each scenario.

(iv) Identify which bond exhibits positive convexity and which exhibits negative convexity, and explain the mechanism.

(v) Discuss the risk management implications for Kingsley Bank of holding negatively convex bonds in the trading book.

Solution

(i) Bond A (Non-Callable) Prices Under Both Scenarios

Scenario 1: Yields fall to 8%

Price = 100 × PVAF(8%, 10) + 1,000 × PVF(8%, 10)

= 100 × 6.710 + 1,000 × 0.463

= 671.00 + 463.00

= ₹1,134.00

Scenario 2: Yields rise to 12%

Price = 100 × PVAF(12%, 10) + 1,000 × PVF(12%, 10)

= 100 × 5.650 + 1,000 × 0.322

= 565.00 + 322.00

= ₹887.00

(ii) Bond B (Callable) Prices Under Both Scenarios

Scenario 1: Yields fall to 8%

The uncallable-equivalent price would be ₹1,134 as computed above. However, the call feature caps the bond's price appreciation. At 8% market yield, the issuer will almost certainly exercise the call at ₹1,030 after 2 years — because they can refinance the 10% coupon debt at the new 8% rate.

The bond's price therefore reflects the expected call outcome: coupons of ₹100 for 2 years plus the call proceeds of ₹1,030 at Year 2, all discounted at 8%.

PVAF(8%, 2) = 1.783; PVF(8%, 2) = 0.857

Price = 100 × 1.783 + 1,030 × 0.857

= 178.30 + 882.71

= ₹1,061.01 (approximately ₹1,061)

Note: In practice, the callable bond price would be capped closer to ₹1,030 as call becomes imminent. For analytical clarity here, we use the PV of expected cash flows assuming the call is exercised at Year 2. The key point is that the callable bond's upside is limited compared to Bond A's ₹1,134.

Scenario 2: Yields rise to 12%

The issuer has no incentive to call the bond because they would need to refinance at the higher 12% rate. The call feature is out-of-the-money and effectively worthless. The bond behaves identically to Bond A at maturity risk-adjusted.

Bond B Price at 12% ≈ ₹887 (same as Bond A)

(iii) Price Change Comparison

Bond	Base Price	Price at 8%	Change (₹)	Change (%)	Price at 12%	Change (₹)	Change (%)
Bond A	1,000	1,134	+134	+13.4%	887	−113	−11.3%

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Bond	Base Price	Price at 8%	Change (₹)	Change (%)	Price at 12%	Change (₹)	Change (%)
Bond B	1,000	1,061	+61	+6.1%	887	−113	−11.3%

(iv) Positive vs Negative Convexity Analysis

Bond A — Positive Convexity:

Gain on rate decline (+13.4%) exceeds loss on rate rise (−11.3%). The bond's price-yield relationship is convex — curves upward when plotted, so the price appreciation from falling yields is larger than the price depreciation from rising yields of the same magnitude. This is the defining property of positive convexity.

Bond B — Negative Convexity in the Falling-Yield Range:

Gain on rate decline (+6.1%) is materially less than loss on rate rise (−11.3%). The call feature truncates upside appreciation — as yields fall, the bond's price runs into the "call ceiling" and cannot appreciate further, while downside on rising yields is uncapped. The price-yield relationship curves the wrong way (concave, not convex) in the low-yield range.

Bond	Convexity Signature	Investor Impact
Bond A (non-callable)	Positive convexity — asymmetric gain	Preferred by investors; the "free lunch" of bond investing
Bond B (callable)	Negative convexity in falling-yield range	Investor gets truncated upside, full downside — must be compensated with higher coupon

(v) Risk Management Implications for Kingsley Bank

(i) Duration measurement understates risk. Standard duration calculations assume linear price-yield sensitivity. For negatively convex bonds, this systematically understates downside risk in rising-rate scenarios because the effective duration extends when the call becomes out-of-the-money.

(ii) Hedging strategies must account for convexity direction. Hedging a portfolio of negatively convex bonds using interest rate futures or swaps (which are positively convex) creates a residual convexity mismatch. The portfolio will underperform the hedge in rising-rate scenarios.

(iii) Capital allocation adjustments. Under Basel III and RBI guidelines for banks, negatively convex bonds attract higher capital charges to reflect their asymmetric risk profile. The trading book capital treatment differs from standard bonds.

(iv) Investor compensation requirements. Because negatively convex bonds transfer optionality from investor to issuer, investors demand higher coupons on callable bonds — typically 40-80 basis points above equivalent non-callable bonds in the Indian market. This coupon premium is the market's compensation for the truncated upside.

(v) Portfolio composition limits. Well-run bank treasuries typically limit callable bond exposure to 15-25% of the fixed income portfolio to control aggregate negative convexity. Concentration in callable bonds becomes especially dangerous in falling-rate environments when call risk is highest.

Question 9 — Term Structure of Interest Rates: The Three Theories

The Head of Fixed Income at your asset management firm has asked you to interpret the current Indian G-Sec yield curve and to identify which of the three classical term structure theories best explains the observed shape. This interpretation informs both the firm's monetary policy expectations and its portfolio duration positioning.

Currently observed spot rate structure:

Maturity	Spot Rate
1-year	6.0%

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Maturity	Spot Rate
2-year	6.5%
3-year	6.8%
4-year	7.0%

Required:

(i) Compute the implied forward rates: $f_{1,1}$ (1-year rate, 1 year forward), $f_{2,1}$ (1-year rate, 2 years forward), and $f_{3,1}$ (1-year rate, 3 years forward).

(ii) Interpret the observed upward-sloping yield curve under the Expectations Theory of the term structure.

(iii) Reinterpret the same curve under the Liquidity Preference Theory, showing how expected future short rates would differ from the implied forward rates.

(iv) Discuss the Market Segmentation Theory and how it applies to the Indian bond market.

(v) Comment on which theory (or combination) best explains the observed Indian yield curve, with reference to institutional participation patterns.

(vi) Studies of the Indian G-Sec market conducted by RBI research staff and academic researchers have documented liquidity premiums typically in the following ranges:

Forward Horizon	Typical Liquidity Premium Range (Empirical)
1-2 years forward	20 to 40 basis points
3-5 years forward	40 to 80 basis points
10+ years forward	100 to 200 basis points

Solution

(i) Implied Forward Rate Computations

$f_{1,1}$ (1-year forward rate, 1 year from now):

$(1 + s_2)^2 = (1 + s_1) \times (1 + f_{1,1})$

$(1.065)^2 = 1.06 \times (1 + f_{1,1})$

$1.1342 / 1.06 = 1 + f_{1,1}$

$1 + f_{1,1} = 1.0700$

$f_{1,1} = 7.00\%$

$f_{2,1}$ (1-year forward rate, 2 years from now):

$(1 + s_3)^3 = (1 + s_2)^2 \times (1 + f_{2,1})$

$(1.068)^3 = (1.065)^2 \times (1 + f_{2,1})$

$1.2183 / 1.1342 = 1 + f_{2,1}$

$1 + f_{2,1} = 1.0741$

$f_{2,1} = 7.41\%$

$f_{3,1}$ (1-year forward rate, 3 years from now):

$(1 + s_4)^4 = (1 + s_3)^3 \times (1 + f_{3,1})$

$(1.07)^4 = (1.068)^3 \times (1 + f_{3,1})$

$1.3108 / 1.2183 = 1 + f_{3,1}$

$1 + f_{3,1} = 1.0759$

$f_{3,1} = 7.59\%$

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Rate	Value	Interpretation
Current 1-year spot (s_1)	6.00%	Rate you can lock in today for 1-year lending
1-yr forward, 1yr out ($f_{1,1}$)	7.00%	Rate the market implies for 1-year lending starting Year 1
1-yr forward, 2yr out ($f_{2,1}$)	7.41%	Rate for 1-year lending starting Year 2
1-yr forward, 3yr out ($f_{3,1}$)	7.59%	Rate for 1-year lending starting Year 3

The forward rate curve is rising from 6.00% to 7.59% over the four-year horizon. This is the pattern that must be interpreted through the term structure theories.

(ii) Expectations Theory Interpretation

The Pure Expectations Theory states that forward rates are unbiased predictors of expected future spot rates. Under this framework, the observed forward rate pattern implies that market participants expect short-term rates to rise steadily over the coming years:

Time Period	Implied Expected Future Spot Rate
Now	6.00%
Year 1	7.00%
Year 2	7.41%
Year 3	7.59%

Economic interpretation under Expectations Theory: The upward-sloping yield curve directly reflects market expectations of tightening monetary policy or rising inflation. The 159 bps rise in expected short rates over four years suggests the market anticipates RBI raising the repo rate materially to combat future inflation pressures.

Empirical challenge: Pure Expectations Theory has strong theoretical elegance but limited empirical support in real bond markets. Forward rates have been shown to be systematically biased upward as predictors of future spot rates, which suggests that a risk premium is embedded in longer-maturity yields.

(iii) Liquidity Preference Theory Interpretation

The Liquidity Preference Theory extends the Expectations Theory by incorporating a term premium: investors demand additional compensation (called the liquidity premium or term premium) for locking their funds into longer-maturity bonds instead of rolling shorter-term instruments.

Framework: Forward Rate = Expected Future Spot Rate + Liquidity Premium

Important methodological note — estimating the liquidity premium:

The liquidity premium is NOT directly observable from the yield curve. It must be estimated using external data such as:

- Surveys of institutional expectations for future spot rates (RBI Consumer Confidence Survey, Bloomberg surveys of primary dealers, or NIPFP forecasts)
- Macroeconomic models of expected policy rates based on inflation and growth forecasts
- Historical averages of the spread between realised spot rates and previously implied forward rates over long time series

Studies of the Indian G-Sec market conducted by RBI research staff and academic researchers have documented liquidity premiums typically in the following ranges:

Forward Horizon	Typical Liquidity Premium Range (Empirical)
1-2 years forward	20 to 40 basis points
3-5 years forward	40 to 80 basis points
10+ years forward	100 to 200 basis points

For pedagogical illustration in this question, ASSUME the following liquidity premium schedule, anchored to the empirical ranges above:

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Forward Rate	Assumed Liquidity Premium (Illustrative)	Rationale
$f_{1,1}$ (1-year forward, 1 year out)	40 bps	Short-end of the empirical 20-40 bps range
$f_{2,1}$ (1-year forward, 2 years out)	60 bps	Mid-point of the empirical 40-80 bps range
$f_{3,1}$ (1-year forward, 3 years out)	80 bps	Upper end of the medium-tenor empirical range

Under Liquidity Preference Theory with these assumed premiums, the actual expected future spot rates are the forward rates MINUS the assumed liquidity premiums:

Time	Forward Rate	Less: Liquidity Premium	Implied Expected Spot Rate
Year 1	7.00%	40 bps	6.60%
Year 2	7.41%	60 bps	6.81%
Year 3	7.59%	80 bps	6.79%

Under this alternative interpretation, the market's actual expectation is for short rates to rise from 6.00% to approximately 6.60-6.80% — a much smaller rise than the naive Expectations Theory interpretation would suggest. The steepness of the observed yield curve is attributed largely to the liquidity premium, not to expectations of aggressive rate hikes.

(iv) Market Segmentation Theory

The Market Segmentation Theory takes a fundamentally different view: it argues that different maturity segments of the bond market are populated by different investor clienteles with distinct preferences and constraints, and the yield curve shape reflects the supply-demand balance in each segment rather than any coherent view about future rates.

Segmentation of the Indian G-Sec market by investor type:

Maturity Segment	Dominant Investor Types	Reason for Preference
Ultra-short (up to 1 year)	Banks, Mutual Funds (Liquid schemes)	Regulatory liquidity requirements; short-duration mandate
Short (1-5 years)	Debt mutual funds, Corporate treasuries	Duration-matched to short-term liabilities
Medium (5-10 years)	Insurance companies, Pension funds	Duration-matched to medium liability profiles
Long (10+ years)	LIC, EPFO, long-term pension trusts	Duration-matched to long-tail liabilities

Under Market Segmentation Theory, the observed yield curve shape reflects the relative supply of bonds versus demand at each maturity. If insurance and pension buyers create strong demand at long maturities, long-maturity yields will be compressed. If short-term liquidity demand from banks and MFs is weak, short-maturity yields will rise. These segment-specific dynamics may have no direct relationship with market-wide expectations about future rates.

(v) Which Theory Best Fits the Observed Indian Yield Curve?

None of the three theories alone fully explains observed yield curve behaviour. Modern academic and practitioner consensus recognises that all three factors contribute to yield curve shape:

(i) Expectations component. Markets do form and price in views about future RBI policy. When the market anticipates rate hikes (as during 2022-23 during global inflation surge), yield curves steepen accordingly.

(ii) Liquidity premium component. Empirical studies of Indian G-Sec markets consistently find a positive term premium of 100-150 bps for 10-year bonds versus 91-day T-Bills. This premium exists even in stable-rate environments, supporting Liquidity Preference Theory.

(iii) Segmentation component. Institutional participation patterns in India (LIC and EPFO dominance at long maturities, MF concentration at short-medium) do create distortions in the yield curve that pure expectations cannot explain. When LIC's investment mandate changes, long-end yields can move independently of policy expectations.

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The pragmatic institutional practitioner uses all three lenses. Analysing an upward-sloping curve, they ask: how much of the steepness reflects genuine rate-hike expectations (Expectations)? How much is the natural term premium (Liquidity Preference)? How much is driven by specific supply-demand imbalances (Segmentation)? Portfolio positioning decisions differ based on which factor dominates.

Question 10 — Warrant Valuation and Speculative Premium

TechCorp Ltd., a listed technology company, has issued warrants alongside a recent convertible bond issue. Each warrant entitles the holder to purchase 1 equity share of TechCorp at a strike price of ₹80 within the next 3 years. The warrant is currently trading in the secondary market at ₹15, and the underlying share is trading at ₹90.

A retail portfolio advisor at your firm has been asked to analyse the warrant's risk-return profile and recommend whether the client (a moderate-risk retail investor) should include warrants in their portfolio.

Feature	Value
Warrant Exercise Price (Strike)	₹80
Current Market Price of Warrant	₹15
Current Stock Price	₹90
Time to Expiry	3 years
Warrant Conversion Ratio	1 warrant → 1 share

Required:

(i) Compute the Intrinsic Value of the warrant.

(ii) Compute the Speculative Premium (Time Value) embedded in the warrant's market price.

(iii) Express the Speculative Premium as a percentage of the warrant's market price.

(iv) Compute the Leverage Ratio of the warrant relative to the underlying stock.

(v) Analyse the investor's return profile under three stock price scenarios at expiry: (a) stock at ₹110, (b) stock at ₹95, (c) stock at ₹70.

(vi) Recommend whether warrants are appropriate for the moderate-risk retail investor described in the question.

Solution

(i) Intrinsic Value

Intrinsic Value = MAX (Stock Price − Exercise Price, 0)

= MAX (90 − 80, 0)

= MAX (10, 0)

= ₹10

The warrant is currently "in-the-money" — the stock trades above the exercise price. The intrinsic value represents the profit an investor would make if they exercised the warrant immediately and sold the resulting share at the market price.

(ii) Speculative Premium (Time Value)

Speculative Premium = Warrant Market Price − Intrinsic Value

= 15 − 10

= ₹5

The ₹5 speculative premium represents the value of the option's remaining time — the possibility that the stock price will rise further during the 3-year holding period. This time value reflects three factors: time to expiry, expected stock volatility, and the risk-free rate.

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(iii) Speculative Premium as Percentage of Market Price

Speculative Premium % = 5 / 15 × 100 = 33.33%

Approximately one-third of the warrant's current market price is speculative. The remaining two-thirds is intrinsic value. This is characteristic of a moderately in-the-money warrant with meaningful time remaining. Deeper in-the-money warrants have lower speculative premium percentages (approaching zero for deep in-the-money short-dated warrants); at-the-money and out-of-the-money warrants have speculative premium percentages approaching 100 percent.

(iv) Leverage Ratio

Leverage Ratio = Stock Price / Warrant Price

= 90 / 15

= 6.0×

The 6.0× leverage ratio means that for every ₹1 an investor could commit to buying the stock (₹90 per share) or to buying warrants (₹15 per warrant), they gain roughly 6× more warrant exposure. In percentage terms, if the stock rises 10%, the warrant will typically rise approximately 60% (for at-the-money warrants; the actual multiplier declines as warrants move deep in-the-money). This asymmetric exposure is the fundamental appeal of warrants to leverage-seeking investors.

(v) Scenario Analysis at Warrant Expiry

At expiry, the warrant's speculative premium collapses to zero. The investor's payoff equals only the intrinsic value at that point.

Scenario	Stock at Expiry	Warrant Payoff	Warrant Return	Stock Return (from ₹90)
Bull Case (a)	₹110	MAX(110-80,0) = ₹30	(30-15)/15 = +100%	(110-90)/90 = +22.2%
Modest Rise (b)	₹95	MAX(95-80,0) = ₹15	(15-15)/15 = 0%	(95-90)/90 = +5.6%
Bear Case (c)	₹70	MAX(70-80,0) = ₹0	(0-15)/15 = −100%	(70-90)/90 = −22.2%

Interpretation of the asymmetric payoff:

(i) Bull case: Warrant delivers 100% return vs stock's 22% return — extreme leverage benefit.

(ii) Modest rise: Warrant is flat while stock returns 5.6%. This is the "break-even at ₹95" outcome (95 = strike ₹80 + current warrant premium ₹15). Any rise below ₹95 is a loss for the warrant holder.

(iii) Bear case: Warrant loses 100% (goes to zero) while stock loses only 22%. This is the fundamental risk of warrant investing — the entire investment can be wiped out.

(vi) Recommendation for Moderate-Risk Retail Investor

Warrants are NOT appropriate for a moderate-risk retail investor as a core portfolio component.

Reasoning:

(i) Asymmetric loss profile. The warrant delivers a maximum loss of 100% of committed capital versus roughly 20-30% typical maximum drawdown on the underlying stock during a bear cycle. This asymmetry is inconsistent with moderate risk tolerance.

(ii) Time decay works against the holder. Unlike stocks, which can be held indefinitely to wait out downturns, warrants have a finite expiry. Time decay is inexorable and accelerates in the final year to expiry.

(iii) Complexity of pricing. Retail investors typically lack the tools to assess whether the ₹5 speculative premium is fair. Warrants that trade at inflated premiums (which happens frequently in illiquid Indian warrant markets) systematically transfer value from retail buyers to issuers.

(iv) Illiquidity in secondary markets. Indian warrant markets are typically thin, with wide bid-ask spreads (5-10 percent). This makes exit costly and forces holders to hold to expiry or accept material execution costs.

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(v) Alternative available. A moderate-risk investor who wants leveraged upside exposure to a specific stock can achieve this through disciplined position sizing in the underlying equity, which avoids the time decay and 100% loss risk of warrants.

Warrants are appropriate only for sophisticated investors with (i) clear directional views, (ii) willingness to accept binary loss outcomes, (iii) understanding of implied volatility and time decay, and (iv) portfolio-level position sizing that limits any single warrant exposure to 1-3 percent of total assets.

Question 11 — Convertible Debenture: Break-Even and Downside Floor Analysis

Nova Pharma Ltd. has issued a listed convertible debenture. A portfolio manager at your fixed income mutual fund is evaluating whether to include this instrument in the fund. Unlike straight bonds, convertibles carry both bond and equity characteristics, and their attractiveness depends heavily on the analyst's view of when conversion becomes economically rational.

Feature	Value
Face Value	₹1,000
Coupon Rate	6% (annual)
Remaining Maturity	10 years
Conversion Ratio	20 equity shares per debenture
Current Share Price	₹40
Current Annual Dividend per Share	₹0.80 (2% dividend yield)
Yield on Comparable Non-Convertible Bonds (Straight Bond Yield)	9%
Current Market Price of Convertible Debenture	₹1,050

PVAF and PVF at 9%:

Period	PVAF (10 yrs)	PVF (10 yrs)
10 years	6.418	0.422

Required:

(i) Compute the Straight Bond Value (the value of the debenture if it were a pure bond without conversion features).

(ii) Compute the Conversion Value at current share price.

(iii) Identify the Downside Floor — the minimum value below which the convertible cannot rationally fall.

(iv) Compute the Conversion Premium — expressed both in absolute rupees and as a percentage.

(v) Compute the Break-Even (Payback) Period, comparing the income advantage of holding the convertible against buying the underlying shares directly.

(vi) Provide a specific investment recommendation based on the analysis.

Solution

(i) Straight Bond Value

The straight bond value equals the present value of the debenture's future cash flows (coupons and face value repayment), discounted at the yield on comparable non-convertible bonds — 9% in this case:

Straight Bond Value = Annual Coupon × PVAF (9%, 10) + Face Value × PVF (9%, 10)

= 60 × 6.418 + 1,000 × 0.422

= 385.08 + 422.00

= ₹807.08

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Note: Annual coupon = 6% × ₹1,000 = ₹60. The 9% discount rate reflects the yield the market demands on similar-credit-quality non-convertible bonds.

(ii) Conversion Value

Conversion Value = Current Share Price × Conversion Ratio

= 40 × 20

= ₹800

This is the value the investor would realise by immediately converting the debenture into 20 shares and selling them at the current market price of ₹40 each.

(iii) Downside Floor

Downside Floor = MAX (Straight Bond Value, Conversion Value)

= MAX (807.08, 800)

= ₹807.08

The convertible cannot rationally trade below ₹807.08 because:

- If share price falls below ₹40, conversion becomes unattractive and the investor retains the straight bond value of ₹807.08.
- If share price rises materially, conversion becomes attractive and the investor exercises for the higher value.

The current market price of ₹1,050 exceeds this floor by ₹243, reflecting the market's valuation of the embedded call option on the underlying shares.

(iv) Conversion Premium

Conversion Premium (₹) = Market Price − Conversion Value

= 1,050 − 800

= ₹250 per debenture

Conversion Premium (%) = 250 / 800 × 100

= 31.25%

The 31.25% premium reflects the market's valuation of the convertible's option-like features. Investors are willing to pay this premium because the convertible offers: (a) downside protection at the ₹807 floor, (b) fixed coupon income during the holding period, and (c) equity upside if the share price rises materially. The premium is essentially the price of this asymmetric payoff structure.

(v) Break-Even (Payback) Period

The break-even period computes how long the annual income advantage of holding the convertible (versus buying the shares directly) takes to recover the conversion premium.

Annual Income Comparison:

Investment Option	Annual Income Source	Amount (₹)
Hold Convertible	Coupon (6% × ₹1,000)	60.00
Buy 20 Shares Directly	Dividends (20 × ₹0.80)	16.00
Annual Income Advantage of Convertible		**44.00**

Break-Even Period = Conversion Premium / Annual Income Advantage

= 250 / 44

= 5.68 years

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Interpretation: The premium paid for the convertible over the direct-share purchase route is recovered through superior income over approximately 5.68 years. After this point, the convertible holder is strictly better off than the direct-share investor.

(vi) Investment Recommendation

Recommendation: PURCHASE the convertible debenture.

Reasoning:

(i) Meaningful downside protection. The ₹807 floor limits potential loss to ₹243 (from current ₹1,050), or approximately 23%. This is substantially less than the potential downside on direct equity holding, where a 40% share price decline (from ₹40 to ₹24) would produce a 40% loss on the equity investment.

(ii) Income premium relative to equity. The 6% coupon substantially exceeds the 2% dividend yield on the underlying shares. This provides a defensible income stream while waiting for conversion economics to become favourable.

(iii) 5.68-year payback within remaining maturity. The break-even period fits comfortably within the 10-year remaining maturity, meaning the investor has time to recover the premium through income advantage.

(iv) Optional equity upside. If Nova Pharma's share price rises materially above the parity level of ₹52.50 (calculated as ₹1,050 / 20 = market price per share required for conversion to equal current market price), the investor participates in equity appreciation.

(v) Conservative fit for fixed income mandate. The straight bond floor and predictable income make convertibles suitable for a diversified fixed income portfolio seeking moderate equity upside exposure without the full downside risk of pure equity holdings.

The strategic case for including this convertible in a fixed income mutual fund is strong. The 5.68-year payback and 23% maximum downside are both within acceptable ranges for the moderately-aggressive segment of the fund's holdings.

Question 12 — REPO Transaction

Part A — Forward Calculation

On 15 April 2026, Reserve Investment Fund (RIF), a large domestic institutional investor, enters into a 21-day REPO transaction with HDFC Bank to raise short-term funds. RIF pledges Government Securities from its trading book as collateral. The complete transaction structure is as follows:

Parameter	Value
Underlying Collateral	8.24% GOI 2033
Face Value per Bond	₹100
Number of Bonds Pledged	2,50,00,000 (2.5 crore)
Clean Market Price (as on 15 April 2026)	₹101.50 per bond
Days Since Last Coupon Payment	60 days
Coupon Frequency	Semi-annual
Initial Margin (Haircut)	5%
REPO Rate	6.75% p.a.
Tenure of REPO	21 days
Day Count Convention	Actual/360 (Indian REPO convention)

Required:

(i) Compute the accrued interest per bond as of the REPO transaction date.

(ii) Compute the dirty (invoice) price per bond.

(iii) Compute the total dirty market value of the pledged collateral pool.

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(iv) Compute the initial cash amount that HDFC Bank lends to RIF, after applying the initial margin.

(v) Compute the REPO interest for the 21-day tenure.

(vi) Compute the total amount that RIF must pay to HDFC Bank at maturity to repurchase the bonds.

Solution

(i) Accrued Interest per Bond

Applying the accrued interest formula on Actual/360 basis:

AI per bond = (Coupon Rate × Face Value × Days Elapsed) / 360

= (8.24% × ₹100 × 60) / 360

= (8.24 × 60) / 360

= 494.40 / 360

= ₹1.3733 per bond ≈ ₹1.37 per bond

Alternative check using the semi-annual approach: The semi-annual coupon is ₹4.12 per bond. Sixty days into a 180-day coupon period, accrued interest = 4.12 × (60/180) = ₹1.373. Same answer confirmed.

(ii) Dirty Price per Bond

Dirty Price = Clean Price + Accrued Interest

= ₹101.50 + ₹1.37

= ₹102.87 per bond

(iii) Total Dirty Market Value of Collateral

Total Dirty Market Value = Number of Bonds × Dirty Price per Bond

= 2,50,00,000 × ₹102.87

Step-by-step arithmetic:

2,50,00,000 × 100.00 = ₹250,00,00,000 = ₹250.00 crore

2,50,00,000 × 2.87 = ₹7,17,50,000 = ₹7.18 crore

Total Dirty Market Value = ₹257.18 crore

(iv) Amount Lent (Principal) After Initial Margin

The 5% initial margin reduces the amount lent below the collateral's dirty market value. The lender effectively "over-collateralises" the loan to protect against decline in bond prices during the 21-day tenor.

Principal = Total Dirty MV × (1 − Haircut)

= 257.18 × (1 − 0.05) = 257.18 × 0.95 **= ₹244.32 crore**

(v) REPO Interest for 21 Days

REPO Interest = Principal × REPO Rate × Days / 360 (Indian Actual/360 convention)

= 244.32 × 0.0675 × 21 / 360

Step-by-step:

244.32 × 0.0675 = 16.492

16.492 × 21 = 346.32

346.32 / 360 = 0.9620

REPO Interest = ₹0.9620 crore = ₹96.20 lakh

(vi) Repurchase Amount at Maturity

Repurchase Amount = Principal + REPO Interest

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= 244.32 + 0.9620

= ₹245.28 crore

Transaction Summary

Item	Amount
Day 0 (15 April) — RIF receives cash from HDFC Bank	₹244.32 crore
Day 0 — RIF delivers 2.5 crore GOI 2033 bonds to HDFC as collateral	Bonds worth ₹257.18 crore (dirty basis)
Day 21 (6 May) — RIF pays repurchase amount to HDFC Bank	₹245.28 crore
Day 21 — HDFC returns 2.5 crore bonds to RIF	**Bonds worth market value on that date**
Effective Cost of Borrowing to RIF	**₹0.96 crore over 21 days (6.75% p.a. equivalent)**

Part B — Reverse Calculation Scenario

A separate REPO transaction from an internal audit review must now be reconstructed. The following limited information about the settled transaction is available in the accounting records; the analyst must work backwards to identify the number of bonds that had been pledged as collateral.

Parameter	Value
Repurchase amount paid at maturity	₹126.36 crore
REPO rate applied	6.60% p.a.
Tenure of REPO	30 days
Day count convention	Actual/360
Initial margin (haircut) that was applied	4%
Underlying collateral	7.20% GOI 2028
Face value per bond	₹100
Clean price at REPO start	₹100.00 per bond
Days since last coupon at REPO start	45 days

Required:

(i) Compute the amount of cash originally lent (the REPO principal).

(ii) Compute the dirty price per bond at the REPO transaction date.

(iii) Compute the total dirty market value of the pledged bonds.

(iv) Compute the number of bonds that had been pledged as collateral.

Solution

(i) Original Principal (Amount Lent)

Working backwards from the repurchase amount using the REPO interest formula:

Repurchase = Principal × (1 + Rate × Days / 360)

126.36 = P × (1 + 0.066 × 30/360)

126.36 = P × (1 + 0.0055)

126.36 = P × 1.0055

P = 126.36 / 1.0055 = ₹125.67 crore

Verification: 125.67 × 1.0055 = 125.67 + (125.67 × 0.0055) = 125.67 + 0.6912 = 126.36 ✓

(ii) Dirty Price per Bond at REPO Start

First compute accrued interest per bond:

AI = (7.20% × ₹100 × 45) / 360 = 324 / 360 = ₹0.90 per bond

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Then dirty price:

Dirty Price = Clean Price + Accrued Interest = 100.00 + 0.90

Dirty Price = ₹100.90 per bond

(iii) Total Dirty Market Value of Pledged Bonds

Working backwards through the initial margin:

Principal = Dirty MV × (1 − Haircut)

125.67 = Dirty MV × (1 − 0.04)

125.67 = Dirty MV × 0.96

Dirty MV = 125.67 / 0.96 = ₹130.91 crore

Verification: 130.91 × 0.96 = 130.91 − 5.24 = 125.67 ✓

(iv) Number of Bonds Pledged

Number of Bonds = Total Dirty Market Value / Dirty Price per Bond

= ₹130.91 crore / ₹100.90 per bond

= ₹130,91,00,000 / ₹100.90

Step-by-step:

130,91,00,000 / 100.90 = ?

Trial: 1,29,74,000 × 100.90 = 130,88,76,600 (short by ₹2,23,400)

Trial: 1,29,74,222 × 100.90 = 130,91,00,000 (approximate match)

Number of Bonds ≈ 1,29,74,000 ≈ 1.30 crore bonds

The precise result is 1,29,74,222 bonds. In practice, physical securities are always in whole numbers, so the actual pledge would be either 1,29,74,000 or 1,29,74,222 depending on the exact reconciliation. The 200-bond difference is immaterial at institutional scale.

Complete Reverse-Direction Summary

Step	Item	Amount
1	Given: Repurchase amount at maturity	₹126.36 crore
2	Derived: Principal (amount lent)	₹125.67 crore
3	Derived: Total dirty market value of collateral	₹130.91 crore
4	Derived: Dirty price per bond	₹100.90
5	Derived: Number of bonds pledged	1.30 crore bonds

Question 13 — Commercial Paper: Reverse-Direction Analysis

Commercial Paper (CP) is a short-term unsecured promissory note issued by corporations and NBFCs to raise short-term funding, typically for periods of 15 days to 1 year. Unlike REPOs which are collateralised, CPs rely purely on the issuer's credit standing. CPs are issued at a discount to face value and redeemed at face value at maturity — the discount effectively representing the interest cost to the issuer.

CP issuances are a significant source of short-term funding for Indian corporates. Companies with strong short-term credit ratings (A1+ from CRISIL, ICRA, CARE, or India Ratings) can typically issue CPs at rates 25-75 basis points below equivalent-tenure bank borrowing rates, making CP an attractive treasury tool.

Standard CP Formulas:

- Discount = Face Value − Issue Price
- Discount Rate (Money Market Convention) = (Discount / Face Value) × (365 / Days)

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- Effective Yield (Bond Equivalent) = (Discount / Issue Price) × (365 / Days)

The effective yield exceeds the discount rate because the discount is earned on a smaller base (the issue price) but calculated as a percentage of the larger denominator (the face value).

Scenario A — Determine Discount, Discount Rate, and Effective Yield

Reliance Industries Ltd. has redeemed a 60-day Commercial Paper at face value of ₹300.00 crore. The CP had originally been issued at ₹296.15 crore.

Required:

- (a) Compute the Discount amount.
- (b) Compute the Discount Rate on money market convention.
- (c) Compute the Effective Yield on bond equivalent basis.
- (d) Compare against a 60-day bank loan at 8.00% p.a. and determine which is cheaper for Reliance.

Solution — Scenario A

(a) Discount Amount:

Discount = 300.00 − 296.15 = ₹3.85 crore

(b) Discount Rate (Money Market Convention):

Discount Rate = (Discount / Face Value) × (365 / Days)

= (3.85 / 300.00) × (365 / 60)

= 0.012833 × 6.0833

= 7.81% p.a.

(c) Effective Yield (Bond Equivalent):

Effective Yield = (Discount / Issue Price) × (365 / Days)

= (3.85 / 296.15) × (365 / 60)

= 0.013000 × 6.0833

= 7.91% p.a.

(d) Cost Comparison vs Bank Loan at 8.00%:

Funding Source	Effective Cost (p.a.)
Commercial Paper (this issuance)	7.91%
Bank Loan (60-day)	8.00%
CP Advantage	**9 basis points cheaper**

CP issuance is 9 bps cheaper than the equivalent bank loan for Reliance. On ₹300 crore for 60 days, this saves the firm approximately ₹4.44 lakh in funding cost — small in absolute terms but meaningful when scaled across the firm's total short-term borrowing programme.

Scenario B — Determine the Issue Price

MRF Ltd. plans to issue a 91-day Commercial Paper with face value of ₹200 crore. Based on the current CP market and MRF's A1+ short-term credit rating, the treasury team expects to be able to issue the CP at an effective yield of 7.25% per annum.

Required: Compute the expected issue proceeds MRF will receive.

Solution — Scenario B

Working backward from the effective yield formula:

Effective Yield = (Discount / Issue Price) × (365 / Days)

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0.0725 = (200 − IP) / IP × (365 / 91)

0.0725 × (91 / 365) = (200 − IP) / IP

0.018075 = (200 − IP) / IP

0.018075 × IP = 200 − IP

IP × 1.018075 = 200

IP = 200 / 1.018075 = ₹196.45 crore

Verification:

- Discount = 200 − 196.45 = ₹3.55 crore
- Effective Yield = (3.55 / 196.45) × (365 / 91) = 0.018075 × 4.011 = 7.25% ✓

MRF will receive ₹196.45 crore at issuance and repay ₹200 crore at maturity 91 days later. The ₹3.55 crore discount represents the effective interest cost.

Scenario C — Determine the Tenure

Tata Motors issued Commercial Paper with face value ₹150 crore at an issue price of ₹147.28 crore. The effective yield on the transaction was 7.50% per annum.

Required: Compute the CP tenure in days.

Solution — Scenario C

Discount = 150 − 147.28 = ₹2.72 crore

Setting up the tenure equation:

Effective Yield = (Discount / Issue Price) × (365 / Days)

0.0750 = (2.72 / 147.28) × (365 / Days)

0.0750 = 0.018469 × (365 / Days)

0.0750 / 0.018469 = 365 / Days

4.060 = 365 / Days

Days = 365 / 4.060 = 89.9 ≈ 90 days

The CP was a standard 90-day issuance — a common tenure in the Indian CP market.

Question 14 — Bootstrapping the Spot Rate Curve from Coupon Bond Prices

A junior analyst at a Mumbai-based fixed income mutual fund has been asked to derive the zero-coupon spot rate curve from three coupon bonds actively trading in the market. This technique — called bootstrapping — is the foundational discipline of institutional bond pricing because it exposes any arbitrage opportunities between the coupon bond market and the theoretical fair value implied by the term structure.

The three coupon bonds in question, each with face value ₹100 and annual coupon payments, are trading at the following market prices:

Bond	Maturity	Coupon Rate	Market Price
Bond X	1 year	5%	₹99.06
Bond Y	2 years	6%	₹98.24
Bond Z	3 years	7%	₹97.66

Required:

(i) Derive the 1-year spot rate (s_1) from Bond X.

(ii) Given s_1, derive the 2-year spot rate (s_2) from Bond Y using the bootstrapping technique.

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(iii) Given s_1 and s_2, derive the 3-year spot rate (s_3) from Bond Z.

(iv) A fourth bond — Bond W — has been noticed by the analyst: a 3-year 9% coupon bond, face value ₹100, currently trading at ₹104.50 in the secondary market. Compute the fair value of Bond W using the derived spot rate curve and determine whether an arbitrage opportunity exists.

(v) If an arbitrage opportunity exists, design a specific trade to capture the mispricing risk-free.

Solution

(i) Deriving the 1-Year Spot Rate (s_1)

Bond X has a single cash flow at Year 1 — coupon of ₹5 plus face value of ₹100 = ₹105.

Bond Price = Cash Flow / $(1 + s_1)$

$99.06 = 105 / (1 + s_1)$

$(1 + s_1) = 105 / 99.06 = 1.0600$

$s_1 = 6.00\%$

(ii) Deriving the 2-Year Spot Rate (s_2)

Bond Y has cash flows of ₹6 at Year 1 and ₹106 (coupon plus face) at Year 2. Each cash flow must be discounted at the spot rate matched to its maturity — Year 1 at $s_1 = 6.00\%$, Year 2 at the unknown s_2.

Bond Price = $6/(1 + s_1) + 106/(1 + s_2)^2$

$98.24 = 6/1.06 + 106/(1 + s_2)^2$

$98.24 = 5.66 + 106/(1 + s_2)^2$

$92.58 = 106/(1 + s_2)^2$

$(1 + s_2)^2 = 106 / 92.58 = 1.1449$

$(1 + s_2) = \sqrt{1.1449} = 1.0700$

$s_2 = 7.00\%$

(iii) Deriving the 3-Year Spot Rate (s_3)

Bond Z has cash flows of ₹7 at Year 1, ₹7 at Year 2, and ₹107 at Year 3. The Year 1 and Year 2 cash flows are discounted at the previously derived spot rates; the Year 3 cash flow requires the unknown s_3.

Bond Price = $7/(1 + s_1) + 7/(1 + s_2)^2 + 107/(1 + s_3)^3$

$97.66 = 7/1.06 + 7/1.1449 + 107/(1 + s_3)^3$

$97.66 = 6.60 + 6.11 + 107/(1 + s_3)^3$

$97.66 = 12.71 + 107/(1 + s_3)^3$

$84.95 = 107/(1 + s_3)^3$

$(1 + s_3)^3 = 107 / 84.95 = 1.2596$

Taking cube root using ICAI convention (given $(1.08)^3 = 1.2597$):

$(1 + s_3) = 1.0800$

$s_3 = 8.00\%$

Derived Zero-Coupon Spot Rate Curve:

Maturity	Spot Rate
1-year	6.00%
2-year	7.00%
3-year	8.00%

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The curve is upward-sloping — consistent with either rising rate expectations or a positive liquidity premium (per Question 12 discussion in Part B).

(iv) Fair Value of Bond W and Arbitrage Detection

Bond W has cash flows of ₹9 at Year 1, ₹9 at Year 2, and ₹109 at Year 3. Applying the derived spot rate curve:

Year	Cash Flow (₹)	Spot Rate	Discount Factor	Present Value (₹)
1	9	6.00%	1 / 1.06 = 0.9434	8.49
2	9	7.00%	1 / 1.1449 = 0.8734	7.86
3	109	8.00%	1 / 1.2597 = 0.7938	86.53
			Fair Value of Bond W	**₹102.88**

Item	Value
Market Price of Bond W	₹104.50
Fair Value (per Spot Curve)	₹102.88
Overpricing	**₹1.62 per bond (1.57%)**

Arbitrage opportunity EXISTS. Bond W trades at a material premium to its no-arbitrage fair value.

(v) Arbitrage Trade Design

The classical no-arbitrage trade: SELL the overpriced Bond W and simultaneously BUY a replicating portfolio that generates the identical cash flow stream at the lower cost. The difference between the two prices is captured as risk-free profit.

Replicating Portfolio Construction using Zero-Coupon Bonds:

If zero-coupon bonds are available at the derived spot rates, the replication is straightforward:

ZCB Maturity	Face Value to Buy	Purchase Cost per ZCB	Cost of Replication (₹)
1-year ZCB at s_1 = 6%	₹9	9 / 1.06 = 8.49	8.49
2-year ZCB at s_2 = 7%	₹9	9 / 1.1449 = 7.86	7.86
3-year ZCB at s_3 = 8%	₹109	109 / 1.2597 = 86.53	86.53
Total Cost of Replicating Portfolio			**₹102.88**

The Arbitrage Trade:

- **(i)** Sell 1 unit of Bond W in the secondary market at ₹104.50 — Cash inflow: ₹104.50
- **(ii)** Simultaneously buy the replicating ZCB portfolio at ₹102.88 — Cash outflow: ₹102.88
- **(iii)** Net cash captured at trade inception: ₹104.50 − ₹102.88 = ₹1.62 per bond
- **(iv)** For every year up to Year 3, the ZCB portfolio pays ₹9 (in Years 1 and 2) or ₹109 (in Year 3), exactly matching what must be paid to the buyer of the short Bond W position. Cash flows offset perfectly.
- **(v)** The ₹1.62 captured at trade inception is risk-free profit — the arbitrage is closed and the trader retains the arbitrage rent.

Alternative: Replication Using Coupon Bonds

If ZCBs are not readily tradeable in the market (a common constraint in Indian corporate bond markets), the replicating portfolio can be constructed by combining Bonds X, Y, and Z in specific proportions. This is algebraically more complex — solving a system of three simultaneous equations — but produces the same fair value of ₹102.88 as the theoretical fair value. In practice, the ZCB approach is preferred when available because Government of India STRIPS (Separately Traded Registered Interest and Principal Securities) provide direct access to zero-coupon Indian G-Sec instruments through the CCIL platform.

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Question 15 — Barbell versus Bullet Portfolio: The Classical Convexity Trade

A senior fixed income portfolio manager at a large Indian pension fund is evaluating two alternative portfolio constructions, both targeting a portfolio Macaulay Duration of exactly 5 years. The initial investment amount is ₹10,000 in each case. Both portfolios use zero-coupon bonds (ZCBs) with current YTM of 8%, meaning that both portfolios have identical duration-weighted interest rate exposure. Where they differ is in convexity — and it is precisely this difference that creates the classical fixed income alpha opportunity known as the barbell trade.

Portfolio A — Bullet (Concentrated):

- 100% invested in a 5-year Zero-Coupon Bond at YTM 8%

Portfolio B — Barbell (Distributed):

- 50% invested in a 2-year Zero-Coupon Bond at YTM 8%
- 50% invested in an 8-year Zero-Coupon Bond at YTM 8%

Compound Factors (Provided) — used for pricing ZCBs at various yields:

Yield	$(1+y)^2$	$(1+y)^5$	$(1+y)^8$
6%	1.1236	1.3382	1.5938
7%	1.1449	1.4026	1.7182
8%	1.1664	1.4693	1.8509
9%	1.1881	1.5386	1.9926
10%	1.2100	1.6105	2.1436

Required:

(i) Verify that both portfolios have Macaulay Duration of 5 years and identify the future face values (FV) of each ZCB.

(ii) Compute the Modified Duration of each portfolio.

(iii) Compute the values of each portfolio at YTM 7% (V_-) and at YTM 9% (V_+), representing ±100 bps parallel shifts around the current 8% YTM.

(iv) Compute the approximate Convexity of each portfolio using the ICAI SM formula: $C^* = [V_+ + V_- - 2V_0] / [2 \times V_0 \times (\Delta y)^2]$.

(v) Compute the actual portfolio values under a 200 bps parallel yield fall (YTM 8% → 6%) and yield rise (YTM 8% → 10%) by direct valuation.

(vi) Use the ICAI price-change formula $\Delta P\% = -MD \times \Delta y + C^* \times (\Delta y)^2$ to predict the ±200 bps price changes for each portfolio, and verify against the actual values.

(vii) Identify the Barbell outperformance in both scenarios and discuss when the Bullet portfolio is preferred despite having lower convexity.

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Solution

(i) Duration Verification and Face Value of Each ZCB

For a Zero-Coupon Bond, there is only one cash flow — the face value at maturity. Therefore Macaulay Duration equals maturity by definition (all weight is on the single terminal cash flow):

- 2-year ZCB: Macaulay Duration = 2 years
- 5-year ZCB: Macaulay Duration = 5 years
- 8-year ZCB: Macaulay Duration = 8 years

Bullet Portfolio Macaulay Duration:

= 100% × 5 = 5 years ✓

Barbell Portfolio Macaulay Duration (weighted average):

= (0.50 × 2) + (0.50 × 8)

= 1.00 + 4.00 = 5 years ✓

Both portfolios have identical Macaulay Duration.

Face Values of ZCBs (at initial ₹10,000 investment, YTM 8%):

Portfolio	ZCB	Investment (₹)	Compound Factor at 8%	Face Value (₹)
Bullet	5-year ZCB	10,000	$(1.08)^5 = 1.4693$	10,000 × 1.4693 = 14,693
Barbell	2-year ZCB	5,000	$(1.08)^2 = 1.1664$	5,000 × 1.1664 = 5,832
Barbell	8-year ZCB	5,000	$(1.08)^8 = 1.8509$	5,000 × 1.8509 = 9,255

(ii) Modified Duration of Each Portfolio

Modified Duration = Macaulay Duration / (1 + y). Applied to each portfolio at YTM 8%:

Bullet Modified Duration:

MD = 5 / (1 + 0.08) = 5 / 1.08 = 4.63

Barbell Modified Duration:

MD = 5 / (1 + 0.08) = 5 / 1.08 = 4.63

Both portfolios have identical Modified Duration of 4.63 — as expected since they share the same Macaulay Duration and same YTM. Under a first-order (duration-only) approximation, they would show identical price sensitivity to yield changes. The second-order convexity effect is what differentiates their actual behaviour.

(iii) Portfolio Values at YTM 7% (V_-) and YTM 9% (V_+)

Bullet Portfolio:

Scenario	Formula	Calculation	Value (₹)
V_0 (at 8%)	$14,693 / (1.08)^5$	14,693 / 1.4693	10,000
V_- (at 7%)	$14,693 / (1.07)^5$	14,693 / 1.4026	10,476
V_+ (at 9%)	$14,693 / (1.09)^5$	14,693 / 1.5386	9,550

Barbell Portfolio:

Scenario	2-year ZCB Value	8-year ZCB Value	Total Portfolio Value (₹)
V_0 (at 8%)	5,832 / 1.1664 = 5,000	9,255 / 1.8509 = 5,000	10,000
V_- (at 7%)	5,832 / 1.1449 = 5,094	9,255 / 1.7182 = 5,387	10,481
V_+ (at 9%)	5,832 / 1.1881 = 4,908	9,255 / 1.9926 = 4,644	9,552

(iv) Approximate Convexity via ICAI SM Formula

Formula (ICAI SM approximate convexity, three-price method):

$C^* = [V_+ + V_- - 2V_0] / [2 \times V_0 \times (\Delta y)^2]$

With Δy = 100 bps = 0.01, therefore $(\Delta y)^2 = 0.0001$, and $2 \times V_0 \times (\Delta y)^2 = 2 \times 10,000 \times 0.0001 = 2.0$

Bullet Convexity:

Numerator = $V_+ + V_- - 2V_0 = 9,550 + 10,476 - 20,000 = 26$

Denominator = $2 \times 10,000 \times (0.01)^2 = 2.0$

C^* (Bullet) = 26 / 2 = 13.00

Barbell Convexity:

Numerator = $V_+ + V_- - 2V_0 = 9,552 + 10,481 - 20,000 = 33$

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Denominator = $2 \times 10{,}000 \times (0.01)^2 = 2.0$

C* (Barbell) = 33 / 2 = 16.50

Convexity Comparison:

Portfolio	Approximate Convexity (C*)
Bullet	13.00
Barbell	16.50
Convexity Differential	**+3.50 (Barbell higher)**

Both portfolios have identical Macaulay Duration and identical Modified Duration, but the Barbell has 3.50 units of additional convexity. This is the source of the barbell's outperformance under any parallel yield shift.

(v) Actual Portfolio Values Under ±200 bps Parallel Shifts

Bullet Portfolio Under 200 bps Yield FALL (YTM 8% → 6%):

Value = $14{,}693 / (1.06)^5 = 14{,}693 / 1.3382 = ₹10{,}979$

Change = 10,979 − 10,000 = +₹979 → +9.79%

Bullet Portfolio Under 200 bps Yield RISE (YTM 8% → 10%):

Value = $14{,}693 / (1.10)^5 = 14{,}693 / 1.6105 = ₹9{,}124$

Change = 9,124 − 10,000 = −₹876 → −8.76%

Barbell Portfolio Under 200 bps Yield FALL (YTM 8% → 6%):

2-year ZCB value = $5{,}832 / (1.06)^2 = 5{,}832 / 1.1236 = ₹5{,}190$

8-year ZCB value = $9{,}255 / (1.06)^8 = 9{,}255 / 1.5938 = ₹5{,}807$

Total = 5,190 + 5,807 = ₹10,997

Change = 10,997 − 10,000 = +₹997 → +9.97%

Barbell Portfolio Under 200 bps Yield RISE (YTM 8% → 10%):

2-year ZCB value = $5{,}832 / (1.10)^2 = 5{,}832 / 1.2100 = ₹4{,}820$

8-year ZCB value = $9{,}255 / (1.10)^8 = 9{,}255 / 2.1436 = ₹4{,}318$

Total = 4,820 + 4,318 = ₹9,138

Change = 9,138 − 10,000 = −₹862 → −8.62%

(vi) Prediction via ICAI Duration-Convexity Formula

Formula (per ICAI SM Q50 convention):

$\Delta P\% = -MD \times \Delta y + C^* \times (\Delta y)^2$

Both portfolios have MD = 4.63. Applying to each scenario:

Bullet Under 200 bps FALL (Δy = −0.02):

$\Delta P\% = -4.63 \times (-0.02) + 13.00 \times (-0.02)^2$

$= +0.0926 + 13.00 \times 0.0004$

$= +0.0926 + 0.0052$

$= +0.0978$ → +9.78%

Barbell Under 200 bps FALL (Δy = −0.02):

$\Delta P\% = -4.63 \times (-0.02) + 16.50 \times (-0.02)^2$

$= +0.0926 + 16.50 \times 0.0004$

$= +0.0926 + 0.0066$

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= +0.0992 → +9.92%

Bullet Under 200 bps RISE (Δy = +0.02):

$\Delta P\% = -4.63 \times (0.02) + 13.00 \times (0.02)^2$

= −0.0926 + 0.0052

= −0.0874 → −8.74%

Barbell Under 200 bps RISE (Δy = +0.02):

$\Delta P\% = -4.63 \times (0.02) + 16.50 \times (0.02)^2$

= −0.0926 + 0.0066

= −0.0860 → −8.60%

Predicted versus Actual Comparison:

Scenario	Portfolio	Predicted ΔP%	Actual ΔP%	Prediction Error
200 bps FALL	Bullet	+9.78%	+9.79%	1 bp
200 bps FALL	Barbell	+9.92%	+9.97%	5 bps
200 bps RISE	Bullet	−8.74%	−8.76%	2 bps
200 bps RISE	Barbell	−8.60%	−8.62%	2 bps

The ICAI duration-convexity formula predicts the actual price change with high accuracy — errors of 1 to 5 basis points across all four scenarios. This confirms that the ICAI approximate convexity of 13.00 for Bullet and 16.50 for Barbell correctly captures the second-order price sensitivity.

(vii) Barbell Outperformance and Portfolio Positioning Discussion

Barbell Outperformance Summary:

Scenario	Bullet Return	Barbell Return	Barbell Advantage
YTM falls 200 bps → 6%	+9.79%	+9.97%	+18 bps
YTM unchanged at 8%	0.00%	0.00%	0 bps
YTM rises 200 bps → 10%	−8.76%	−8.62%	+14 bps

Why Barbell Outperforms in Both Directions:

The mathematics: for identical duration, higher convexity produces asymmetrically favourable outcomes. When yields fall, both portfolios gain, but the higher-convexity barbell gains more (+18 bps). When yields rise, both portfolios lose, but the higher-convexity barbell loses less (+14 bps advantage). This positive convexity benefit is the closest thing fixed income has to a "free lunch" — no additional interest rate risk (identical duration) yet superior returns under any parallel yield movement.

The predicted convexity benefit via the ICAI formula = (Barbell C* − Bullet C*) × $(\Delta y)^2$ × 100 = 3.50 × 0.0004 × 100 = 14 bps. This matches the observed rate-rise advantage exactly and is close to the rate-fall advantage of 18 bps (with the small extra from third-order effects at larger yield shifts).

When Bullet is Preferred Despite Lower Convexity:

(i) Non-parallel yield shifts, particularly steepening. If long rates rise faster than short rates (steepening curve), the barbell's long-dated 8-year bond suffers disproportionately while the 2-year bond provides limited offset. The bullet's concentrated 5-year exposure escapes the steepening damage. This is a real risk in Indian markets during RBI tightening cycles.

(ii) Twist scenarios. When 2-year and 8-year yields move in opposite directions (rare but observed during liquidity crises), the barbell can suffer while the bullet is unaffected.

(iii) Higher transaction costs. Constructing and rebalancing a two-bond barbell costs more than holding a single bullet. In illiquid corporate bond segments, the bid-ask spread on the barbell may exceed the convexity benefit.

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(iv) When the analyst's specific view is on the 5-year point. If the portfolio manager has strong conviction on 5-year yields falling, the bullet delivers full exposure to that specific rate movement without dilution from 2-year and 8-year positions.

From my capital markets experience, the barbell trade is deployed most successfully by portfolio managers with a general view that volatility will rise but no specific view on curve shape. In stable, low-volatility environments, the convexity benefit is too small to justify the added complexity; in high-volatility environments, the barbell earns its keep systematically. The current Indian bond market — with RBI navigating global inflation risks and domestic growth constraints — is a genuinely volatile environment where the barbell strategy is worth serious consideration.

Question 16 — Multi-Period Cash Flow Matching versus Duration-Based Immunization

A defined-benefit pension fund faces three known future liability payments as members retire in Years 2, 4, and 6 from today. The Chief Investment Officer must construct a bond portfolio that funds each of these liabilities with the highest possible degree of certainty. The pension fund liabilities are:

Year of Payment	Liability Amount
Year 2	₹50 lakh
Year 4	₹75 lakh
Year 6	₹1 crore (₹100 lakh)

All bond markets currently trade at a flat 7% yield curve (spot rates are 7% at all maturities). The following compound and discount factors are provided:

Year	$(1.07)^n$	$1 / (1.07)^n$
2	1.1449	0.8734
3	1.2250	0.8163
4	1.3108	0.7629
5	1.4026	0.7130
6	1.5007	0.6663

Required:

Part A — Exact Cash Flow Matching:

Zero-Coupon Bonds are available at maturities of exactly 2 years, 4 years, and 6 years, all yielding 7%. The CIO wants to construct an EXACT cash flow matching portfolio — each liability funded by a bond that matures on the exact liability date.

(i) Compute the face value of each ZCB that must be purchased to exactly fund each liability.

(ii) Compute the total rupee investment required today to fund all three liabilities.

(iii) State why this portfolio is immunized against all forms of interest rate risk (parallel or non-parallel shifts) between today and Year 6.

Part B — Duration-Based Immunization (Restricted Universe):

Now suppose that only two ZCBs are available in the market — a 3-year ZCB and a 5-year ZCB, both at YTM 7%. Exact cash flow matching is impossible because none of the liability payment dates coincide with the available bond maturity dates. The CIO must fall back on duration-based immunization.

(i) Compute the present value of the aggregate liability portfolio at 7%.

(ii) Compute the duration of the aggregate liability portfolio.

(iii) Determine the portfolio weights and rupee amounts to invest in the 3-year and 5-year ZCBs such that the portfolio's PV and duration exactly match the liability's PV and duration.

(iv) Compute the face values of each ZCB that will be purchased.

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(v) Discuss the residual risks in this immunized portfolio that were absent in the Part A exact-matching portfolio.

Solution — Part A: Exact Cash Flow Matching

A(i) Face Values of ZCBs Required

Each ZCB must produce cash flow equal to the corresponding liability at maturity. Since ZCBs have no coupons — only face value payment at maturity — the face value required equals the liability amount exactly.

Liability	Amount (₹ lakh)	ZCB Required	Face Value to Purchase
Year 2	50	2-year ZCB	₹50 lakh
Year 4	75	4-year ZCB	₹75 lakh
Year 6	100	6-year ZCB	₹100 lakh

A(ii) Total Investment Required Today

Each ZCB is purchased at its present value — the face value discounted at the 7% spot rate matched to the ZCB's maturity.

ZCB	Face Value (₹ lakh)	PV Factor at 7%	Cost Today (₹ lakh)
2-year ZCB	50	1 / 1.1449 = 0.8734	50 × 0.8734 = 43.67
4-year ZCB	75	1 / 1.3108 = 0.7629	75 × 0.7629 = 57.22
6-year ZCB	100	1 / 1.5007 = 0.6663	100 × 0.6663 = 66.63
Total Investment Today			**₹167.52 lakh**

The CIO must invest ₹167.52 lakh (₹1.6752 crore) today across the three ZCBs to fund the three future liabilities.

A(iii) Why This Portfolio Faces Zero Interest Rate Risk

The exact cash flow matching construction has a remarkable property: it is immune to all forms of interest rate movement between today and Year 6.

(i) Each ZCB pays exactly the required amount at exactly the required date. There is no need to reinvest coupons (ZCBs have no coupons) and no need to sell a bond before its maturity date (each bond matures precisely when its funds are required).

(ii) Consequently, the portfolio faces no reinvestment risk and no price risk during the holding period. Whatever happens to yields between today and Year 6 is entirely irrelevant to the portfolio's ability to fund the liabilities.

(iii) Even non-parallel yield curve shifts — steepening, flattening, twist — have no impact because the portfolio's cash flow schedule exactly matches the liability schedule, cash flow for cash flow.

(iv) This is the strongest form of liability-driven investment. When exact-matching instruments are available, exact cash flow matching should always be preferred over any approximation technique.

The trade-off:

The reason exact matching is not always used in practice is that the specific-maturity ZCBs required for each liability may not exist in the market. In the Indian G-Sec context, STRIPS (Separately Traded Registered Interest and Principal Securities) provide direct access to zero-coupon Indian G-Sec instruments, but the range of available maturities is limited. When exact matching is not feasible, duration-based immunization — as in Part B — becomes the fallback.

Solution — Part B: Duration-Based Immunization

B(i) Present Value of Aggregate Liabilities

Liability Year	Amount (₹ lakh)	PVF at 7%	PV (₹ lakh)
Year 2	50	0.8734	43.67
Year 4	75	0.7629	57.22
Year 6	100	0.6663	66.63
Total PV of Liabilities			**₹167.52 lakh**

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Note: The total PV is identical to Part A's total investment (₹167.52 lakh). This is not a coincidence — under the same 7% flat yield curve, exact matching and duration matching produce the same total investment amount. The difference lies in the risk profile, not the initial investment.

B(ii) Duration of the Aggregate Liability Portfolio

The liability duration is the PV-weighted average time to payment:

Year (t)	PV (₹ lakh)	Weight (PV / Total PV)	t × Weight
2	43.67	43.67 / 167.52 = 0.2607	0.5214
4	57.22	57.22 / 167.52 = 0.3416	1.3664
6	66.63	66.63 / 167.52 = 0.3977	2.3862
		Liability Duration	**4.274 years**

Liability Duration = 4.274 years (approximately 4.27 years)

B(iii) Portfolio Weights and Investment Amounts

The immunized portfolio must have both PV equal to ₹167.52 lakh and duration equal to 4.274 years.

Duration matching equation:

$w_3 \times 3 + w_5 \times 5 = 4.274$

Since ZCB durations equal their maturities: 3-year ZCB has duration 3, 5-year ZCB has duration 5.

Using $w_3 + w_5 = 1$:

$w_3 \times 3 + (1 - w_3) \times 5 = 4.274$

$3w_3 + 5 - 5w_3 = 4.274$

$-2w_3 = -0.726$

$w_3 = 0.363$ (36.3%)

$w_5 = 0.637$ (63.7%)

Rupee Investment Allocation:

ZCB	Weight	Investment (₹ lakh)
3-year ZCB	36.3%	167.52 × 0.363 = 60.81
5-year ZCB	63.7%	167.52 × 0.637 = 106.71
Total	**100.0%**	**167.52**

B(iv) Face Values of ZCBs to Purchase

Each ZCB face value is found by compounding the rupee investment forward at 7% for the ZCB's maturity.

3-year ZCB:

Face Value = Investment × $(1.07)^3$ = 60.81 × 1.2250 = ₹74.49 lakh

5-year ZCB:

Face Value = Investment × $(1.07)^5$ = 106.71 × 1.4026 = ₹149.67 lakh

Verification via reverse discounting (should match investment amounts):

74.49 × 0.8163 = 60.80 lakh ✓ (₹0.01 rounding)

149.67 × 0.7130 = 106.72 lakh ✓ (₹0.01 rounding)

B(v) Residual Risks Absent in Part A

Duration-based immunization protects the portfolio's aggregate value against parallel shifts in the yield curve, but it introduces residual risks that exact cash flow matching does not face:

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(i) Reinvestment risk on interim cash flows. The 3-year ZCB matures at Year 3 (with ₹74.49 lakh cash) but the next liability (₹75 lakh) is not due until Year 4. This ₹74.49 lakh must be reinvested for one year at whatever short-term rate prevails at Year 3. If the yield curve has shifted by then, the reinvestment rate will differ from the assumed 7%, creating a small shortfall or surplus.

(ii) Price risk on early liquidation. The Year 2 liability (₹50 lakh) requires selling a fraction of the 3-year ZCB before its maturity. The realised sale price depends on the prevailing 1-year yield at Year 2, which may differ from the current forward 1-year yield implied by today's curve.

(iii) Non-parallel yield curve shifts. Immunization protects against parallel shifts but not against steepening, flattening, or twist scenarios. If short rates rise while long rates fall (curve inversion), the portfolio's actual value may differ materially from its target.

(iv) Convexity mismatch. Even if duration is matched, differences in convexity between assets (barbell of 3-year and 5-year ZCBs) and liabilities (2-year, 4-year, and 6-year) create residual risk under large yield movements. In extreme cases this can cause meaningful shortfalls.

(v) Rebalancing requirement. As time passes, the durations of assets and liabilities drift at different rates. Duration-based immunization requires periodic rebalancing (typically annually) to maintain the duration match — creating ongoing transaction costs that exact matching avoids entirely.

Practical Implication:

The pension fund's CIO should always prefer exact cash flow matching (Part A) when the matching instruments are available. Duration-based immunization (Part B) is a second-best solution used when the ideal matching instruments do not exist in the market. In institutional practice, sophisticated LDI teams often use a hybrid: exact matching for large near-term liabilities (where matching bonds are most likely to exist) and duration matching for longer-dated liabilities (where the matching universe is thinner). This hybrid approach captures the best of both frameworks — certainty where possible, approximation where necessary.

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CHAPTER 6 — PORTFOLIO MANAGEMENT

Question 1 — Beta Computation and Systematic vs Unsystematic Risk Decomposition

A quantitative equity analyst at a Bangalore-based hedge fund is computing the beta of Stock X (a listed mid-cap Indian pharmaceutical company) relative to the Nifty 50 market index. Six months of monthly return data has been collected:

Month	Stock X Return (%)	Market Return (%)
1	+4.0	+2.0
2	−3.0	−1.5
3	+6.0	+3.5
4	+2.0	+1.0
5	−2.0	−1.0
6	+5.0	+3.0

Required:

(i) Compute the mean returns for Stock X and the Market.

(ii) Compute the deviations from the mean and their squared and cross-product values.

(iii) Compute the Covariance between Stock X and the Market.

(iv) Compute the Variance of the Market.

(v) Compute the Beta of Stock X.

(vi) Decompose the total risk (variance) of Stock X into systematic (market-driven) and unsystematic (firm-specific) components. Interpret the results.

Solution

(i) Mean Returns

Mean Return of Stock X = (4 − 3 + 6 + 2 − 2 + 5) / 6 = 12 / 6 = 2.00%

Mean Return of Market = (2 − 1.5 + 3.5 + 1 − 1 + 3) / 6 = 7 / 6 = 1.17%

(ii) Deviations, Squared Deviations, and Cross-Products

Month	R_X	R_M	(R_X − R̄_X)	(R_M − R̄_M)	(R_X − R̄_X)(R_M − R̄_M)	(R_M − R̄_M)²
1	4.0	2.0	+2.00	+0.83	1.660	0.689
2	−3.0	−1.5	−5.00	−2.67	13.350	7.129
3	6.0	3.5	+4.00	+2.33	9.320	5.429
4	2.0	1.0	0.00	−0.17	0.000	0.029
5	−2.0	−1.0	−4.00	−2.17	8.680	4.709
6	5.0	3.0	+3.00	+1.83	5.490	3.349
Sum	**12**	**7**	**0**	**0**	**38.500**	**21.334**

(iii) Covariance between Stock X and Market

Cov(X, M) = Σ [(R_X − R̄_X)(R_M − R̄_M)] / n = 38.500 / 6 = 6.417

(iv) Variance of the Market

Var(M) = Σ (R_M − R̄_M)² / n = 21.334 / 6 = 3.556

(v) Beta of Stock X

β_X = Cov(X, M) / Var(M) = 6.417 / 3.556 = 1.805

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Interpretation: Stock X has beta of approximately 1.80, meaning it is materially more volatile than the market. A 1% market move typically produces a 1.80% move in Stock X (in the same direction). This makes Stock X an aggressive holding — attractive when market outlook is bullish but exposing the portfolio to elevated losses when markets decline.

(vi) Systematic vs Unsystematic Risk Decomposition

Total Variance of Stock X:

First compute $\Sigma(R_X - \bar{R}_X)^2$ separately:

$= (2)^2 + (-5)^2 + (4)^2 + (0)^2 + (-4)^2 + (3)^2 = 4 + 25 + 16 + 0 + 16 + 9 = 70$

$Var(X) = 70 / 6 = 11.667$

Systematic Variance (Market-Driven):

Systematic Var $= \beta_X^2 \times Var(M) = (1.805)^2 \times 3.556 = 3.258 \times 3.556 = 11.586$

Unsystematic Variance (Firm-Specific):

Unsystematic Var = Total Var − Systematic Var = 11.667 − 11.586 = 0.081

Risk Decomposition:

Component	Variance	% of Total Risk
Systematic (Market-Driven)	11.586	99.3%
Unsystematic (Firm-Specific)	0.081	0.7%
Total Variance of Stock X	**11.667**	**100.0%**

Interpretation: Stock X's total risk is almost entirely systematic (99.3%). This means the stock is well-diversified in the firm-specific sense — nearly all its volatility comes from market-wide movements, not from company-specific news. For a portfolio manager, this is an important signal: adding more stocks similar to X would not materially reduce portfolio volatility because the diversifiable component is already very small. Effective portfolio construction must combine X with stocks of low correlation to the market (defensive stocks with beta below 1).

Question 2 — Capital Market Line and Optimal Portfolio with Risk-Free Asset

A wealth advisor at a private banking arm is constructing portfolios for clients using the market portfolio (equity index) combined with a risk-free asset (short-term G-Sec). The Capital Market Line (CML) framework governs how these combinations produce optimal risk-return trade-offs.

Market Parameters:

Parameter	Value
Expected Market Return (Rm)	15.0%
Market Standard Deviation (σm)	20.0%
Risk-free Rate (Rf)	6.0%

Required:

(i) Compute the slope of the Capital Market Line (also called the Sharpe ratio of the market).

(ii) For a Conservative Client — 70% in market portfolio and 30% in risk-free asset — compute portfolio expected return and standard deviation.

(iii) For an Aggressive Client — targeting portfolio standard deviation of 25% — compute the required allocation (may require borrowing at Rf) and the resulting expected return.

(iv) For an Ambitious Client — targeting expected return of 20% — compute the required allocation and resulting standard deviation.

(v) Distinguish the Capital Market Line (CML) from the Security Market Line (SML). Explain when to use each.

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Solution

(i) Slope of the Capital Market Line

Slope (Sharpe ratio) = (Rm – Rf) / σm

= (15% – 6%) / 20%

= 9% / 20%

= 0.45

Interpretation: for every 1% additional standard deviation the investor accepts, they earn 0.45% additional expected return. This is the market's price of risk.

(ii) Conservative Client (70% Market, 30% Risk-Free)

Expected Return:

$E(R_p)$ = w_m × Rm + w_rf × Rf

= 0.70 × 15% + 0.30 × 6%

= 10.5% + 1.8%

= 12.30%

Standard Deviation:

σ_p = w_m × σm (risk-free asset has zero SD)

= 0.70 × 20%

= 14.00%

(iii) Aggressive Client (Target σ = 25%)

Since 25% > 20% (market SD), the client needs LEVERAGE — borrow at Rf and invest more than 100% in the market.

Compute Market Weight:

σ_p = w_m × σm

25% = w_m × 20%

w_m = 25% / 20% = 1.25 (125% in market)

w_rf = 1 – 1.25 = –0.25 (borrow 25% at Rf)

Compute Expected Return:

$E(R_p)$ = 1.25 × 15% + (–0.25) × 6%

= 18.75% – 1.50%

= 17.25%

The client with ₹1 crore invests ₹1.25 crore in the market (borrowing ₹25 lakh at 6%) and earns expected 17.25% on their ₹1 crore capital. This leveraged approach is available in Indian markets via margin trading facilities offered by brokers.

(iv) Ambitious Client (Target Return = 20%)

Compute Market Weight:

$E(R_p)$ = w_m × 15% + (1 – w_m) × 6% = 20%

6% + w_m × (15% – 6%) = 20%

w_m × 9% = 14%

w_m = 14 / 9 = 1.556 (155.6% in market)

w_rf = 1 – 1.556 = –0.556 (borrow 55.6% at Rf)

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Resulting Standard Deviation:

$\sigma_p = 1.556 \times 20\% = 31.11\%$

Higher return (20%) requires substantially higher risk (31.11%) and material leverage (56% borrowing). This is aggressive positioning suitable only for clients with high risk tolerance, long time horizon, and no near-term liquidity needs.

(v) CML vs SML — When to Use Each

Feature	Capital Market Line (CML)	Security Market Line (SML)
Y-axis	Expected Return E(R)	Expected Return E(R)
X-axis	Total Risk (σ)	Systematic Risk (β)
Applies To	Only efficient portfolios	All securities and portfolios
Slope	Sharpe ratio (Rm − Rf) / σm	Market Risk Premium (Rm − Rf)
Use Case	Optimal portfolio selection	Individual security valuation

(i) Use CML when constructing efficient portfolios. Every point on the CML represents a specific combination of the market portfolio and risk-free asset — an efficient portfolio that no rational investor should deviate from.

(ii) Use SML when evaluating individual securities. Each stock has its own β and can be plotted on the SML; positions above the SML are underpriced (α > 0), positions below are overpriced (α < 0).

(iii) CML applies only to well-diversified portfolios where unsystematic risk has been eliminated. Individual securities carry both systematic and unsystematic risk and therefore lie BELOW the CML (never on it).

(iv) In practice, portfolio construction uses BOTH: SML for stock selection (identifying positive-alpha stocks), CML for asset allocation (choosing the market/risk-free mix).

Question 3 — Sharpe's Single Index Model: Portfolio Variance Decomposition

A portfolio analyst at a Chennai-based equity mutual fund is using Sharpe's Single Index Model to decompose the risk of a three-stock portfolio. The Single Index Model assumes that all covariance between stocks flows through their common exposure to the market — dramatically simplifying the variance-covariance matrix computation compared with the full Markowitz framework.

Portfolio Composition (Equal Weights):

Stock	Weight	Beta (β)	Unsystematic Variance (σ_e^2)
Stock 1	33.33%	1.2	25
Stock 2	33.33%	1.0	16
Stock 3	33.33%	0.8	9

Market Variance (σ_m^2): 20

Required:

(i) Compute the portfolio beta (β_p) as the weighted average of individual betas.

(ii) Compute the Systematic Variance of the portfolio.

(iii) Compute the Unsystematic Variance of the portfolio.

(iv) Compute the Total Variance and Standard Deviation of the portfolio.

(v) Comment on how the unsystematic variance would change if the portfolio were expanded from 3 stocks to 10, 30, or 100 stocks with similar risk profiles.

Solution

(i) Portfolio Beta

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$\beta_p = w_1 \times \beta_1 + w_2 \times \beta_2 + w_3 \times \beta_3$

$= (1/3) \times 1.2 + (1/3) \times 1.0 + (1/3) \times 0.8$

$= 0.4 + 0.333 + 0.267$

$= 1.00$

The portfolio beta of exactly 1.00 indicates market-neutral exposure — the portfolio moves in lockstep with the market on average, though individual stocks vary.

(ii) Systematic Variance

Systematic Var = $\beta_p^2 \times \sigma_m^2$

$= (1.00)^2 \times 20 = 20.00$

(iii) Unsystematic Variance

Unsystematic Var = $\Sigma\, w_i^2 \times \sigma_{e_i}^2$

$= (1/3)^2 \times 25 + (1/3)^2 \times 16 + (1/3)^2 \times 9$

$= (1/9) \times (25 + 16 + 9)$

$= (1/9) \times 50$

$= 5.56$

(iv) Total Portfolio Variance and Standard Deviation

Component	Value
Systematic Variance ($\beta_p^2 \times \sigma_m^2$)	20.00
Unsystematic Variance ($\Sigma\, w^2 \times \sigma_e^2$)	5.56
Total Portfolio Variance	**25.56**
Portfolio Standard Deviation (√25.56)	**5.06%**

(v) Diversification Effect: Unsystematic Variance Falls as 1/n

For an equal-weighted portfolio of n stocks with similar unsystematic variances, the portfolio unsystematic variance falls proportional to 1/n:

Unsystematic Variance ≈ Average σ_e^2 / n

With average $\sigma_e^2 = 50/3 \approx 16.67$ (from our data):

Number of Stocks	Approximate Unsystematic Variance	Reduction vs 3 Stocks
3 stocks	5.56	Base case
10 stocks	16.67 / 10 = 1.67	70% reduction
30 stocks	16.67 / 30 = 0.56	90% reduction
100 stocks	16.67 / 100 = 0.17	97% reduction

Key Insight: The Diversification Free Lunch

As portfolio size increases, unsystematic variance approaches zero, while systematic variance (20.00) remains constant regardless of portfolio size. The total portfolio variance therefore converges to the systematic variance — a hard floor beneath which portfolio risk cannot be reduced through diversification alone.

This is why institutional portfolio managers typically hold 30 to 60 stocks. Beyond about 30 stocks, additional diversification produces marginal risk reduction because unsystematic variance is already almost fully eliminated. Adding stocks beyond 60 mainly adds monitoring costs without meaningful risk-reduction benefit.

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Question 4 — Portfolio Evaluation: Sharpe, Treynor, and Jensen's Alpha

A senior wealth advisor at a Mumbai-based private banking arm is evaluating three actively managed equity mutual fund schemes for a High-Net-Worth client. The client, a 45-year-old Indian professional, has ₹1 crore to allocate to equity mutual funds through the SIP route and needs to select the scheme delivering the best risk-adjusted performance. The advisor also needs to assess whether each fund manager's demonstrated skill justifies the typical active management expense ratio of 1.0% to 2.0% per annum charged by Indian mutual funds.

Market Parameters (Same for All Three Funds):

Parameter	Value
Risk-Free Rate (Rf) — 10-year G-Sec yield	6.00%
Market Return (Rm) — Nifty 50 TRI	14.00%
Market Standard Deviation (σm)	15.00%
Market Risk Premium (Rm − Rf)	8.00%

Fund-Specific Data (Trailing 3-Year Annualised):

Fund	Fund Type	Return (Ri)	SD (σi)	Beta (βi)
Fund A	Active Growth (Large-Cap)	20.0%	25.0%	1.30
Fund B	Diversified Large-Cap	17.0%	18.0%	1.10
Fund C	Balanced/Hybrid Fund	15.0%	12.0%	0.75

Required:

(i) Compute the Sharpe Ratio for each of the three funds and compare with the Market Sharpe Ratio.

(ii) Compute the Treynor Ratio for each of the three funds and compare with the Market Treynor Ratio.

(iii) Compute Jensen's Alpha for each of the three funds using the CAPM benchmark.

(iv) Rank the three funds by each of the three metrics separately. Where rankings differ, reconcile the divergence and explain what drives it.

(v) Advise the client on: (a) which evaluation metric is most appropriate for each fund type, and (b) whether each fund manager's demonstrated performance justifies the typical 1-2% active management expense ratio.

Solution

(i) Sharpe Ratio Computation

Formula (ICAI SM Section 10.1):

Sharpe Ratio (S) = (Ri − Rf) / σi

Sharpe measures excess return per unit of TOTAL risk (standard deviation). It captures both systematic and unsystematic risk in the denominator.

Fund A: S_A = (20% − 6%) / 25% = 14% / 25% = 0.560

Fund B: S_B = (17% − 6%) / 18% = 11% / 18% = 0.611

Fund C: S_C = (15% − 6%) / 12% = 9% / 12% = 0.750

Market: S_M = (14% − 6%) / 15% = 8% / 15% = 0.533

Fund	Excess Return (Ri − Rf)	Total Risk (σi)	Sharpe Ratio	vs Market (0.533)
Fund A	14.0%	25.0%	0.560	Marginally above
Fund B	11.0%	18.0%	0.611	Above
Fund C	9.0%	12.0%	0.750	Significantly above
Market	8.0%	15.0%	0.533	Benchmark

Interpretation of Sharpe results:

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All three funds deliver a Sharpe Ratio above the market — meaning each provides better excess return per unit of total risk than passive index-tracking. Fund C is the most efficient on total risk basis (0.750), earning ₹0.75 of excess return for every ₹1 of standard deviation absorbed. Fund A, despite the highest absolute return (20%), has only a marginally better Sharpe than the market because it takes on very high total risk (25%).

(ii) Treynor Ratio Computation

Formula (ICAI SM Section 10.2):

Treynor Ratio (T) = (Ri − Rf) / βi

Treynor measures excess return per unit of SYSTEMATIC risk (beta). It excludes unsystematic risk on the assumption that this can be diversified away.

Fund A: T_A = (20% − 6%) / 1.30 = 14% / 1.30 = 10.77

Fund B: T_B = (17% − 6%) / 1.10 = 11% / 1.10 = 10.00

Fund C: T_C = (15% − 6%) / 0.75 = 9% / 0.75 = 12.00

Market: T_M = (14% − 6%) / 1.00 = 8% / 1.00 = 8.00

Fund	Excess Return (Ri − Rf)	Systematic Risk (βi)	Treynor Ratio	vs Market (8.00)
Fund A	14.0%	1.30	10.77	Above
Fund B	11.0%	1.10	10.00	Above
Fund C	9.0%	0.75	12.00	Significantly above
Market	8.0%	1.00	8.00	Benchmark

Interpretation of Treynor results:

All three funds outperform the market on a systematic-risk-adjusted basis. Fund C again dominates (12.00) because it earns solid excess return with materially low beta exposure (0.75). Fund A rises to second place on Treynor (10.77) — its high total risk penalty from Sharpe doesn't hurt it here because Treynor ignores unsystematic risk. Fund B drops to third.

(iii) Jensen's Alpha Computation

Formula (ICAI SM Section 10.3):

Jensen's Alpha (α) = Actual Return − Expected Return per CAPM

Expected Return per CAPM = Rf + βi × (Rm − Rf)

Step 1: Compute CAPM Expected Return for each fund.

Fund A: 6% + 1.30 × 8% = 6% + 10.4% = 16.4%

Fund B: 6% + 1.10 × 8% = 6% + 8.8% = 14.8%

Fund C: 6% + 0.75 × 8% = 6% + 6.0% = 12.0%

Step 2: Compute Alpha = Actual − Expected.

α_A = 20.0% − 16.4% = 3.6%

α_B = 17.0% − 14.8% = 2.2%

α_C = 15.0% − 12.0% = 3.0%

Fund	Actual Return	CAPM Expected Return	Jensen's Alpha	Assessment
Fund A	20.0%	16.4%	+3.6%	Meaningful positive skill
Fund B	17.0%	14.8%	+2.2%	Modest positive skill
Fund C	15.0%	12.0%	+3.0%	Meaningful positive skill

Interpretation of Jensen's Alpha:

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Alpha measures excess return over and above what CAPM would predict given the fund's beta. All three alphas are positive, indicating each manager delivers value beyond what pure market exposure would provide. Fund A leads (+3.6%), followed closely by Fund C (+3.0%). Fund B lags with +2.2%. Note that ICAI SM specifically cautions: "[Jensen's Alpha] will only produce meaningful results if it is used to compare two portfolios which have similar betas." Our funds have betas of 1.30, 1.10, and 0.75 — not identical, so cross-fund comparison of alphas requires some judgement.

(iv) Ranking Comparison and Reconciliation

The three metrics produce three different rankings — a critically important pedagogical insight.

Rank	By Sharpe Ratio	By Treynor Ratio	By Jensen's Alpha
1st (Best)	Fund C (0.750)	Fund C (12.00)	Fund A (+3.6%)
2nd	Fund B (0.611)	Fund A (10.77)	Fund C (+3.0%)
3rd	Fund A (0.560)	Fund B (10.00)	Fund B (+2.2%)

Reconciling the divergent rankings:

Why Fund A ranks LOW on Sharpe but HIGH on Alpha:

Fund A takes on very high total risk (σ = 25%), much of which appears to be unsystematic (firm-specific bets, sector concentration). Sharpe penalises this heavily by dividing by total σ. However, Alpha measures only excess return over CAPM-predicted return, which is based on beta (systematic risk) alone. The unsystematic risk that hurt A's Sharpe doesn't enter the Alpha calculation. Result: A's high absolute return combined with its relatively moderate beta (1.30) produces the largest positive Alpha, but its high standard deviation drags down its Sharpe.

Why Fund C dominates BOTH Sharpe and Treynor but has lower Alpha than A:

Fund C is a balanced fund with low total risk (12%) and low beta (0.75). Its excess return of 9% is modest in absolute terms, but per-unit-of-risk (whether total or systematic) it is highly efficient — hence the top ranking on Sharpe and Treynor. However, its low beta means CAPM expects only 12% return from it. Delivering 15% actual produces an Alpha of 3.0% — solid, but below Fund A's 3.6%. The lesson: Alpha rewards absolute excess return over CAPM, not efficiency of risk-taking.

Why Fund B ranks middle-to-bottom on all metrics:

Fund B occupies the middle in every dimension — moderate return, moderate risk, moderate beta, moderate alpha. It is neither the most efficient risk-taker (C) nor the most skilled active manager (A). This is common for large-cap diversified funds that closely track their benchmark — they deliver "acceptable" performance but rarely stand out on any specific dimension.

(v) Client Advisory Recommendation

(a) Choosing the Right Metric per ICAI SM Guidance

ICAI SM Section 10.2 provides explicit guidance on when to use each metric:

Direct quotation from ICAI SM: *"When one has to evaluate the funds which are sector specific, Sharpe ratio would be more meaningful. This is due to the fact that unsystematic risk would be present in sector specific funds… On the contrary, if we consider diversified equity funds, the element of unsystematic risk would be very negligible as these funds are expected to be well diversified by virtue of their nature. Hence, Treynor ratio would be more apt here."*

Fund	Fund Type	ICAI-Preferred Metric	Rationale
Fund A	Active Growth (concentrated stock selection)	Sharpe Ratio	High σ signals meaningful unsystematic (stock-specific) risk that needs to be captured in evaluation
Fund B	Diversified Large-Cap	Treynor Ratio	Well-diversified, so unsystematic risk is minimal; systematic (beta) risk is the relevant measure
Fund C	Balanced/Hybrid (mixed asset classes)	Sharpe Ratio	Not fully equity-diversified due to debt component; total risk more relevant than beta alone

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(b) Fee Justification Analysis

Indian mutual funds charge an expense ratio ranging from about 0.5% (low-cost index funds) to 2.0% (aggressive active equity). For active management fees to be justified, the fund manager's demonstrated skill (measured by Jensen's Alpha, since Alpha is the CAPM-adjusted excess return attributable to the manager) should meaningfully exceed the fee. Analysis:

Fund	Alpha (Gross of Fees)	Typical Fee	Net Alpha (Alpha – Fee)	Fee Justified?
Fund A	+3.6%	1.75%	+1.85%	Yes — Clear positive net skill
Fund B	+2.2%	1.50%	+0.70%	Marginal — barely covers fee
Fund C	+3.0%	1.25%	+1.75%	Yes — Solid net skill

Final Client Recommendation:

(i) Fund C is the clear all-round winner for this HNW client. It leads on both Sharpe (best risk-efficient) and Treynor (best systematic-risk-adjusted), while also delivering meaningful positive net Alpha (1.75%). Its low beta (0.75) suits a 45-year-old professional building long-term wealth without excessive volatility.

(ii) Fund A is the second choice for the equity-satellite allocation. Highest Alpha (3.6%) means the manager has demonstrated real stock-picking skill. However, the high total risk (25%) means the client should size this position carefully — no more than 20-25% of the equity allocation.

(iii) Fund B is not recommended for this client. Marginal alpha net of fees, mediocre rankings on risk-adjusted metrics. The client could achieve similar performance with a low-cost large-cap index fund charging 0.20% expense ratio.

(iv) Suggested allocation of the ₹1 crore mandate: ₹65 lakh in Fund C (core diversified equity), ₹25 lakh in Fund A (growth satellite), ₹10 lakh in a low-cost Nifty 50 Index Fund (broad market exposure at low cost).

Question 5 — Portfolio Rebalancing: Buy-and-Hold vs Constant Mix vs CPPI

A wealth advisor is comparing three portfolio rebalancing strategies for a client with ₹10 lakh to invest across equity and debt. The client's initial allocation is 60% equity (₹6 lakh) and 40% debt (₹4 lakh). Over the next two periods, the equity market first falls 20% and then rises 30% (debt remains stable at flat return for simplicity). The three strategies produce materially different final outcomes.

Market Movement:

- Period 1: Equity falls 20% (from ₹6 lakh to ₹4.8 lakh)
- Period 2: Equity rises 30% (from Period 1 level)
- Debt earns 0% return throughout (for analytical simplicity)

CPPI Parameters:

- Floor: ₹6 lakh (client's minimum acceptable portfolio value)
- Multiplier: 2

Required:

(i) Compute the final portfolio value under the Buy-and-Hold strategy (no rebalancing).

(ii) Compute the final portfolio value under the Constant Mix strategy (rebalance to 60:40 after Period 1).

(iii) Compute the final portfolio value under the CPPI strategy (Constant Proportion Portfolio Insurance).

(iv) Compare the three strategies and identify which performs best in this volatile-but-recovering market.

(v) Discuss which strategy is most appropriate under different market outlooks (trending, volatile-but-recovering, or sustained decline).

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Solution

(i) Buy-and-Hold Strategy

Under Buy-and-Hold, the initial allocation is maintained without any rebalancing. Equity and debt positions simply track their respective returns.

Period	Equity Value (₹ lakh)	Debt Value (₹ lakh)	Total Portfolio (₹ lakh)
Start (t=0)	6.00	4.00	10.00
After Period 1 (equity −20%)	6.00 × 0.80 = 4.80	4.00	8.80
After Period 2 (equity +30%)	4.80 × 1.30 = 6.24	4.00	10.24

Buy-and-Hold Final Value = ₹10.24 lakh (Return: +2.4%)

(ii) Constant Mix Strategy

Under Constant Mix, the manager rebalances back to the target 60:40 allocation after Period 1. This means BUYING equity at the low (since equity has fallen and now represents less than 60% of portfolio value).

Period	Equity Before	Debt Before	Total	Post-Rebalance Equity	Post-Rebalance Debt
Start	6.00	4.00	10.00	6.00 (60%)	4.00 (40%)
After P1 (before rebalance)	4.80	4.00	8.80	—	—
After P1 rebalance to 60:40	—	—	8.80	8.80 × 60% = 5.28	8.80 × 40% = 3.52
After P2 (equity +30%)	5.28 × 1.30 = 6.86	3.52	10.38	—	—

Constant Mix Final Value = ₹10.38 lakh (Return: +3.8%)

The Constant Mix strategy outperforms Buy-and-Hold by ₹0.14 lakh (14 basis points on the ₹10 lakh initial capital). This outperformance comes from the disciplined "buy low" behaviour — the strategy forces the investor to buy more equity precisely when equity has fallen.

(iii) CPPI Strategy (Constant Proportion Portfolio Insurance)

CPPI dynamically adjusts equity allocation based on the cushion above the floor:

Equity Allocation = Multiplier × (Portfolio Value − Floor)

Period	Portfolio	Cushion (Portfolio − Floor)	Target Equity (2 × Cushion)	Actual Equity	Debt (Portfolio − Equity)
Start (t=0)	10.00	10.00 − 6.00 = 4.00	2 × 4.00 = 8.00 (but capped at 60%)	6.00	4.00

Note: In this problem, we start with the given 60:40 allocation (6.00 equity, 4.00 debt). We then apply CPPI logic at each rebalancing point.

Period 1 Movement (equity falls 20%):

Equity Value after P1 = 6.00 × 0.80 = ₹4.80 lakh

Debt Value after P1 = ₹4.00 lakh

Portfolio Value after P1 = ₹8.80 lakh

CPPI Rebalance after Period 1:

Cushion = Portfolio − Floor = 8.80 − 6.00 = ₹2.80 lakh

Target Equity = Multiplier × Cushion = 2 × 2.80 = ₹5.60 lakh

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Target Debt = 8.80 − 5.60 = ₹3.20 lakh

Since current equity (₹4.80) is BELOW target (₹5.60), CPPI buys equity: acquire ₹0.80 lakh of equity by selling debt.

Period 2 Movement (equity rises 30%):

Equity Value after P2 = 5.60 × 1.30 = ₹7.28 lakh

Debt Value after P2 = ₹3.20 lakh

Total Portfolio after P2 = 7.28 + 3.20 = ₹10.48 lakh

CPPI Final Value = ₹10.48 lakh (Return: +4.8%)

(iv) Strategy Comparison

Strategy	Final Value (₹ lakh)	Return	Rank in this Scenario
Buy-and-Hold	10.24	+2.4%	3rd (worst)
Constant Mix	10.38	+3.8%	2nd
CPPI (m=2)	10.48	+4.8%	1st (best)

In this volatile-but-recovering scenario, CPPI outperforms both alternatives. However, this outcome is highly dependent on the specific market movement pattern. In a trending market (equity keeps rising), Buy-and-Hold would win because it maintains full exposure throughout. In a sustained decline market, CPPI would preserve capital best because it progressively reduces equity as portfolio value approaches the floor.

(v) Strategy Selection by Market Outlook

Market Outlook	Best Strategy	Rationale
Sustained Uptrend	Buy-and-Hold	Maintains full equity exposure; captures compound growth
Volatile-but-Recovering	Constant Mix	Disciplined buy-low/sell-high produces alpha
Sharp Rebound after Fall	CPPI (higher multiplier)	Aggressive re-entry as portfolio recovers above floor
Sustained Decline	CPPI (low multiplier)	Progressively reduces equity, preserves capital
Sideways / Range-bound	Constant Mix	Extracts value from cyclical mean reversion

Practical Application:

In institutional practice, sophisticated wealth managers use HYBRID strategies that combine elements of all three. During normal market conditions, they may use Constant Mix rebalancing quarterly or semi-annually. During episodes of high volatility (like the COVID-19 crash of March 2020 or the Global Financial Crisis of 2008), they may switch to CPPI-like dynamic allocation to protect against tail risk. During confirmed bull markets, they may lean toward Buy-and-Hold to avoid selling winners too early. The choice is context-dependent, not formulaic.

Question 6 — Minimum Variance Portfolio with Efficient Frontier Analysis

A portfolio construction analyst is evaluating a two-asset portfolio universe. The analyst wants to identify the specific weight combination that minimises portfolio variance — the Minimum Variance Portfolio (MVP) — and understand its position on the efficient frontier.

Asset Parameters:

Parameter	Asset A	Asset B
Expected Return E(R)	12.0%	10.0%
Standard Deviation (σ)	15.0%	10.0%

Correlation between A and B: ρ(A,B) = 0.30

Required:

(i) Compute the Covariance between A and B.

(ii) Compute the weights of the Minimum Variance Portfolio (MVP).

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(iii) Compute the expected return and standard deviation of the MVP.

(iv) Compare the MVP against the 100% Asset A and 100% Asset B portfolios to identify why the MVP is worth targeting.

(v) Explain the concept of the Efficient Frontier and identify which points on it are relevant to different investor preferences.

Solution

(i) Covariance between A and B

$Cov(A, B) = \rho_{AB} \times \sigma_A \times \sigma_B$

$= 0.30 \times 15 \times 10$

$= 45.0$

(ii) Minimum Variance Portfolio Weights

Formula: $w_A^* = (\sigma_B^2 - \rho\sigma_A \sigma_B) / (\sigma_A^2 + \sigma_B^2 - 2\rho\sigma_A \sigma_B)$

Numerator $= \sigma_B^2 - \rho \times \sigma_A \times \sigma_B$

$= 100 - 0.30 \times 15 \times 10$

$= 100 - 45$

$= 55$

Denominator $= \sigma_A^2 + \sigma_B^2 - 2 \times \rho \times \sigma_A \times \sigma_B$

$= 225 + 100 - 90$

$= 235$

$w_A^* = 55 / 235 = 0.234$ (23.4%)

$w_B^* = 1 - 0.234 = 0.766$ (76.6%)

The MVP concentrates heavily in Asset B (the lower-variance asset), which is intuitive — to minimise variance, allocate more to the safer asset.

(iii) MVP Expected Return and Standard Deviation

Expected Return:

$E(R_{MVP}) = 0.234 \times 12\% + 0.766 \times 10\%$

$= 2.808\% + 7.660\%$

$= 10.47\%$

Standard Deviation:

$\sigma_{MVP}^2 = (0.234)^2 \times (15)^2 + (0.766)^2 \times (10)^2 + 2 \times 0.234 \times 0.766 \times 45$

$= 0.0548 \times 225 + 0.5868 \times 100 + 16.13$

$= 12.32 + 58.68 + 16.13$

$= 87.13$

$\sigma_{MVP} = \sqrt{87.13} = 9.33\%$

(iv) MVP vs Corner Portfolios

Portfolio	Weight A	Weight B	Expected Return	Standard Deviation
100% Asset A	100%	0%	12.00%	15.00%
100% Asset B	0%	100%	10.00%	10.00%
Minimum Variance Portfolio	23.4%	76.6%	10.47%	9.33%

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Key Insight — The MVP Beats Its Own Component:

The MVP has σ = 9.33%, which is LOWER than 100% Asset B (σ = 10.00%). Yet the MVP delivers a higher return (10.47% vs 10.00%). This demonstrates the diversification free lunch — you can achieve LOWER risk AND HIGHER return simultaneously by combining assets with ρ < 1, compared with holding either asset alone.

(v) The Efficient Frontier

The efficient frontier is the set of portfolios that offer the highest expected return for a given level of risk. In the two-asset case:

(i) Portfolios below the MVP (i.e., with lower expected return than 10.47%) are INEFFICIENT — any such portfolio has a corresponding portfolio at the same risk level but higher return.

(ii) The MVP is the leftmost point on the efficient frontier — the lowest-risk portfolio in the universe.

(iii) Above the MVP, moving toward 100% Asset A produces higher expected returns but also higher risk. This is the classical risk-return trade-off — investors accept more risk to earn more return.

(iv) Every portfolio between the MVP and 100% Asset A is efficient — no other combination of A and B produces higher return at the same risk level.

(v) Investor choice on the efficient frontier depends on risk tolerance: risk-averse investors prefer portfolios closer to the MVP; aggressive investors prefer portfolios closer to 100% Asset A.

In Modern Portfolio Theory (Markowitz 1952):

The efficient frontier for a full universe of many assets is a curve in return-risk space that dominates all suboptimal portfolios. Adding more assets (as long as they are not perfectly correlated with existing assets) shifts the frontier further to the left — producing lower risk for the same return. This is why diversification across asset classes (equity, debt, gold, real estate) is universally recommended in institutional portfolio construction.

Question 7 — Arbitrage Pricing Theory (APT) versus CAPM

The Arbitrage Pricing Theory (APT), developed by Stephen Ross in 1976, extends the CAPM framework by allowing multiple systematic risk factors (rather than just one market factor). This multi-factor structure allows APT to capture dimensions of risk that CAPM systematically misses — such as macroeconomic factors, industry factors, and style factors.

Setup — Two-Factor APT Model:

Factor	Stock Sensitivity	Factor Risk Premium
Factor 1: GDP Growth	1.2	3.0%
Factor 2: Inflation	0.8	2.0%

Other Parameters:

- Risk-free Rate (Rf) = 6.0%
- Expected Return on the Stock (analyst estimate) = 13.0%
- CAPM Beta of the Stock (against Nifty 50) = 1.1
- Nifty 50 Expected Return = 14.0% (for comparison with CAPM)

Required:

(i) Compute the expected return on the Stock using the two-factor APT model.

(ii) Compute the APT alpha — the difference between the stock's expected return and its APT-required return.

(iii) Compute the CAPM-required return using single-factor CAPM.

(iv) Compute the CAPM alpha for comparison.

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(v) Explain why APT and CAPM produce different alphas for the same stock and discuss which framework is more useful in institutional practice.

Solution

(i) APT Expected Return

APT Formula: $E(R) = Rf + \beta_1 \times RP_1 + \beta_2 \times RP_2$

Where:

- β_1 = sensitivity to Factor 1 (GDP Growth) = 1.2
- β_2 = sensitivity to Factor 2 (Inflation) = 0.8
- RP_1 = Factor 1 risk premium = 3.0%
- RP_2 = Factor 2 risk premium = 2.0%

APT Expected Return = 6% + 1.2 × 3% + 0.8 × 2%

= 6% + 3.6% + 1.6%

APT Expected Return = 11.2%

(ii) APT Alpha

APT Alpha = Expected Return − APT Required Return

= 13.0% − 11.2%

= +1.8%

The stock is UNDERVALUED per the APT framework — it offers 180 bps more return than the APT model would demand for its risk exposure. This is a positive alpha signal that would attract institutional buyers.

(iii) CAPM Required Return

CAPM Formula: $E(R) = Rf + \beta \times (Rm - Rf)$

CAPM Required Return = 6% + 1.1 × (14% − 6%)

= 6% + 1.1 × 8%

= 6% + 8.8%

CAPM Required Return = 14.8%

(iv) CAPM Alpha

CAPM Alpha = Expected Return − CAPM Required Return

= 13.0% − 14.8%

= −1.8%

The stock is OVERVALUED per the CAPM framework — it offers 180 bps LESS return than CAPM would demand. This is a negative alpha signal that would attract institutional sellers.

(v) Reconciliation and Practitioner Discussion

The Contradiction:

Framework	Required Return	Alpha	Signal
APT (2-factor)	11.2%	+1.8%	UNDERVALUED (Buy)
CAPM (1-factor)	14.8%	−1.8%	OVERVALUED (Sell)

Why the Two Frameworks Disagree:

(i) CAPM uses a single beta against the market. The stock's beta of 1.1 implies moderate market sensitivity, and the market return of 14% translates to a high required return of 14.8%.

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(ii) APT decomposes market risk into two distinct factors — GDP growth and inflation. The stock is much more sensitive to GDP growth (1.2) than to inflation (0.8), and each factor commands a lower risk premium separately than the aggregate market does.

(iii) The 180-bps sign flip is not random — it reflects that the CAPM implicitly assumes the stock's total systematic risk is captured by the single market beta, while APT correctly recognises that the stock's actual risk exposures do not perfectly align with market beta.

(iv) In effect, APT is telling us that the stock's true systematic risk (as measured by its exposure to fundamental factors) is LESS than what CAPM's single-beta approach suggests. Therefore APT demands lower compensation than CAPM does.

Which Framework Is More Useful in Institutional Practice?

(i) CAPM's simplicity is its main strength. Single-factor structure makes it easy to apply, easy to communicate to non-technical stakeholders, and easy to estimate empirically. Every equity research desk uses CAPM as the baseline valuation discount rate.

(ii) APT's flexibility captures dimensions CAPM misses. Sophisticated quantitative equity funds — Renaissance, Two Sigma, AQR Capital in the US; smaller quant shops in India — use multi-factor models based on APT principles. These models can explain and predict return patterns that pure CAPM cannot.

(iii) In academic research (Fama-French, Carhart), APT-style multi-factor models have been shown to capture return variation more accurately than CAPM. The three-factor model (market + size + value) and five-factor model (adding profitability and investment) are extensions of APT thinking.

(iv) In INDIAN institutional practice, most fundamental equity research desks use CAPM as the primary discount rate framework, but the more sophisticated quant funds have moved to multi-factor APT-style models. The choice reflects a trade-off between simplicity and accuracy.

Reconciling the Contradictory Signals:

When APT and CAPM produce contradictory alphas (as in this question), the sophisticated analyst does not simply pick one framework. Instead, they treat the disagreement as a signal that the stock's risk profile is unusual — perhaps because its exposures to GDP growth and inflation differ from what its market beta alone would suggest. This warrants deeper fundamental research to understand why. In some cases, the APT framework reveals hidden opportunities (as in our question, the +1.8% APT alpha suggests genuine mispricing); in other cases, the CAPM view proves more accurate because the specified APT factors do not fully capture systematic risk. Empirical validation across multiple market cycles is essential before adopting either framework as the definitive guide.

Question 8 — Multi-Asset Portfolio Construction with Cross-Asset Correlations

A senior wealth advisor at a boutique investment management firm is constructing a multi-asset portfolio combining equity, debt, and gold — the three principal asset classes accessible to Indian retail investors. Unlike the two-asset framework, multi-asset construction requires careful handling of pairwise correlations, which can either amplify or mitigate the diversification benefit.

Asset Class Parameters:

Asset Class	Weight	E(R)	σ
Equity	60%	15.0%	25.0%
Debt	30%	8.0%	5.0%
Gold	10%	10.0%	20.0%

Pairwise Correlations:

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Correlation Pair	Value	Interpretation
ρ(Equity, Debt)	−0.20	Slight negative — debt performs well when equity falls
ρ(Equity, Gold)	−0.30	Meaningful negative — gold is a classic equity hedge
ρ(Debt, Gold)	+0.10	Slight positive — some common macro exposure

Required:

(i) Compute the expected return of the multi-asset portfolio.

(ii) Compute the variance and standard deviation of the multi-asset portfolio using the three-asset variance formula.

(iii) Compute what the portfolio standard deviation would be if all three asset classes were held individually (100% in each) and compare against the diversified portfolio SD.

(iv) Discuss why negative correlations amplify the diversification benefit compared to positive correlations.

(v) Explain the role of gold as a hedge asset in Indian investor portfolios and discuss when the allocation to gold should be increased or decreased.

Solution

(i) Portfolio Expected Return

$E(R_p) = \Sigma\ w_i \times E(R_i)$

$= 0.60 \times 15\% + 0.30 \times 8\% + 0.10 \times 10\%$

$= 9.0\% + 2.4\% + 1.0\%$

$= 12.40\%$

(ii) Portfolio Variance and Standard Deviation

Three-Asset Variance Formula:

$\sigma_p^2 = \Sigma\ w_i^2 \times \sigma_i^2 + 2 \times \Sigma_i\ \Sigma_j\ (w_i \times w_j \times \rho_{ij} \times \sigma_i \times \sigma_j)$ for $i < j$

Own-Variance Terms:

Equity: $(0.60)^2 \times (25)^2 = 0.36 \times 625 = 225.00$

Debt: $(0.30)^2 \times (5)^2 = 0.09 \times 25 = 2.25$

Gold: $(0.10)^2 \times (20)^2 = 0.01 \times 400 = 4.00$

Sum of Own-Variance Terms = 225.00 + 2.25 + 4.00 = 231.25

Cross-Covariance Terms (each multiplied by 2):

Equity-Debt: $2 \times 0.60 \times 0.30 \times (-0.20) \times 25 \times 5 = 2 \times 0.60 \times 0.30 \times (-0.20) \times 125 = -9.00$

Equity-Gold: $2 \times 0.60 \times 0.10 \times (-0.30) \times 25 \times 20 = 2 \times 0.60 \times 0.10 \times (-0.30) \times 500 = -18.00$

Debt-Gold: $2 \times 0.30 \times 0.10 \times (+0.10) \times 5 \times 20 = 2 \times 0.30 \times 0.10 \times (0.10) \times 100 = 0.60$

Sum of Cross-Covariance Terms = −9.00 − 18.00 + 0.60 = −26.40

Total Portfolio Variance:

$\sigma_p^2 = 231.25 + (-26.40) = 204.85$

$\sigma_p = \sqrt{204.85} = 14.31\%$

(iii) Comparison with Single-Asset Portfolios

Portfolio	Expected Return	Standard Deviation	Sharpe Ratio (assume Rf = 6%)
100% Equity	15.00%	25.00%	(15 − 6) / 25 = 0.360
100% Debt	8.00%	5.00%	(8 − 6) / 5 = 0.400

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Portfolio	Expected Return	Standard Deviation	Sharpe Ratio (assume Rf = 6%)
100% Gold	10.00%	20.00%	(10 – 6) / 20 = 0.200
Diversified 60:30:10	**12.40%**	**14.31%**	**(12.4 – 6) / 14.31 = 0.447**

The diversified portfolio delivers the HIGHEST Sharpe ratio (0.447) — meaning it offers the best risk-adjusted return among all four alternatives. This is the value proposition of multi-asset construction: combining assets with imperfect (especially negative) correlations produces a superior risk-adjusted portfolio compared with any single-asset holding.

The Negative Correlation Advantage:

Note that the portfolio SD (14.31%) is materially LOWER than the weighted average of individual SDs, which would be 0.60 × 25 + 0.30 × 5 + 0.10 × 20 = 15.00 + 1.50 + 2.00 = 18.50%. This is the diversification benefit — the portfolio SD is 4.19 percentage points below the weighted average, entirely due to the negative correlations between equity-debt and equity-gold.

(iv) Why Negative Correlations Amplify Diversification

(i) When two assets are POSITIVELY correlated (ρ > 0), they tend to move in the same direction. Combining them provides limited risk reduction because losses in one asset are accompanied by losses in the other.

(ii) When two assets are UNCORRELATED (ρ = 0), they move independently. Combining them provides moderate risk reduction through statistical averaging of independent volatilities.

(iii) When two assets are NEGATIVELY correlated (ρ < 0), they tend to move in opposite directions. Combining them provides MAXIMUM risk reduction because losses in one asset are systematically offset by gains in the other.

(iv) The equity-gold negative correlation (−0.30) is especially valuable during equity market stress. When Indian equity markets crashed 40% in March 2020 (COVID pandemic onset), gold rose 15% over the same period, providing genuine hedging value.

(v) The equity-debt negative correlation (−0.20) reflects the classical flight-to-safety pattern. When equity markets fall, investors rotate into bonds, driving bond prices up (and yields down). This produces the observed negative correlation.

(v) The Role of Gold in Indian Portfolios

Traditional and Modern Rationale:

(i) Historical hedge against equity crashes. Gold's negative correlation with equity is well-established in Indian and global markets. During major equity drawdowns (2008 GFC, 2020 COVID), gold typically appreciates as investors seek safety.

(ii) Inflation hedge. Gold has historically preserved purchasing power during high-inflation periods. In India, gold has been a traditional store of value for over four millennia — a cultural preference that overlaps with sound financial reasoning.

(iii) Currency hedge. Since gold is priced in US dollars globally, INR depreciation raises the rupee price of gold. Indian investors benefit when the rupee weakens (which typically coincides with equity stress).

(iv) Portfolio insurance. A 5-10% gold allocation acts as insurance — most of the time it provides little contribution to returns, but during crises it delivers substantial protection.

When to Increase Gold Allocation:

(i) Elevated equity valuations (P/E ratios materially above historical means)

(ii) Rising geopolitical tensions or macroeconomic uncertainty

(iii) Anticipated rupee weakness or global currency volatility

(iv) Rising inflation expectations

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(v) Approaching retirement (increased need for wealth preservation vs growth)

When to Decrease Gold Allocation:

(i) Strong equity bull market with reasonable valuations

(ii) Rising real interest rates (gold has no yield; higher real rates make gold relatively less attractive)

(iii) Stable currency and low geopolitical stress

(iv) Long time horizon with high risk tolerance (equity likely outperforms over long horizons)

Question 9 — Comprehensive Client Advisory Case: Portfolio Construction for a Salaried Professional

Mr. Aditya Sharma is 40 years old, a mid-level executive at a Mumbai IT services firm with a stable annual salary. He has accumulated ₹1 crore in investable surplus after clearing his home loan and other essential financial obligations. His time horizon to retirement is 15 years. He describes himself as "moderately risk-tolerant" - willing to accept some volatility for higher returns but not comfortable with the possibility of losing more than 20% of his portfolio value in any single year.

Investment Universe (Asset Classes with Historical Return Assumptions):

Asset Class	Expected Annual Return	Standard Deviation
Equity Mutual Funds (Diversified Large-Cap)	12.0%	20.0%
Debt Mutual Funds (Medium-Duration)	7.0%	5.0%
Gold ETF	9.0%	18.0%
Real Estate Investment Trusts (REITs)	10.0%	15.0%

Correlation Assumptions:

- Equity-Debt: −0.20
- Equity-Gold: −0.30
- Equity-REIT: +0.50
- Debt-Gold: +0.10
- Debt-REIT: +0.20
- Gold-REIT: 0.00

Risk-Free Rate: 6.0%

Required:

(i) Design an appropriate asset allocation strategy for Mr. Sharma reflecting his 40-year age, 15-year horizon, moderate risk tolerance, and stable income.

(ii) Compute the expected portfolio return and standard deviation using the proposed allocation.

(iii) Compute the portfolio's Sharpe ratio and compare it against a 100% equity benchmark.

(iv) Recommend a rebalancing strategy for the 15-year holding period, including how the allocation should evolve as Mr. Sharma approaches retirement (the glidepath).

(v) Discuss tax-efficient rebalancing considerations under Indian income tax rules.

Solution

(i) Recommended Asset Allocation

Guided by the 40-year-old moderate-risk profile with 15-year horizon and stable income:

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Asset Class	Recommended Allocation	Rupee Investment (₹ lakh)	Rationale
Equity Mutual Funds	50%	50.00	Growth engine for long-horizon wealth creation; adequate for moderate risk tolerance
Debt Mutual Funds	25%	25.00	Stability and yield; buffer against equity volatility
Gold ETF	10%	10.00	Portfolio insurance and inflation hedge
REITs	15%	15.00	Income-generating diversification; less correlated with pure equity
Total	**100%**	**100.00**	

Allocation Rationale:

(i) The 50% equity allocation is appropriate for a 40-year-old with 15 years to retirement. The traditional "110 minus age" rule of thumb suggests 70% equity, but Mr. Sharma's moderate risk tolerance and 20% single-year drawdown limit warrants moderating this to 50%.

(ii) The 25% debt allocation provides stability and predictable income. Medium-duration debt funds capture reasonable yield while maintaining acceptable interest rate risk.

(iii) The 10% gold allocation is consistent with the classical Indian portfolio wisdom — a modest allocation provides material downside protection during equity crises without meaningfully compromising long-run returns.

(iv) The 15% REIT allocation adds real estate exposure without the illiquidity and management burden of direct property ownership. REITs have moderate positive correlation with equity but distinct income characteristics.

(ii) Expected Portfolio Return and Standard Deviation

Expected Return:

$E(R_p) = 0.50 \times 12\% + 0.25 \times 7\% + 0.10 \times 9\% + 0.15 \times 10\%$

$= 6.00\% + 1.75\% + 0.90\% + 1.50\%$

$= 10.15\%$

Portfolio Variance (using four-asset formula):

Own-variance terms:

Equity: $(0.50)^2 \times (20)^2 = 0.25 \times 400 = 100.00$

Debt: $(0.25)^2 \times (5)^2 = 0.0625 \times 25 = 1.56$

Gold: $(0.10)^2 \times (18)^2 = 0.01 \times 324 = 3.24$

REIT: $(0.15)^2 \times (15)^2 = 0.0225 \times 225 = 5.06$

Sum of own-variance = 109.86

Cross-covariance terms (each multiplied by 2):

Equity-Debt: $2 \times 0.50 \times 0.25 \times (-0.20) \times 20 \times 5 = -5.00$

Equity-Gold: $2 \times 0.50 \times 0.10 \times (-0.30) \times 20 \times 18 = -10.80$

Equity-REIT: $2 \times 0.50 \times 0.15 \times (+0.50) \times 20 \times 15 = +22.50$

Debt-Gold: $2 \times 0.25 \times 0.10 \times (+0.10) \times 5 \times 18 = +0.45$

Debt-REIT: $2 \times 0.25 \times 0.15 \times (+0.20) \times 5 \times 15 = +1.13$

Gold-REIT: $2 \times 0.10 \times 0.15 \times (0.00) \times 18 \times 15 = 0.00$

Sum of cross-covariance = 8.28

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Total Portfolio Variance = 109.86 + 8.28 = 118.14

Portfolio SD = √118.14 = 10.87%

(iii) Sharpe Ratio and Benchmark Comparison

Multi-Asset Portfolio Sharpe:

= $(E(R_p) - Rf) / \sigma_p$ = (10.15% − 6%) / 10.87% = 4.15 / 10.87 = 0.382

100% Equity Benchmark Sharpe:

= (12% − 6%) / 20% = 6/20 = 0.300

Portfolio	Return	SD	Sharpe Ratio
Recommended Multi-Asset	10.15%	10.87%	0.382
100% Equity Benchmark	12.00%	20.00%	0.300
Multi-Asset Advantage	**Lower return**	**Materially lower risk**	**27% higher Sharpe**

The multi-asset portfolio delivers a Sharpe ratio 27% higher than pure equity, despite delivering a lower absolute return. This is the essence of good portfolio construction — accepting a modest return sacrifice for materially better risk-adjusted performance and downside protection.

(iv) 15-Year Rebalancing Strategy and Glidepath

Rebalancing Frequency: Annual

Annual rebalancing captures the benefits of buy-low-sell-high discipline without incurring excessive transaction costs. Quarterly rebalancing is possible but adds cost drag without proportionate benefit.

Glidepath Toward Retirement:

Age Range	Equity %	Debt %	Gold %	REIT %	Character
40-45 (Years 0-5)	50	25	10	15	Growth-oriented (current allocation)
45-50 (Years 5-10)	45	30	10	15	Gradual moderation begins
50-55 (Years 10-15)	40	35	10	15	Growing focus on capital preservation
Beyond 55 (post-retirement)	30	45	10	15	Income-oriented, capital preservation

Rationale for the Glidepath:

(i) The equity allocation reduces gradually from 50% to 30% over the 15-year horizon. This reflects the shrinking time available to recover from any major equity drawdown.

(ii) Debt allocation increases correspondingly. Post-retirement, debt provides the income stream that will fund Mr. Sharma's ongoing expenses.

(iii) Gold and REIT allocations remain relatively stable throughout. These are permanent portfolio components serving specific functions (hedging and income diversification respectively).

(iv) The transition is GRADUAL, not stepped. Sharp allocation changes are behaviourally difficult and often create tax liabilities. Small annual adjustments (say, 1% equity reduction each year) are cleaner and less disruptive.

(v) Tax-Efficient Rebalancing Under Indian Rules

Key Tax Considerations for Indian Investors:

(i) Long-Term Capital Gains (LTCG) on Equity: Gains above ₹1 lakh per financial year are taxed at 10%. Holdings above 1 year qualify as long-term. Rebalancing strategy should aim to keep annual realised gains below ₹1 lakh where possible.

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(ii) Short-Term Capital Gains (STCG) on Equity: Gains within 1 year are taxed at 20%. Rebalancing that triggers short-term gains is materially more expensive.

(iii) LTCG on Debt Mutual Funds: Following the 2023 tax changes, all debt fund gains are now taxed as short-term regardless of holding period. This affects the debt component of the portfolio.

(iv) Tax-Efficient Rebalancing Techniques: Use Systematic Transfer Plans (STPs) to gradually move between equity and debt over time, spreading realisation across multiple financial years to stay below tax thresholds.

(v) Systematic Withdrawal Plans (SWPs): During retirement, SWPs from equity funds preserve the long-term status of remaining units while providing regular income — more tax-efficient than lump-sum redemptions.

(vi) Direct vs Regular Plans: Direct plans of mutual funds have lower expense ratios (typically 50-100 bps annually). Over 15 years, this differential compounds to material wealth impact.

(vii) ELSS Considerations: Equity-Linked Savings Schemes offer Section 80C tax deduction up to ₹1.5 lakh with a 3-year lock-in. Suitable for building the equity allocation while capturing tax benefits.

Practical Rebalancing Implementation:

Rather than making one large annual rebalancing trade, spread the rebalancing across the year through monthly Systematic Investment Plans (SIPs) into under-weighted assets and Systematic Withdrawal Plans from over-weighted assets. This approach captures rupee-cost averaging benefits, minimises timing risk, spreads tax realisation across the year, and eliminates the behavioural difficulty of large one-time reallocations.

Question 10 — Sharpe's Optimum Portfolio: Reverse Working

Priyanka Rao, CFA, is a senior portfolio analyst at Sundaram Wealth Advisors in Chennai. She has inherited a Sharpe's Optimal Portfolio previously constructed by a colleague who has since left the firm. The colleague's working papers show the full security universe considered and the final portfolio composition, but the market variance (σm^2) and the cut-off rate (C*) — which were on a separate spreadsheet — have been lost due to a system crash. Priyanka must reverse-derive the missing parameters to validate the portfolio.

Universe of Securities Considered (5 stocks under Nifty 50):

Security	Expected Return (Ri)	Beta (βi)	Unsystematic Variance (σei^2)
Security A	21%	1.50	45
Security B	15%	1.00	25
Security C	12%	0.75	15
Security D	10%	0.80	20
Security E	8%	0.50	10

Other Known Parameters:

- Risk-Free Rate: Rf = 6%
- Expected Market Return (from CAPM benchmark): Rm = 12%

Final Portfolio Composition (from colleague's records):

Security	Selected?	Weight in Optimal Portfolio
Security A	Yes	40.19%
Security B	Yes	34.31%
Security C	Yes	25.50%
Security D	No	—
Security E	No	—

Lost Data (to be reverse-derived):

- Market Variance (σm^2) — the variance of the market index

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- Cut-Off Rate (C*) — the maximum Ci from Sharpe's methodology

Required:

(i) Compute the excess return-to-beta ratio (Treynor's ratio) for each of the 5 securities and rank them.

(ii) Using the given portfolio weights, reverse-derive the cut-off rate C* from the pairwise Zi ratios of the selected securities.

(iii) Using C* obtained in part (ii), reverse-derive the market variance σm^2 from Sharpe's Ci formula applied at the cut-off security.

(iv) Verify that securities D and E are correctly excluded from the optimal portfolio.

(v) Compute the portfolio expected return, portfolio beta, systematic variance, unsystematic variance, and total portfolio variance.

(vi) Using CAPM, compute the expected return and Jensen's Alpha of the optimal portfolio. Comment on the manager's performance.

(vii) Explain briefly in what sense Sharpe's Optimal Portfolio construction is consistent with CAPM assumptions.

Solution

(i) Excess Return to Beta Ratio (Treynor's Ratio)

For each security, ai = (Ri − Rf) / βi:

Security	Ri − Rf	βi	ai = (Ri − Rf)/βi	Rank
A	21% − 6% = 15%	1.50	15 / 1.50 = 10.00	1
B	15% − 6% = 9%	1.00	9 / 1.00 = 9.00	2
C	12% − 6% = 6%	0.75	6 / 0.75 = 8.00	3
D	10% − 6% = 4%	0.80	4 / 0.80 = 5.00	4
E	8% − 6% = 2%	0.50	2 / 0.50 = 4.00	5

Securities ranked from highest to lowest excess return-to-beta: A (10) > B (9) > C (8) > D (5) > E (4).

(ii) Reverse-Deriving C* from Portfolio Weights

Sharpe's proportion formula is:

$Xi = Zi / \Sigma Zj$, where $Zi = (\beta i / \sigma ei^2) \times [(Ri - Rf)/\beta i - C^*] = (\beta i / \sigma ei^2) \times (ai - C^*)$

Since Xi is proportional to Zi, the ratio Zi/Zj equals Xi/Xj for any two selected securities. Taking Security A and Security B:

ZA / ZB = XA / XB

Compute $\beta i/\sigma ei^2$ for the selected securities:

Security	$\beta i / \sigma ei^2$	ai (from part (i))
A	1.50 / 45 = 0.03333	10.00
B	1.00 / 25 = 0.04000	9.00
C	0.75 / 15 = 0.05000	8.00

Substituting into the ZA/ZB equation:

[0.03333 × (10 − C*)] / [0.04000 × (9 − C*)] = 40.19 / 34.31 = 1.1714

Rearranging:

0.03333 × (10 − C*) × 34.31 = 0.04000 × (9 − C*) × 40.19

1.1436 × (10 − C*) = 1.6076 × (9 − C*)

11.436 − 1.1436 C* = 14.468 − 1.6076 C*

(1.6076 − 1.1436) C* = 14.468 − 11.436

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0.464 C* = 3.032

C* = 6.535

Verification using ZA/ZC ratio:

Expected ratio: XA/XC = 40.19 / 25.50 = 1.5761

At C* = 6.535: ZA = 0.03333 × (10 − 6.535) = 0.03333 × 3.465 = 0.11548

ZC = 0.05000 × (8 − 6.535) = 0.05000 × 1.465 = 0.07325

ZA / ZC = 0.11548 / 0.07325 = 1.5766 ≈ 1.5761 ✓ (matches within rounding)

Confirmed: C* = 6.535

(iii) Reverse-Deriving σm² from the Ci Formula

Sharpe's formula for Ci at the cut-off security (Security C, the last selected in ranked order) is:

$C^* = [\sigma m^2 \times \Sigma(Ri - Rf)\beta i/\sigma ei^2] / [1 + \sigma m^2 \times \Sigma \beta i^2/\sigma ei^2]$

Compute the cumulative sums for the selected securities A, B, C:

Security	$(Ri - Rf)\beta i / \sigma ei^2$	$\beta i^2 / \sigma ei^2$
A	(15)(1.50)/45 = 22.50/45 = 0.5000	$(1.50)^2/45 = 2.25/45 = 0.0500$
B	(9)(1.00)/25 = 9/25 = 0.3600	$(1.00)^2/25 = 1/25 = 0.0400$
C	(6)(0.75)/15 = 4.5/15 = 0.3000	$(0.75)^2/15 = 0.5625/15 = 0.0375$
Sum (A+B+C)	**$\Sigma_1 = 1.1600$**	**$\Sigma_2 = 0.1275$**

Substituting into the Ci formula at the cut-off:

$6.535 = [\sigma m^2 \times 1.16] / [1 + \sigma m^2 \times 0.1275]$

$6.535 \times (1 + 0.1275\ \sigma m^2) = 1.16\ \sigma m^2$

$6.535 + 0.8332\ \sigma m^2 = 1.16\ \sigma m^2$

$(1.16 - 0.8332)\ \sigma m^2 = 6.535$

$0.3268\ \sigma m^2 = 6.535$

$\sigma m^2 = 20.00$

Recovered Parameters:

- Cut-Off Rate: C* = 6.535
- Market Variance: $\sigma m^2 = 20.00$ (or 4.47% Standard Deviation)

(iv) Verifying that D and E Are Correctly Excluded

Per Sharpe's methodology, a security is included in the optimal portfolio ONLY IF its excess return-to-beta ratio (ai) exceeds the cut-off rate C*. Checking:

Security	ai (Treynor ratio)	vs C* = 6.535	Verdict
A	10.00	10.00 > 6.535	Included ✓
B	9.00	9.00 > 6.535	Included ✓
C	8.00	8.00 > 6.535	Included ✓
D	5.00	5.00 < 6.535	Excluded ✓
E	4.00	4.00 < 6.535	Excluded ✓

Alternative verification via Ci monotonicity:

Compute Ci sequentially in ranked order and confirm that Ci peaks at Security C:

Ranked Order	Cumulative Σ_1	Cumulative Σ_2	$Ci = 20 \times \Sigma_1 / (1 + 20 \times \Sigma_2)$
A only	0.5000	0.0500	20 × 0.5 / 2.00 = 5.000

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Ranked Order	Cumulative Σ_1	Cumulative Σ_2	$Ci = 20 \times \Sigma_1 / (1 + 20 \times \Sigma_2)$
A + B	0.8600	0.0900	20 × 0.86 / 2.80 = 6.143
A + B + C	1.1600	0.1275	20 × 1.16 / 3.55 = 6.535 ← MAX = C*
A + B + C + D	1.3200	0.1595	20 × 1.32 / 4.19 = 6.301 (decreases)
A + B + C + D + E	1.4200	0.1845	20 × 1.42 / 4.69 = 6.055 (decreases)

Ci peaks at 6.535 when Security C is added and then declines. Adding D or E would REDUCE the cut-off ratio — hence they are correctly excluded from the optimal portfolio.

(v) Portfolio Metrics — Return, Beta, and Variance Decomposition

Portfolio Expected Return:

$Rp = XA \times RA + XB \times RB + XC \times RC$

$= 0.4019 \times 21\% + 0.3431 \times 15\% + 0.2550 \times 12\%$

$= 8.44\% + 5.15\% + 3.06\%$

$= 16.65\%$

Portfolio Beta:

$\beta p = XA \times \beta A + XB \times \beta B + XC \times \beta C$

$= 0.4019 \times 1.50 + 0.3431 \times 1.00 + 0.2550 \times 0.75$

$= 0.6029 + 0.3431 + 0.1913$

$= 1.1373$

Systematic Variance:

$\sigma^2 sys = \beta p^2 \times \sigma m^2 = (1.1373)^2 \times 20.00 = 1.2934 \times 20 = 25.87$

Unsystematic Variance:

$\sigma^2 unsys = \Sigma Xi^2 \times \sigma ei^2$

$= (0.4019)^2 \times 45 + (0.3431)^2 \times 25 + (0.2550)^2 \times 15$

$= 0.1615 \times 45 + 0.1177 \times 25 + 0.0650 \times 15$

$= 7.269 + 2.943 + 0.975$

$= 11.19$

Total Portfolio Variance and Standard Deviation:

$\sigma^2 p = \sigma^2 sys + \sigma^2 unsys = 25.87 + 11.19 = 37.06$

$\sigma p = \sqrt{37.06} = 6.088\%$ (portfolio standard deviation)

Metric	Value	% of Total Variance
Systematic Variance ($\beta^2 p \times \sigma m^2$)	25.87	69.8%
Unsystematic Variance ($\Sigma X^2 i \times \sigma ei^2$)	11.19	30.2%
Total Portfolio Variance	**37.06**	**100.0%**

Observation: With only 3 stocks, unsystematic risk still accounts for 30% of total portfolio variance. If more diversified (say 15-20 stocks), unsystematic variance would fall toward zero and total variance would converge to systematic variance.

(vi) CAPM Expected Return and Jensen's Alpha

CAPM Expected Return of the Portfolio:

$E(Rp)CAPM = Rf + \beta p \times (Rm - Rf)$

$= 6\% + 1.1373 \times (12\% - 6\%)$

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= 6% + 1.1373 × 6%

= 6% + 6.824%

= 12.82%

Jensen's Alpha:

α = Actual Return − CAPM Expected Return

= 16.65% − 12.82%

= +3.83%

Interpretation of the Manager's Performance:

The Sharpe-optimal portfolio delivers a Jensen's Alpha of +3.83%, indicating that the portfolio outperforms the CAPM benchmark by nearly 4 percentage points. This positive alpha is meaningful and consistent with the intent of Sharpe's methodology — to construct a portfolio that maximises risk-adjusted excess return through disciplined security selection based on (Ri − Rf)/βi rankings and the cut-off criterion. The manager has effectively identified securities whose combined risk-return profile is superior to what pure market exposure at similar beta (1.1373) would deliver.

(vii) Sharpe's Optimal Portfolio and CAPM Consistency

Sharpe's Optimal Portfolio and the Capital Asset Pricing Model (CAPM) are theoretically consistent in the following ways:

(i) Common assumption of market-driven covariance. Sharpe's Single Index Model, on which the optimal portfolio construction rests, assumes that all covariance between individual securities flows through their common exposure to the market. CAPM is a special case that further assumes markets are in equilibrium and market risk is the only priced risk factor.

(ii) Both anchor systematic risk to market variance. In Sharpe's model, systematic variance of a security is $\beta^2 \times \sigma m^2$. In CAPM, the required return is Rf + β × (Rm − Rf) — where β measures sensitivity to market risk. Both frameworks price the same risk factor (β) using the same market anchor (σm^2).

(iii) Convergence to the market portfolio in equilibrium. If all investors were to construct Sharpe optimal portfolios and if the security universe is comprehensive, the aggregate holdings would converge to the market portfolio — precisely the tangency portfolio in CAPM/CML analysis. Sharpe's model can be viewed as a practical algorithm for finding portfolios that approach the CAPM efficient frontier.

(iv) Distinction remains at the diversification level. Sharpe's model explicitly retains unsystematic variance ($\Sigma Xi^2 \times \sigma ei^2$) in portfolio construction, allowing the analyst to see how much firm-specific risk remains. CAPM in its pure form assumes such risk is fully diversified away and thus not priced. In practice, Sharpe's model provides the granularity that CAPM abstracts away.

ICAI SM Section 11 discusses Sharpe's Optimal Portfolio; Section 8 covers CAPM. Both are examined together in this question because a well-constructed Sharpe portfolio should exhibit positive alpha relative to CAPM only if the manager has skill in security selection — which is exactly what the +3.83% Jensen's Alpha in this question indicates.

Question 11 — Arbitrage Pricing Theory: Multi-Factor Integrated Application

Sneha Kulkarni, CFA, is a senior quant analyst at ICICI Prudential AMC in Mumbai. She uses a three-factor Arbitrage Pricing Theory (APT) framework to price four categories of stocks constituting the Indian equity universe, reconcile the framework with CAPM, and identify arbitrage opportunities via long-short portfolio construction.

Risk-Free Rate: Rf = 6.0%

Factor Data:

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Factor	Risk Premium (λ)	Expected Value (EV)	Actual Realised Value (AV)
GDP Growth Rate	3.0%	6.0%	7.5%
Inflation Rate	−2.5%	5.0%	6.0%
Sensex Return (Market Return)	6.0%	12.0%	15.0%

Note: The negative risk premium (λ) on Inflation reflects that investors are willing to accept LOWER return for stocks that hedge against inflation. Positive betas on Inflation therefore reduce required return.

Stock Categories (constituting the entire Nifty universe):

Category	Weight in Index	β_GDP	β_Inflation	β_Sensex	Actual Return (observed)
Small-cap Growth (SCG)	15%	1.4	0.8	1.5	17.5%
Large-cap Growth (LCG)	40%	1.1	0.5	1.2	12.0%
Small-cap Value (SCV)	20%	0.8	0.3	0.9	13.5%
Large-cap Value (LCV)	25%	0.6	0.2	0.7	9.0%

Required:

(i) Using the standard APT formula, compute the Expected Return E(Ri) for each of the four stock categories.

(ii) Using the ICAI TYK Q38 Surprise Factor formula, compute the APT-implied return for each category given the actual factor realizations. Comment on the interpretation.

(iii) Compute the weighted average APT Expected Return of the Nifty market index using the category weights.

(iv) Using CAPM (with Sensex as the market benchmark), compute the Expected Return for each stock category. Reconcile the differences between APT and CAPM expected returns.

(v) Compare Actual Returns with APT Expected Returns to identify undervalued and overvalued categories. Construct a long-short arbitrage portfolio using SCG (long) and LCV (short) with a total capital of ₹5,00,000, targeting portfolio sensitivities of β_GDP = 1.80 and β_Inflation = 1.10.

(vi) Discuss the fundamental conceptual differences between APT and CAPM, and identify when each model is more appropriate for use in Indian equity markets.

Solution

(i) APT Expected Return — Standard Formula

Formula (ICAI SM Section 9):

E(Ri) = Rf + β_GDP × λ_GDP + β_Inflation × λ_Inflation + β_Sensex × λ_Sensex

For Small-cap Growth (SCG):

E(RSCG) = 6.0% + 1.4 × 3.0% + 0.8 × (−2.5%) + 1.5 × 6.0%

= 6.0% + 4.20% + (−2.00%) + 9.00%

= 17.20%

For Large-cap Growth (LCG):

E(RLCG) = 6.0% + 1.1 × 3.0% + 0.5 × (−2.5%) + 1.2 × 6.0%

= 6.0% + 3.30% + (−1.25%) + 7.20%

= 15.25%

For Small-cap Value (SCV):

E(RSCV) = 6.0% + 0.8 × 3.0% + 0.3 × (−2.5%) + 0.9 × 6.0%

= 6.0% + 2.40% + (−0.75%) + 5.40%

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= 13.05%

For Large-cap Value (LCV):

E(RLCV) = 6.0% + 0.6 × 3.0% + 0.2 × (−2.5%) + 0.7 × 6.0%

= 6.0% + 1.80% + (−0.50%) + 4.20%

= 11.50%

Category	Rf Component	β_GDP × λ_GDP	β_Inf × λ_Inf	β_Sensex × λ_Sensex	E(Ri) APT
SCG	6.00%	4.20%	−2.00%	9.00%	17.20%
LCG	6.00%	3.30%	−1.25%	7.20%	15.25%
SCV	6.00%	2.40%	−0.75%	5.40%	13.05%
LCV	6.00%	1.80%	−0.50%	4.20%	11.50%

(ii) APT-Implied Return using Surprise Factor Formula (ICAI TYK Q38 Convention)

Formula (per ICAI TYK Q38 solution):

R (APT with surprises) = Rf + Σ βj × (AVj − EVj)

First, compute the factor surprises (Actual − Expected):

Factor	Actual (AV)	Expected (EV)	Surprise (AV – EV)
GDP Growth	7.5%	6.0%	+1.5%
Inflation	6.0%	5.0%	+1.0%
Sensex Return	15.0%	12.0%	+3.0%

Compute for each category:

SCG: R = 6.0% + 1.4 × 1.5% + 0.8 × 1.0% + 1.5 × 3.0%

= 6.0% + 2.10% + 0.80% + 4.50%

= 13.40%

LCG: R = 6.0% + 1.1 × 1.5% + 0.5 × 1.0% + 1.2 × 3.0%

= 6.0% + 1.65% + 0.50% + 3.60%

= 11.75%

SCV: R = 6.0% + 0.8 × 1.5% + 0.3 × 1.0% + 0.9 × 3.0%

= 6.0% + 1.20% + 0.30% + 2.70%

= 10.20%

LCV: R = 6.0% + 0.6 × 1.5% + 0.2 × 1.0% + 0.7 × 3.0%

= 6.0% + 0.90% + 0.20% + 2.10%

= 9.20%

Interpretation:

The Surprise Factor formula computes what APT predicts the return to be given the specific factor realizations observed in the period. This differs from the standard APT expected return because it uses (Actual − Expected) surprises rather than the risk premiums λ. In our example, the observed surprises (1.5%, 1.0%, 3.0%) are smaller in magnitude than the risk premiums (3.0%, −2.5%, 6.0%), so the surprise-implied returns are correspondingly lower than the standard APT expected returns. In practical use, the surprise formula is used ex-post to decompose realized returns into a systematic component (attributable to factor surprises) and an idiosyncratic residual.

(iii) Weighted APT Market Index Expected Return

The Nifty market index expected return is the weight-adjusted average of the four categories' APT expected returns:

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E(R_Market)APT = 15% × 17.20% + 40% × 15.25% + 20% × 13.05% + 25% × 11.50%

= 2.580% + 6.100% + 2.610% + 2.875%

= 14.165% ≈ 14.17%

This represents the equilibrium expected return on the Nifty as demanded by APT for the aggregate multi-factor exposure of the index.

(iv) CAPM Expected Return and Reconciliation with APT

CAPM formula: E(Ri) = Rf + βi × (Rm − Rf) = 6% + βi × 6%

(where Rm = 12.0% Sensex expected return, MRP = 6%, and βi = β_Sensex from the factor table)

Category	β_Sensex	CAPM E(Ri) = 6 + β × 6	APT E(Ri)	APT − CAPM
SCG	1.50	6.0% + 9.00% = 15.00%	17.20%	+2.20%
LCG	1.20	6.0% + 7.20% = 13.20%	15.25%	+2.05%
SCV	0.90	6.0% + 5.40% = 11.40%	13.05%	+1.65%
LCV	0.70	6.0% + 4.20% = 10.20%	11.50%	+1.30%

Market Index Return under CAPM:

β_Market to Sensex = 15% × 1.50 + 40% × 1.20 + 20% × 0.90 + 25% × 0.70

= 0.225 + 0.480 + 0.180 + 0.175

= 1.060

E(R_Market)CAPM = 6.0% + 1.060 × 6.0% = 6.0% + 6.36% = 12.36%

APT: 14.17% vs CAPM: 12.36% → APT is higher by 1.81%

Reconciliation:

APT delivers HIGHER expected returns than CAPM across all four categories. The explanation lies in the additional risk factors that APT prices explicitly:

- Contribution from GDP Growth risk: β_GDP × λ_GDP is positive (positive beta × positive premium)
- Contribution from Inflation risk: β_Inflation × λ_Inflation is negative (positive beta × negative premium)
- Net additional premium demanded by APT = β_GDP × 3% + β_Inflation × (−2.5%), on top of what CAPM demands for Sensex exposure alone

For SCG: additional APT premium = 1.4 × 3% + 0.8 × (−2.5%) = 4.20% − 2.00% = 2.20%, matching the APT − CAPM difference exactly. Similarly for other categories.

(v) Arbitrage Identification and Long-Short Portfolio Construction

Step 1: Mispricing Analysis

Category	Actual Return	APT E(Ri)	Mispricing (Actual − Expected)	Signal
SCG	17.5%	17.20%	+0.30%	Undervalued (BUY)
LCG	12.0%	15.25%	−3.25%	Overvalued (SELL)
SCV	13.5%	13.05%	+0.45%	Undervalued (BUY)
LCV	9.0%	11.50%	−2.50%	Overvalued (SELL)

SCG and LCV present the largest mispricing signals in opposite directions — ideal candidates for a long-short arbitrage portfolio.

Step 2: Determine Weights for Target Factor Sensitivities

Let w_SCG = weight in long SCG position, w_LCV = weight in short LCV position (negative).

Constraint: w_SCG + w_LCV = 1 (fully invested)

Target sensitivities:

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β_GDP: 1.4 × w_SCG + 0.6 × w_LCV = 1.80 ... (Eq. 1)

β_Inflation: 0.8 × w_SCG + 0.2 × w_LCV = 1.10 ... (Eq. 2)

Substituting w_LCV = 1 − w_SCG into Eq. 1:

1.4 × w_SCG + 0.6 × (1 − w_SCG) = 1.80

1.4 w_SCG + 0.6 − 0.6 w_SCG = 1.80

0.8 w_SCG = 1.20

w_SCG = +1.50 (long)

w_LCV = 1 − 1.50 = −0.50 (short)

Verification with Eq. 2:

0.8 × 1.50 + 0.2 × (−0.50) = 1.20 + (−0.10) = 1.10 ✓

Step 3: Investment Amounts (Total Capital ₹5,00,000)

Position	Weight	Amount (₹)	Action
Long SCG	+1.50	1.50 × 5,00,000 = 7,50,000	Buy SCG worth ₹7,50,000
Short LCV	−0.50	−0.50 × 5,00,000 = −2,50,000	Short-sell LCV worth ₹2,50,000
Total Portfolio	**1.00**	**₹5,00,000**	**Fully invested**

Cash Flow Verification:

Cash in from investor: +₹5,00,000

Cash in from short sale proceeds: +₹2,50,000

Cash out for long SCG purchase: −₹7,50,000

Net cash position: 5,00,000 + 2,50,000 − 7,50,000 = ₹0 ✓ (self-funded portfolio)

Step 4: Portfolio Sensitivities and Returns

Actual Sensex Sensitivity (not targeted, but computed):

β_Sensex_Portfolio = 1.5 × 1.50 + 0.7 × (−0.50) = 2.25 − 0.35 = 1.90

APT Expected Return of the Arbitrage Portfolio:

E(R_Arb) = 6.0% + 1.80 × 3.0% + 1.10 × (−2.5%) + 1.90 × 6.0%

= 6.0% + 5.40% + (−2.75%) + 11.40%

= 20.05%

Actual (Observed) Return of the Arbitrage Portfolio:

R_Arb = 1.50 × 17.5% + (−0.50) × 9.0%

= 26.25% − 4.50%

= 21.75%

Arbitrage Profit:

Alpha (Arbitrage Gain) = Actual Return − Expected Return

= 21.75% − 20.05%

= +1.70%

The portfolio delivers 1.70% excess return over what APT would justify for its risk exposure. This positive alpha reflects the analyst's successful exploitation of the mispricing in SCG (undervalued) and LCV (overvalued).

(vi) APT vs CAPM — Conceptual Comparison

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Dimension	CAPM	APT
Risk Factors	Single factor (market only)	Multiple factors (macro variables like GDP, Inflation, Interest Rate, plus market)
Model Assumption	Market portfolio is efficient	No arbitrage opportunities exist in equilibrium
Investor Behaviour	Requires mean-variance optimising rational investors	Weaker assumption — just no arbitrage
Equilibrium Basis	Market clearing where all investors hold efficient portfolios	Absence of risk-free arbitrage profits
Factor Risk Premiums	Only market risk premium (Rm − Rf)	Risk premium for each priced factor (λ1, λ2, ..., λn)
Parsimony	Very parsimonious — needs only β and MRP	Complex — needs many betas and factor premiums
Empirical Accuracy	Often falls short — Fama-French 3 and 5-factor extensions needed	More accurate as multiple risks are priced

When Each Model is More Appropriate in Indian Equity Markets:

(i) Use CAPM for: individual stock cost-of-capital estimation for corporate finance decisions, simple portfolio construction for retail investors, back-of-envelope hurdle rates for capital budgeting, and where the market factor dominates (typical for large-cap diversified equity funds tracking Nifty 50 closely).

(ii) Use APT for: institutional multi-strategy portfolio construction (e.g., hedge funds like Quant Capital, DSP BlackRock quant desk), risk decomposition of returns across macroeconomic drivers, factor-based investment products (multi-factor smart beta ETFs), performance attribution beyond market beta, and stress-testing portfolios under macro-factor shocks (RBI rate hikes, inflation surprises, GDP downgrades).

(iii) In the Indian context, APT is particularly relevant for sectoral funds (IT, Banking, Pharma) where sector-specific factor exposures matter beyond just market beta, and for cross-cap strategies (small vs large) where GDP growth sensitivity differentiates categories systematically.

Question 12 — Sharpe / Treynor / Jensen Backward Working with SIM

Neha Chatterjee is an investment analyst at Kotak Institutional Equities. She has been asked to review two actively managed Nifty-based mutual fund schemes for inclusion in her firm's Model Portfolio. The performance data received from the funds' auditors contains only the three risk-adjusted performance ratios (Sharpe, Treynor, and Jensen's Alpha) and the market parameters. The funds' underlying actual returns, betas, and standard deviations were on a separate spreadsheet that was corrupted during data transfer. Neha must reverse-derive all missing parameters, decompose the risk using the Single Index Model, and then evaluate the funds combined as a 60:40 portfolio.

Market Parameters (Both Funds):

Parameter	Value
Risk-Free Rate (Rf) — 10-year G-Sec yield	6.00%
Market Expected Return (Rm) — Nifty 50 TRI	14.00%
Market Standard Deviation (σm)	15.00%
Market Risk Premium (MRP = Rm − Rf)	8.00%

Fund Performance Ratios (Received from Auditors):

Metric	Fund A — Kotak Emerging Bluechip	Fund B — Kotak Thematic India
Sharpe Ratio	0.75	0.60
Treynor Ratio	12.00	15.00
Jensen's Alpha	4.00%	3.50%

Lost Data (to be reverse-derived):

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- Expected Return (Ri) for each fund
- Fund Beta (βi) for each fund
- Fund Standard Deviation (σi) and Variance (σi²) for each fund
- SIM decomposition: Systematic Variance (βi²σm²) and Unsystematic Variance (σεi²)

Required:

(i) For each fund, reverse-derive the Beta (βi) using the identity that relates Jensen's Alpha and Treynor Ratio through the market risk premium.

(ii) For each fund, reverse-derive the expected return (Ri) using the Treynor Ratio.

(iii) For each fund, reverse-derive the total standard deviation (σi) and total variance (σi²) using the Sharpe Ratio.

(iv) Under the Single Index Model, decompose each fund's total variance into Systematic Variance (βi²σm²) and Unsystematic Variance (σεi²). Compute σεi (unsystematic standard deviation) for each fund.

(v) Compute the Coefficient of Determination (R^2) and Correlation with Market (ρi,m) for each fund. Comment on the diversification level implied.

(vi) Construct a portfolio investing 60% in Fund A and 40% in Fund B. Compute the portfolio's Return (Rp), Beta (βp), Variance (σp²) under SIM, Standard Deviation (σp), Sharpe Ratio, Treynor Ratio, and Jensen's Alpha.

(vii) Compare the portfolio Sharpe/Treynor/Jensen with the simple weight-averages of the individual funds' ratios. Identify which metric is linearly aggregatable and explain the reason mathematically.

(viii) Based on the SIM decomposition, evaluate which fund shows stronger evidence of stock-selection skill and comment on whether the alpha comes from pure security selection or from factor tilting (defensive positioning).

Solution

(i) Reverse-Derive Beta using Jensen's Alpha and Treynor Identity

Derive the key identity linking α, T, β, and MRP:

Start with Jensen's Alpha: α = Ri − Rf − βi × MRP ... (Eq. 1)

From Treynor Ratio: Ti = (Ri − Rf) / βi ⇒ Ri − Rf = Ti × βi ... (Eq. 2)

Substitute (Eq. 2) into (Eq. 1):

α = Ti × βi − βi × MRP

α = βi × (Ti − MRP)

Therefore: βi = α / (Ti − MRP)

Fund A:

βA = 4.00% / (12.00 − 8.00) = 4.00 / 4.00

βA = 1.00

Fund B:

βB = 3.50% / (15.00 − 8.00) = 3.50 / 7.00

βB = 0.50

(ii) Reverse-Derive Expected Return using Treynor

From Treynor: Ri = Rf + Ti × βi

Fund A: RA = 6.00% + 12.00 × 1.00 = 6.00% + 12.00% = 18.00%

Fund B: RB = 6.00% + 15.00 × 0.50 = 6.00% + 7.50% = 13.50%

Verification via Jensen's Alpha equation:

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Fund A: α_check = 18.00% − [6.00% + 1.00 × 8.00%] = 18.00% − 14.00% = 4.00% ✓

Fund B: α_check = 13.50% − [6.00% + 0.50 × 8.00%] = 13.50% − 10.00% = 3.50% ✓

(iii) Reverse-Derive Total Risk σi using Sharpe Ratio

From Sharpe: Si = (Ri − Rf) / σi ⇒ σi = (Ri − Rf) / Si

Fund A: σA = (18.00% − 6.00%) / 0.75 = 12.00 / 0.75

σA = 16.00%, σA² = 256.00

Fund B: σB = (13.50% − 6.00%) / 0.60 = 7.50 / 0.60

σB = 12.50%, σB² = 156.25

(iv) SIM Decomposition — Systematic and Unsystematic Variance

Single Index Model (ICAI SM Section 7):

$\sigma_i^2 = \beta_i^2 \times \sigma_m^2 + \sigma\varepsilon_i^2$

Therefore: $\sigma\varepsilon_i^2 = \sigma_i^2 - \beta_i^2 \times \sigma_m^2$

Fund A:

Systematic Variance = $\beta A^2 \times \sigma m^2 = (1.00)^2 \times (15)^2 = 1.00 \times 225 = 225.00$

Unsystematic Variance = $\sigma A^2 - \beta A^2 \times \sigma m^2 = 256.00 - 225.00 = 31.00$

σεA = √31.00 = 5.57%

Fund B:

Systematic Variance = $\beta B^2 \times \sigma m^2 = (0.50)^2 \times (15)^2 = 0.25 \times 225 = 56.25$

Unsystematic Variance = $\sigma B^2 - \beta B^2 \times \sigma m^2 = 156.25 - 56.25 = 100.00$

σεB = √100.00 = 10.00%

Metric	Fund A	Fund B
Total Variance (σi^2)	256.00	156.25
Systematic Variance ($\beta i^2 \times \sigma m^2$)	225.00 (87.9%)	56.25 (36.0%)
Unsystematic Variance ($\sigma\varepsilon i^2$)	31.00 (12.1%)	100.00 (64.0%)
Unsystematic SD (σεi)	5.57%	10.00%

(v) Coefficient of Determination (R^2) and Market Correlation

R^2 = Systematic Variance / Total Variance = $\beta i^2 \sigma m^2 / \sigma i^2$

Correlation with Market (ρi,m) = √R^2

Fund A:

$R^2A = 225 / 256 = 0.8789 = 87.89\%$

ρA,m = √0.8789 = 0.9375

Fund B:

$R^2B = 56.25 / 156.25 = 0.3600 = 36.00\%$

ρB,m = √0.3600 = 0.6000

Interpretation:

- Fund A: 87.9% of return variability is explained by Nifty movements. Fund A is heavily correlated with the market (ρ = 0.94), consistent with a well-diversified large-cap fund closely tracking the index. Only 12.1% of variance is stock-specific.

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- Fund B: Only 36% of variability is explained by Nifty. Fund B has substantial stock-specific risk (64% of variance is unsystematic), consistent with a concentrated thematic or mid-cap fund where individual stock selections drive most of the return variation. The correlation of 0.60 with market is modest.

(vi) 60:40 Portfolio Metrics

Weights: XA = 0.60, XB = 0.40

Portfolio Return:

Rp = 0.60 × 18.00% + 0.40 × 13.50% = 10.80% + 5.40% = 16.20%

Portfolio Beta:

βp = 0.60 × 1.00 + 0.40 × 0.50 = 0.60 + 0.20 = 0.80

Portfolio Variance under SIM:

$\sigma p^2 = (XA\ \beta A + XB\ \beta B)^2 \times \sigma m^2 + XA^2 \times \sigma \varepsilon A^2 + XB^2 \times \sigma \varepsilon B^2$

$\sigma p^2 = (0.60 \times 1.00 + 0.40 \times 0.50)^2 \times 225 + (0.60)^2 \times 31 + (0.40)^2 \times 100$

$= (0.80)^2 \times 225 + 0.36 \times 31 + 0.16 \times 100$

$= 144.00 + 11.16 + 16.00$

$= 171.16$

Portfolio Standard Deviation:

$\sigma p = \sqrt{171.16} = 13.08\%$

Portfolio Performance Ratios:

Sharpe_p = (16.20 − 6.00) / 13.08 = 10.20 / 13.08 = 0.780

Treynor_p = (16.20 − 6.00) / 0.80 = 10.20 / 0.80 = 12.75

Jensen α_p = 16.20 − [6.00 + 0.80 × 8.00] = 16.20 − 12.40 = 3.80%

Metric	Value
Return (Rp)	16.20%
Beta (βp)	0.80
Variance (σp^2)	171.16
Standard Deviation (σp)	13.08%
Sharpe Ratio	0.780
Treynor Ratio	12.75
Jensen's Alpha	3.80%

(vii) Portfolio vs Simple-Weighted Aggregation of Individual Ratios

Simple weighted averages (X_i × Metric_i):

Metric	Fund A × 0.60	Fund B × 0.40	Sum	Portfolio (from vi)	Aggregation Result
Sharpe Ratio	0.75 × 0.6 = 0.450	0.60 × 0.4 = 0.240	0.690	0.780	≠ Sum (Portfolio > Sum)
Treynor Ratio	12.00 × 0.6 = 7.20	15.00 × 0.4 = 6.00	13.20	12.75	≠ Sum
Jensen's Alpha	4.00% × 0.6 = 2.40%	3.50% × 0.4 = 1.40%	3.80%	3.80%	= Sum ✓ LINEAR

Mathematical Analysis of Aggregation Behaviour:

Jensen's Alpha is LINEARLY AGGREGATABLE:

$\alpha_p = Rp - Rf - \beta p \times MRP$

$= \Sigma Xi \times Ri - Rf - (\Sigma Xi \times \beta i) \times MRP$ [since $\Sigma Xi = 1$, $Rf = \Sigma Xi \times Rf$]

$= \Sigma Xi \times [Ri - Rf - \beta i \times MRP]$

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= ΣXi × αi ✓

Verification: 0.60 × 4.00% + 0.40 × 3.50% = 2.40% + 1.40% = 3.80% ✓ matches portfolio αp

Treynor Ratio is BETA-WEIGHTED aggregatable:

Tp = (Rp − Rf) / βp

= [ΣXi (Ri − Rf)] / [ΣXi × βi]

= [ΣXi × βi × Ti] / [ΣXi × βi] [using Ri − Rf = βi × Ti]

= Σ [(Xi × βi) / (ΣXi × βi)] × Ti

Verification: (0.60 × 1.00 × 12.00 + 0.40 × 0.50 × 15.00) / (0.60 × 1.00 + 0.40 × 0.50)

= (7.20 + 3.00) / 0.80 = 10.20 / 0.80 = 12.75 ✓ matches portfolio Tp

Sharpe Ratio is NEITHER simply nor beta-weighted aggregatable:

Sp = (Rp − Rf) / σp

The denominator σp involves the non-linear combination $\sqrt{[(\Sigma X_i\beta_i)^2\sigma_m^2 + \Sigma X_i^2\sigma\varepsilon_i^2]}$, so no closed-form weighted-average expression exists. σp depends on both the correlation structure and the individual variances. In our example, σp = 13.08% which is LESS than the weighted average of individual σ (0.6×16 + 0.4×12.5 = 14.6%), reflecting the diversification benefit. This makes Portfolio Sharpe HIGHER than the weighted average of individual Sharpes (0.78 > 0.69).

(viii) Skill Analysis — Stock Selection vs Factor Tilting

Dimension	Fund A	Fund B
Market Beta (β)	1.00 (market-matching)	0.50 (defensive tilt)
Jensen's Alpha	4.00%	3.50%
R^2 (Systematic Explanation)	87.9%	36.0%
Unsystematic SD (σε)	5.57%	10.00%
Alpha per Unit Idiosyncratic Risk (α/σε)	4.00 / 5.57 = 0.72	3.50 / 10.00 = 0.35

Analysis of Fund A — Pure Stock Selection Skill:

Fund A carries the same market exposure as the Nifty (β = 1.00). This means the manager takes NO factor bet — the entire 4.00% alpha comes from picking stocks that outperform the market within the same systematic risk envelope. Additionally, Fund A carries low unsystematic risk (σε = 5.57%), delivering 0.72 units of alpha per unit of stock-specific volatility. This is a strong signature of skilled stock selection — the manager identifies mispriced securities without betting on market direction or defensive positioning.

Analysis of Fund B — Mixed Signal (Selection + Factor Tilt):

Fund B has a defensive beta of 0.50, meaning it takes only half of the market's systematic risk. This defensive positioning is itself a factor tilt — a bet that the market will not deliver high returns, or that low-beta stocks will outperform on a risk-adjusted basis. Fund B's alpha of 3.50% must be interpreted with this tilt in mind: some portion may be genuine stock selection, but some may come from favourable regime for defensive stocks during the sample period. The high unsystematic risk (σε = 10.00%) means Fund B delivers only 0.35 units of alpha per unit of stock-specific volatility — half of Fund A's efficiency. This is characteristic of concentrated thematic funds where the manager takes large idiosyncratic bets.

Conclusion:

Fund A shows stronger and cleaner evidence of stock-selection skill. Fund B's alpha is partially attributable to defensive factor tilting and carries higher stock-specific risk per unit of alpha. For Neha's Model Portfolio, Fund A should carry the higher weight (as it does in the 60:40 construction) with Fund B providing complementary defensive exposure. If

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the Indian equity market enters a bearish or high-volatility regime, Fund B's low beta will provide downside protection, but its alpha attribution should be revisited across market regimes.

Question 13 — Critical Line Theory: Efficient Frontier under Real-World Constraints

Rahul Mehta, a portfolio manager at Axis Mutual Fund, is constructing a two-asset portfolio for the firm's flagship diversified equity scheme. The universe consists of two Nifty 50 constituents — an aggressive-growth technology stock (Security A) and a defensive FMCG stock (Security B). As an Indian mutual fund manager, Rahul is subject to SEBI Regulation 44(1) which prohibits short-selling of equity securities in most mutual fund schemes. Rahul wants to understand both the theoretical (unconstrained) efficient frontier and the constrained feasible frontier, and how the SEBI constraint affects portfolio optimization.

Security Data:

Parameter	Security A (Aggressive Growth)	Security B (Defensive Value)
Expected Return (Ri)	15.00%	10.00%
Standard Deviation (σi)	20.00%	12.00%
Variance (σi²)	400.00	144.00

Additional Market Parameters:

- Correlation Coefficient (ρAB): 0.80
- Covariance (σAB): 0.80 × 20 × 12 = 192.00
- Risk-Free Rate (Rf): 6.00% (10-year G-Sec yield)

Required:

(i) Tabulate the portfolio expected return (Rp) and standard deviation (σp) for weights on Security A of wA = −0.50, −0.25, 0.00, 0.25, 0.50, 0.75, 1.00, 1.25, 1.50. This maps out the complete two-asset frontier including infeasible regions.

(ii) Derive the UNCONSTRAINED Minimum Variance Portfolio (MVP) using calculus. Verify that wA < 0 (i.e., short-selling Security A is required to reach the theoretical MVP).

(iii) Under SEBI's no-short-sale constraint (wA, wB ≥ 0), determine the CONSTRAINED MVP. Quantify the efficiency loss relative to unconstrained MVP.

(iv) Derive the UNCONSTRAINED Tangency Portfolio (maximum Sharpe Ratio on the Capital Market Line). Verify that wA > 1 (i.e., borrowing to leverage or short-selling Security B is required).

(v) Under SEBI's no-short-sale constraint, determine the CONSTRAINED Tangency Portfolio. Compute the loss in Sharpe Ratio.

(vi) Explain the concept of the Critical Line and identify the critical points in this two-asset case. Show how the efficient frontier is discontinuously modified at each critical point when constraints become binding.

(vii) Practitioner discussion: Given SEBI's no-short-sale constraint on Indian mutual funds, discuss how portfolio managers can synthetically replicate short exposure and what implications this has for the achievable efficient frontier in Indian markets.

Solution

(i) Two-Asset Frontier Tabulation

Key formulas:

$R_p = w_A \times R_A + (1 - w_A) \times R_B = 10\% + 5w_A$

$\sigma_p^2 = w_A^2\sigma_A^2 + (1 - w_A)^2\sigma_B^2 + 2w_A(1 - w_A)\rho_{AB}\sigma_A\sigma_B$

$= 400w_A^2 + 144(1 - w_A)^2 + 2w_A(1 - w_A)(192)$

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$= 400wA^2 + 144 - 288wA + 144wA^2 + 384wA - 384wA^2$

$= 160wA^2 + 96wA + 144$

wA	wB = 1 − wA	Rp	$\sigma p^2 = 160wA^2 + 96wA + 144$	σp	Region
−0.50	+1.50	7.50%	40 − 48 + 144 = 136.00	11.66%	Infeasible under SEBI
−0.30	+1.30	8.50%	14.4 − 28.8 + 144 = 129.60	11.38%	Unconstrained MVP
−0.25	+1.25	8.75%	10 − 24 + 144 = 130.00	11.40%	Infeasible under SEBI
0.00	+1.00	10.00%	0 + 0 + 144 = 144.00	12.00%	Constrained MVP (corner)
0.25	+0.75	11.25%	10 + 24 + 144 = 178.00	13.34%	Constrained feasible
0.50	+0.50	12.50%	40 + 48 + 144 = 232.00	15.23%	Constrained feasible
0.75	+0.25	13.75%	90 + 72 + 144 = 306.00	17.49%	Constrained feasible
1.00	0.00	15.00%	160 + 96 + 144 = 400.00	20.00%	Constrained corner
1.25	−0.25	16.25%	250 + 120 + 144 = 514.00	22.67%	Infeasible under SEBI
1.32	−0.32	16.60%	278.8 + 126.7 + 144 = 549.5	23.44%	Unconstrained Tangency
1.50	−0.50	17.50%	360 + 144 + 144 = 648.00	25.46%	Infeasible under SEBI

The table reveals the fundamental tension: efficient portfolios lie at wA = −0.30 (theoretical MVP) and wA = 1.32 (theoretical tangency), but both require short-selling and are outside the SEBI-compliant feasible region [0, 1].

(ii) Unconstrained Minimum Variance Portfolio

Approach — Calculus Minimization:

Take the first derivative of σp^2 with respect to wA and set to zero:

$d(\sigma p^2)/dwA = 320wA + 96 = 0$

$wA^* = -96 / 320 = -0.30$

Second-order condition: $d^2(\sigma p^2)/dwA^2 = 320 > 0$ → confirms minimum (convex function).

Alternative — Closed-Form MVP Formula:

$wA^* = (\sigma B^2 - \rho AB\sigma A\sigma B) / (\sigma A^2 + \sigma B^2 - 2\rho AB\sigma A\sigma B)$

$= (144 - 192) / (400 + 144 - 384)$

$= -48 / 160$

$= -0.30$ ✓

Portfolio Characteristics at Unconstrained MVP:

$Rp,MVP = 10\% + 5 \times (-0.30) = 10\% - 1.50\% = 8.50\%$

$\sigma p,MVP^2 = 160 \times 0.09 + 96 \times (-0.30) + 144 = 14.4 - 28.8 + 144 = 129.60$

$\sigma p,MVP = \sqrt{129.60} = 11.38\%$

Interpretation: The theoretical MVP requires shorting ₹30 of Security A for every ₹100 of portfolio equity and investing ₹130 in Security B. Since ρAB = 0.80 is high, going long-B/short-A creates a natural hedge that reduces variance below either individual security's variance.

(iii) Constrained MVP under SEBI No-Short-Sale Constraint

Under wA ≥ 0 and wB ≥ 0, the unconstrained MVP at wA = −0.30 is infeasible. The Kuhn-Tucker analysis reveals that the constraint wA ≥ 0 is binding. At the corner solution:

Constrained MVP: wA = 0, wB = 1

$Rp,MVP_constrained = 10.00\%$

$\sigma p,MVP_constrained^2 = 144.00$

$\sigma p,MVP_constrained = 12.00\%$

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Verification that wA = 0 is Optimal Corner:

At wA = 0, $d(\sigma p^2)/dwA = 320 \times 0 + 96 = +96 > 0$

Since the derivative is positive at the corner, moving in the feasible direction (wA > 0) would INCREASE variance. Hence wA = 0 minimises variance subject to the constraint.

Efficiency Loss:

Metric	Unconstrained MVP	Constrained MVP	Efficiency Loss
wA	−0.30 (short)	0.00 (corner)	Constraint binds
Rp	8.50%	10.00%	+1.50% (higher return but as by-product)
σp^2	129.60	144.00	+14.40 (higher variance)
σp	11.38%	12.00%	+0.62% (11.1% higher variance)

The efficiency cost of the SEBI constraint at the MVP corner is approximately 11% higher variance for a Rahul-style mutual fund manager. Over long horizons, this compounds to material tracking error against theoretically optimal portfolios.

(iv) Unconstrained Tangency Portfolio (Maximum Sharpe on CML)

Closed-Form Formula for Tangency Weight:

$wA_t = [(RA - Rf)\sigma B^2 - (RB - Rf)\sigma AB] / [(RA - Rf)\sigma B^2 + (RB - Rf)\sigma A^2 - (RA - Rf + RB - Rf)\sigma AB]$

Numerator = (15 − 6) × 144 − (10 − 6) × 192

= 9 × 144 − 4 × 192

= 1296 − 768

= 528

Denominator = 9 × 144 + 4 × 400 − 13 × 192

= 1296 + 1600 − 2496

= 400

wA_t = 528 / 400 = 1.32

wB_t = 1 − 1.32 = −0.32 (short-sell Security B)

Tangency Portfolio Characteristics:

$Rp,t = 10\% + 5 \times 1.32 = 16.60\%$

$\sigma p,t^2 = 160 \times 1.7424 + 96 \times 1.32 + 144 = 278.78 + 126.72 + 144 = 549.50$

$\sigma p,t = \sqrt{549.50} = 23.44\%$

$Sharpe_t = (16.60 - 6.00) / 23.44 = 10.60 / 23.44 = 0.4523$

Interpretation: The theoretical tangency (highest-Sharpe risky portfolio on CML) requires borrowing to invest 132% of equity in Security A while short-selling 32% of Security B. This leveraged and hedged position produces the highest risk-adjusted return.

(v) Constrained Tangency under SEBI No-Short-Sale

Since unconstrained $wA_t = 1.32 > 1$, the constraint $wA \leq 1$ (equivalently $wB \geq 0$) is binding. The constrained tangency portfolio is at the corner:

Constrained Tangency: wA = 1, wB = 0 (100% Security A)

$Rp,t_constrained = 15.00\%$

$\sigma p,t_constrained = 20.00\%$

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Sharpe_t_constrained = (15.00 − 6.00) / 20.00 = 9.00 / 20.00 = 0.4500

Loss in Sharpe Ratio:

Unconstrained Sharpe: 0.4523

Constrained Sharpe: 0.4500

Loss: 0.0023 (approx. 0.5% relative reduction)

The loss appears small at the corner in this specific example but scales up dramatically when three or more securities are involved, or when correlations differ across pairs. In multi-asset settings, the difference between unconstrained and constrained tangency can be 5-15% of Sharpe magnitude.

(vi) The Critical Line Concept

Definition:

The Critical Line is the locus of all efficient portfolios traced out in weight-space as the investor's risk aversion parameter changes. In an unconstrained Markowitz problem, the Critical Line is a straight line in weight-space connecting the MVP to the highest-return portfolio. The Critical Line becomes SEGMENTED (piecewise linear) when inequality constraints are added — at each point where a constraint becomes binding, a "critical point" emerges and the composition of the efficient portfolio changes discontinuously.

Critical Points in this Two-Asset Case:

Critical Point	Weight (wA, wB)	Rp, σp	Constraint Status
Left Critical Boundary	(0.00, 1.00)	10.00%, 12.00%	wA = 0 binding (SEBI wA ≥ 0)
Right Critical Boundary	(1.00, 0.00)	15.00%, 20.00%	wB = 0 binding (SEBI wB ≥ 0)

Structure of Efficient Frontier:

Unconstrained (Theoretical) Efficient Frontier:

- Extends from MVP at wA = −0.30 (Rp = 8.5%, σp = 11.38%) toward infinity
- Continuous smooth hyperbola in (σ, R) space
- Contains Tangency Portfolio at wA = 1.32 (Rp = 16.6%, σp = 23.44%)
- No discontinuities — one connected smooth curve

Constrained (SEBI-Feasible) Efficient Frontier:

- Restricted to 0 ≤ wA ≤ 1
- Starts at (10.00%, 12.00%) — corresponding to wA = 0 (Constrained MVP)
- Ends at (15.00%, 20.00%) — corresponding to wA = 1 (Constrained Tangency)
- Below wA = 0 and above wA = 1: infeasible (excluded)
- The efficient frontier is a shorter arc within the full theoretical frontier

Insight — Critical Line Segmentation:

In this two-asset case, the constrained efficient frontier is a continuous arc between two critical corners. In multi-asset settings, additional critical points emerge internally where individual asset weights hit zero. Between consecutive critical points, the composition of the efficient portfolio is a linear combination of a fixed set of assets — and the segment of the frontier is described by a critical line in weight-space. As we cross a critical point moving along the frontier, an asset either enters (moves off zero weight) or exits (weight reduces to zero), and the critical line changes direction. The efficient frontier under constraints thus consists of MULTIPLE critical lines pieced together, hence "Critical Line Theory" (Markowitz's own terminology from his 1959 book).

(vii) Practitioner Discussion — Indian Mutual Fund Context

SEBI Regulatory Framework:

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Under SEBI Mutual Fund Regulations, 1996, and subsequent circulars, equity mutual funds cannot short-sell securities (with narrow exceptions for arbitrage schemes and hedged strategies). This creates a fundamental disconnect between textbook efficient frontier theory and real-world portfolio construction for Indian retail products.

Synthetic Short Replication Strategies:

(i) Nifty 50 futures short positions: A fund cannot short an individual stock (say TCS), but it CAN short the Nifty 50 futures. This gives partial hedging against systematic risk but not stock-specific short exposure.

(ii) Long-Short Arbitrage Schemes: A specific category of mutual fund (like Kotak Equity Arbitrage Fund) is permitted limited short-selling for arbitrage purposes. These funds can approach unconstrained efficient portfolios more closely, though within strict tracking-error and leverage limits.

(iii) Category III AIFs and Long-Short PMS: Alternative Investment Funds (AIFs) and portfolio management services (PMS) products have far more latitude for short-selling. This is why unconstrained Markowitz-style optimization is more directly applicable to hedge-fund style products.

(iv) Derivatives-based synthetic shorts: Put options on individual stocks (available for Nifty 200 constituents on NSE) allow synthetic short exposure without triggering SEBI's short-sale prohibition. However, option premiums add cost and time-decay creates carry drag.

(v) Overweight/underweight relative to benchmark: While pure short-selling is prohibited, funds can meaningfully UNDERWEIGHT a stock relative to benchmark. This provides a partial substitute for shorting — if a stock is 5% of Nifty 50 and the fund holds 0% of it, the fund is effectively "short 5%" relative to benchmark tracking.

Implications for Achievable Efficient Frontier:

Indian mutual funds operate on a truncated efficient frontier that lies inside the theoretical Markowitz frontier. The efficiency gap widens with the intensity of the constraint — small-cap and thematic funds with concentrated positions face the largest gap because their unconstrained optimal weights would frequently include shorts. Large-cap diversified funds are less affected because their unconstrained optima are typically within the feasible region. This is why quantitatively-managed diversified funds (e.g., ICICI Prudential Nifty ETF, HDFC Nifty 50 Index Fund) achieve efficient frontiers close to the theoretical benchmark, while concentrated actively-managed funds may exhibit substantial efficiency loss quantified in Sharpe Ratio units.

Question 14 — Real Estate Valuation using Multiple approaches

Meera Iyengar is the Head of Acquisitions at Embassy Office Parks REIT, one of India's largest listed real estate investment trusts. She is evaluating the acquisition of "Whitefield Tech Tower", a Grade-A commercial office building in the Whitefield IT corridor of Bengaluru. The seller has quoted an asking price of ₹115 crore. Meera must apply the four ICAI-recognised real estate valuation methods, reconcile the estimates, and provide an investment recommendation to the REIT board.

Property Details:

Parameter	Details
Property Name	Whitefield Tech Tower
Location	Whitefield IT Corridor, Bengaluru
Type	Grade-A Commercial Office Building
Total Leasable Area	1,00,000 sq ft
Land Area	2 acres
Age	8 years
Building Useful Life	50 years
Current Occupancy	92%
Seller Asking Price	₹115.00 crore

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Market Data for Valuation:

- Recent comparable transactions in Whitefield: benchmark rate ₹11,000 per sq ft (weighted average of 3 recent deals)
- Adjustment for subject property: +5% location (closer to Metro station), +2% for newer age → total +7%
- Prevailing gross rental in Whitefield: ₹90 per sq ft per month
- Annual operating expenses (property tax, maintenance, insurance): ₹1.50 crore
- Market capitalisation rate for Grade-A Bengaluru offices: 7.50%
- Land value in Whitefield: ₹15 crore per acre
- Building replacement cost: ₹4,500 per sq ft
- Location/neighbourhood adjustment on building: +15% for premium IT corridor
- Rental growth rate (long-term): 6% p.a.
- Corporate tax rate on rental income: 30%
- REIT required rate of return (discount rate): 10%
- Terminal capitalisation rate at Year 5 exit: 8.00%

Required:

(i) Apply the Sales Comparison Approach to value Whitefield Tech Tower.

(ii) Apply the Income Approach using the cap-rate methodology to value the property.

(iii) Apply the Cost Approach — land value plus depreciated building value with location adjustment.

(iv) Apply the Discounted After-Tax Cash Flow Approach with a 5-year holding period and terminal value at exit.

(v) Reconcile the four valuations using appropriate weights, indicating the rationale for the weighting scheme.

(vi) Compare the reconciled valuation with the seller's asking price of ₹115 crore. Provide a specific recommendation to the REIT board on whether to proceed, renegotiate, or reject the transaction.

Solution

(i) Sales Comparison Approach

This approach uses recent transactions of comparable properties as a benchmark, then adjusts for property-specific factors. ICAI SM Section 16.1.2 draws an analogy to the Price-Earnings Multiplier used for equity shares — the market provides a per-unit rate that is applied to the subject property.

Computation:

Base benchmark rate (from comparable transactions): ₹11,000 per sq ft

Adjustment for subject property:

Location premium (proximity to Metro): +5.00%

Age adjustment (newer building): +2.00%

Total adjustment: +7.00%

Adjusted rate: ₹11,000 × 1.07 = ₹11,770 per sq ft

Valuation = ₹11,770 × 1,00,000 sq ft

Sales Comparison Value = ₹1,17,70,00,000 = ₹117.70 crore

(ii) Income Approach

This approach values the property by capitalising the perpetual Net Operating Income (NOI) at the market cap rate. ICAI SM Section 16.1.2 draws an analogy to the value of a Perpetual Debenture or Irredeemable Preference Share, where value = perpetual cash flow / market required rate of return.

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Step 1: Compute Effective Gross Rental Income

Monthly rent per sq ft: ₹90

Annual rent per sq ft: ₹90 × 12 = ₹1,080

Gross Rental (100% occupancy): ₹1,080 × 1,00,000 = ₹10,80,00,000 = ₹10.80 crore

Occupancy adjustment (92%): ₹10.80 × 0.92 = ₹9.936 crore

Step 2: Compute Net Operating Income (NOI)

Effective Gross Rental: ₹9.936 crore

Less: Operating Expenses: ₹1.500 crore

NOI = ₹8.436 crore

Step 3: Capitalise at Market Cap Rate

Market Cap Rate for Bengaluru Grade-A offices: 7.50%

Value = NOI / Cap Rate = ₹8.436 / 0.075

Income Approach Value = ₹1,12,48,00,000 = ₹112.48 crore

(iii) Cost Approach

This approach estimates the cost to replace the building in its present depreciated form, plus the value of the underlying land. ICAI SM Section 16.1.2 specifically mentions adjustment for location, neighbourhood, and other factors.

Step 1: Land Value

Land Area: 2 acres

Rate per acre: ₹15.00 crore

Land Value = 2 × 15 = ₹30.00 crore

Step 2: Building Replacement Cost (New)

Area: 1,00,000 sq ft

Rate: ₹4,500 per sq ft

Replacement Cost (New) = ₹4,500 × 1,00,000 = ₹45.00 crore

Step 3: Depreciation Adjustment

Age: 8 years

Useful Life: 50 years

Depreciation rate (straight-line): 8/50 = 16%

Depreciated Building Value: ₹45 × (1 − 0.16) = ₹45 × 0.84

Depreciated Building Value = ₹37.80 crore

Step 4: Location/Neighbourhood Adjustment

Whitefield IT Corridor premium: +15% on building value

Adjusted Building Value: ₹37.80 × 1.15

Adjusted Building Value = ₹43.47 crore

Step 5: Total Property Value

Total = Land Value + Adjusted Building Value

= ₹30.00 + ₹43.47

Cost Approach Value = ₹73.47 crore

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Note: The Cost Approach materially UNDERSTATES the market value in this case, because it does not capture the market's willingness to pay a premium for a well-located, income-producing property. The Cost Approach is more appropriate for special-purpose properties (schools, hospitals) or when comparable transactions and reliable income data are unavailable.

(iv) Discounted After-Tax Cash Flow Approach

ICAI SM Section 16.1.2 describes this method as similar to the NPV technique — PV of expected inflows at required rate of return, reduced by the amount of investment. Here we compute the intrinsic value (PV of expected inflows including terminal value) using a 5-year holding period.

Step 1: Compute Year-Wise After-Tax Cash Flows

Building depreciation for tax shield: ₹45 crore / 50 years = ₹0.90 crore per year (constant)

After-Tax Cash Flow formula: NOI × (1 − t) + Depreciation × t

Year	NOI (Growing @ 6%)	NOI × 0.70	Depn × 0.30	After-Tax CF (₹ crore)
1	8.436	5.905	0.270	6.175
2	8.942	6.259	0.270	6.529
3	9.479	6.635	0.270	6.905
4	10.047	7.033	0.270	7.303
5	10.650	7.455	0.270	7.725

Step 2: Terminal Value at End of Year 5

Terminal Value = Year 5 CFAT / Terminal Cap Rate

Substituting values:

Terminal Value = 7.725 / 0.08

Terminal Value (at end of Year 5) = ₹96.5625 crore ≈ ₹96.56 crore

Step 3: Discount at Required Rate of Return of 10%

Year	Cash Flow (₹ crore)	Discount Factor @ 10%	Present Value (₹ crore)
1	6.175	0.9091	5.614
2	6.529	0.8264	5.395
3	6.905	0.7513	5.189
4	7.303	0.6830	4.988
5	7.725	0.6209	4.796
Year 5 (Terminal Value)	96.56	0.6209	59.955
Total Present Value			**85.94**

Discounted After-Tax Cash Flow Value = ₹85.94crore

NPV Analysis at Seller's Asking Price of ₹115 crore:

NPV = PV of Inflows − Investment = ₹85.94 − ₹115.00 = − ₹29.06 crore

Highly negative NPV → Property is significantly overvalued at asking price using this method.

(v) Reconciliation of the Four Valuations

Summary of Valuations:

Method	Valuation (₹ crore)	Reliability Ranking	Weighting Rationale
Sales Comparison	117.70	High	Reflects actual market transactions; strong for active markets like Bengaluru IT corridor

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Method	Valuation (₹ crore)	Reliability Ranking	Weighting Rationale
Income Approach	112.48	Highest	Directly captures income-generation capability — the primary reason to hold commercial real estate
Cost Approach	73.47	Low	Understates value for income-producing properties; ignores location premium
Discounted AT CF	85.94	High	Captures tax effects and terminal value; useful for cross-verification

Weighted Reconciliation:

Method	Valuation (₹ crore)	Weight	Weighted Value (₹ crore)
Sales Comparison	117.70	30%	35.310
Income Approach	112.48	35%	39.368
Cost Approach	73.47	15%	11.021
Discounted AT CF	85.94	20%	17.188
RECONCILED WEIGHTED VALUATION			**102.89**

The Income Approach receives the highest weight (35%) because it directly captures the income-generation logic that underpins REIT investment. Sales Comparison (30%) receives strong weight because Bengaluru IT corridor has an active transaction market. Discounted AT CF (20%) provides tax-adjusted cross-verification. Cost Approach (15%) is deliberately underweighted because it understates market value for well-located income-producing properties — but is retained as a lower-bound sanity check.

(vi) Investment Recommendation to the REIT Board

Valuation vs Asking Price:

Reference Point	Value (₹ crore)	vs Asking Price ₹115 crore
Sales Comparison	117.70	Asking price fair (small margin)
Income Approach	112.48	Overpaying by ₹2.52 crore (2.2%)
Cost Approach	73.47	Significantly overpaying, but not the primary metric
Discounted After-Tax CF	85.94	Overpaying by ₹29.06 crore (25.3%)
Weighted Reconciled Value	**102.89**	**Overpaying by ₹12.11 crore (~10.5%)**

Additional Cap Rate Analysis:

Implied Cap Rate at Asking Price of ₹115 crore = NOI / Purchase Price = ₹8.436 / ₹115 = 7.336%

Market Cap Rate for Bengaluru Grade-A: 7.50%

Implied cap rate (7.34%) BELOW market cap rate (7.50%) — seller pricing at a premium.

Recommendation to the REIT Board:

(i) DO NOT proceed at the asking price of ₹115 crore. With the revised DCF treatment, THREE of the four methods (Income Approach, Discounted After-Tax CF, Weighted Reconciled Value) indicate the property is overvalued by 2% to 25%. Only Sales Comparison marginally supports the asking price.

(ii) Counter-offer at ₹100-₹103 crore, anchored to the revised weighted reconciled valuation of ₹102.89 crore. This gives the REIT a meaningful margin of safety of ~10-12% versus asking price, and implies a cap rate of 8.2%-8.4% — well above the market rate of 7.50%.

(iii) The revised DCF valuation of ₹85.94 crore acts as a floor below which the offer should not go, but which the seller is unlikely to accept given the Sales Comparison and Income Approach values are much higher. A negotiated settlement in the ₹100-₹105 crore band is the realistic target.

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(iv) If seller is firm at ₹115 crore, walk away UNLESS strategic considerations justify a premium. Given the wider gap (₹12 crore) now visible with the corrected DCF, the case for walking away is stronger than in the earlier analysis.

(v) The wide range across methods (₹73 crore to ₹118 crore, a 60% spread) suggests further due diligence — obtain a professional appraisal from a SEBI-registered valuer, verify tenant lease terms and expiry profile, and pressure-test the operating expenses assumption (₹1.50 crore is at the low end for a 100,000 sq ft Grade-A property).

Final Board Recommendation

The Acquisitions team recommends counter-offering at ₹100 crore with a 30-day window for the seller to accept. Maximum negotiated price should not exceed ₹105 crore to preserve the margin of safety indicated by the DCF analysis. If seller does not accept, the deal should be closed unless a value-add strategy can bridge the ₹10-15 crore gap between reasonable acquisition price and asking price.

Question 15 — Integrated CAPM Portfolio Analysis with Portfolio Revision

Aditi Sharma, CA, is a personal wealth advisor at Ambit Private Wealth in Mumbai. Her HNW client Mr. Anand Bhatia holds a diversified portfolio of Indian equity and fixed-income securities. Anand has requested a comprehensive review to (a) determine whether each security is fairly priced under CAPM, (b) evaluate the portfolio's overall risk-return profile against CAPM benchmarks, and (c) recommend a portfolio revision if any securities are meaningfully mispriced.

Portfolio Holdings (as of Financial Year-End Review):

Security	Cost (₹)	Dividends / Interest (₹)	Current Market Value (₹)	Beta (βi)
Reliance Industries Ltd. (RIL)	40,000	400	46,800	1.20
HDFC Bank Ltd.	30,000	300	33,300	0.90
ITC Ltd.	25,000	1,000	27,750	0.60
Infosys Ltd.	20,000	250	21,350	1.10
7% GOI Bond 2032	35,000	2,450	34,300	0.05
TOTAL	**1,50,000**	**4,400**	**1,63,500**	

Market Data:

- Risk-Free Rate (Rf) — 10-year G-Sec yield: 6.50%
- Expected Market Return (Rm) — Nifty 50 TRI: 13.00%
- Market Risk Premium (MRP = Rm − Rf): 6.50%

Required:

(i) Compute the actual return on each security using the standard formula: (Dividends/Interest + Market Value − Cost) / Cost.

(ii) Compute the portfolio-weighted actual return using cost weights.

(iii) Compute the CAPM Expected Return for each security using E(Ri) = Rf + βi × MRP.

(iv) Compute the portfolio-weighted beta (cost weights) and portfolio Expected Return per CAPM.

(v) Identify which securities are undervalued and overvalued by comparing actual returns with CAPM expected returns. Compute the individual and portfolio-level Jensen's Alpha.

(vi) Anand accepts your recommendation to rebalance: sell 50% of Infosys (overvalued) and redeploy the ₹10,000 proceeds equally between Reliance (undervalued) and ITC (undervalued). Compute the revised portfolio's Actual Return, Beta, CAPM Expected Return, and Alpha. Quantify the improvement.

(vii) Comment on whether the portfolio revision is genuinely value-enhancing, and identify what additional considerations Aditi should discuss with Anand before executing the trades.

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Solution

(i) Actual Return on Each Security

Formula: Actual Return = (Dividends/Interest + Market Value − Cost) / Cost

Security	Div/Int (₹)	MV − Cost (₹)	Total Gain (₹)	Cost (₹)	Return (%)
RIL	400	6,800	7,200	40,000	18.00%
HDFC Bank	300	3,300	3,600	30,000	12.00%
ITC	1,000	2,750	3,750	25,000	15.00%
Infosys	250	1,350	1,600	20,000	8.00%
7% GOI Bond	2,450	−700	1,750	35,000	5.00%

(ii) Portfolio-Weighted Actual Return (Cost Weights)

Cost-based weights:

Security	Cost (₹)	Weight (Cost / Total)
RIL	40,000	40,000/1,50,000 = 26.67%
HDFC Bank	30,000	30,000/1,50,000 = 20.00%
ITC	25,000	25,000/1,50,000 = 16.67%
Infosys	20,000	20,000/1,50,000 = 13.33%
7% GOI Bond	35,000	35,000/1,50,000 = 23.33%
Total	**1,50,000**	**100.00%**

Portfolio Actual Return:

Rp = 0.2667 × 18.00 + 0.2000 × 12.00 + 0.1667 × 15.00 + 0.1333 × 8.00 + 0.2333 × 5.00

= 4.80 + 2.40 + 2.50 + 1.067 + 1.167

= 11.93%

(iii) CAPM Expected Return for Each Security

Formula: E(Ri) = Rf + βi × (Rm − Rf) = 6.50% + βi × 6.50%

Security	βi	βi × MRP (6.5%)	E(Ri) CAPM
RIL	1.20	7.80%	6.50 + 7.80 = 14.30%
HDFC Bank	0.90	5.85%	6.50 + 5.85 = 12.35%
ITC	0.60	3.90%	6.50 + 3.90 = 10.40%
Infosys	1.10	7.15%	6.50 + 7.15 = 13.65%
7% GOI Bond	0.05	0.325%	6.50 + 0.325 = 6.83%

(iv) Portfolio Beta and Portfolio CAPM Expected Return

Portfolio Beta (Cost-Weighted):

βp = 0.2667 × 1.20 + 0.2000 × 0.90 + 0.1667 × 0.60 + 0.1333 × 1.10 + 0.2333 × 0.05

= 0.3200 + 0.1800 + 0.1000 + 0.1467 + 0.0117

= 0.7583

Portfolio Expected Return per CAPM:

E(Rp) = Rf + βp × MRP

= 6.50% + 0.7583 × 6.50%

= 6.50% + 4.929%

= 11.43%

(v) Individual and Portfolio-Level Alpha Analysis

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Formula: αi = Actual Return − CAPM Expected Return

Security	Actual Return	CAPM E(Ri)	Alpha (α)	Valuation Signal
RIL	18.00%	14.30%	+3.70%	UNDERVALUED — Increase Holding
HDFC Bank	12.00%	12.35%	−0.35%	Marginally overvalued — Hold
ITC	15.00%	10.40%	+4.60%	UNDERVALUED — Increase Holding
Infosys	8.00%	13.65%	−5.65%	OVERVALUED — Reduce/Exit
7% GOI Bond	5.00%	6.83%	−1.83%	Overvalued — Consider re-yield

Portfolio-Level Alpha:

αp = Portfolio Actual Return − Portfolio CAPM Expected Return

= 11.93% − 11.43%

= +0.50%

Interpretation: The portfolio overall delivers 50 basis points of excess return over CAPM benchmark, indicating modest positive selection skill. However, this aggregate figure conceals large individual mispricings — the strong positive alpha in RIL (+3.70%) and ITC (+4.60%) is being significantly offset by the sharply negative alpha in Infosys (−5.65%). Portfolio revision to reduce the drag from Infosys should meaningfully improve the aggregate alpha.

(vi) Portfolio Revision — Sell 50% Infosys, Redeploy to RIL and ITC

Rebalancing Actions:

- Sell 50% of Infosys holding: 50% × ₹20,000 = ₹10,000 released
- Add ₹5,000 to Reliance Industries
- Add ₹5,000 to ITC

Revised Portfolio Composition:

Security	Original Cost (₹)	Change (₹)	Revised Cost (₹)	Revised Weight
RIL	40,000	+5,000	45,000	45,000/1,50,000 = 30.00%
HDFC Bank	30,000	0	30,000	20.00%
ITC	25,000	+5,000	30,000	20.00%
Infosys	20,000	−10,000	10,000	10,000/1,50,000 = 6.67%
7% GOI Bond	35,000	0	35,000	23.33%
Total	**1,50,000**	**0**	**1,50,000**	**100.00%**

Revised Portfolio Actual Return (using same asset-level returns):

Rp,new = 0.3000 × 18.00 + 0.2000 × 12.00 + 0.2000 × 15.00 + 0.0667 × 8.00 + 0.2333 × 5.00

= 5.400 + 2.400 + 3.000 + 0.533 + 1.167

= 12.50%

Revised Portfolio Beta:

βp,new = 0.3000 × 1.20 + 0.2000 × 0.90 + 0.2000 × 0.60 + 0.0667 × 1.10 + 0.2333 × 0.05

= 0.3600 + 0.1800 + 0.1200 + 0.0733 + 0.0117

= 0.7450

Revised Portfolio CAPM Expected Return:

E(Rp,new) = 6.50% + 0.7450 × 6.50%

= 6.50% + 4.8425%

= 11.34%

Revised Portfolio Alpha:

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$\alpha_{p,new}$ = 12.50% − 11.34%

= +1.16%

Improvement Analysis:

Metric	Before Revision	After Revision	Change
Portfolio Actual Return	11.93%	12.50%	+57 bps
Portfolio Beta	0.7583	0.7450	−0.0133 (slight de-risk)
Portfolio CAPM Expected	11.43%	11.34%	−9 bps (reflects lower β)
Portfolio Alpha	**+0.50%**	**+1.16%**	**+66 bps (132% relative improvement)**

The revision more than DOUBLES the portfolio alpha from +0.50% to +1.16% — a 66 basis point absolute improvement — while simultaneously reducing portfolio beta (systematic risk) by 0.013. This is the ideal outcome of active portfolio management: higher alpha AND lower systematic risk.

(vii) Additional Considerations Before Executing the Revision

While the mathematical case for revision is compelling, Aditi should discuss the following practical considerations with Anand before executing the trades:

(i) Capital Gains Tax on Infosys Sale: If the Infosys shares have been held for less than 12 months, Short-Term Capital Gains (STCG) at 20% will apply. If held over 12 months, Long-Term Capital Gains (LTCG) at 10% applies on gains above ₹1 lakh per year. Even the reduced Infosys stake carries an embedded tax cost — the 50% partial sale may not fully offset the tax drag, so consider whether a smaller trim (e.g., 25%) achieves adequate rebalancing with less tax friction.

(ii) Beta Stability Assumption: The alpha analysis assumes historical betas persist. Infosys' beta of 1.10 may not remain stable if the IT sector fundamentally repriceres (e.g., due to AI-driven revenue disruption, US visa policy changes affecting large-cap Indian IT). Aditi should stress-test the alpha calculation using a beta range (say, β = 0.9 to 1.3 for Infosys) to check robustness.

(iii) Concentration and Diversification: Post-revision, RIL alone rises to 30% of the portfolio — this concentration risk should be discussed. Anand may prefer capping single-stock exposure at 25%, which would suggest allocating the ₹10,000 proceeds partly to HDFC Bank (which was neutral) or a Nifty 50 Index Fund for diversification.

(iv) Alpha Persistence and Mean Reversion: A single-period alpha (whether positive or negative) may not persist. Infosys' underperformance may reverse if IT sector sentiment shifts; RIL's alpha may compress as the market catches up to its Jio-related re-rating. Aditi should discuss whether Anand is comfortable making tactical bets on transient mispricings.

(v) Transaction Costs and Impact: For a ₹10,000 rebalance, brokerage (0.05-0.30% depending on plan), STT (0.10% on delivery), and exchange charges will consume approximately ₹30-60 in total costs. Small in absolute terms but relevant for micro-rebalancing decisions.

(vi) Client's Broader Portfolio Context: The five-security portfolio may be a subset of Anand's total wealth. If Anand also holds ESOPs in Infosys through his employer, the true Infosys concentration may be much higher than shown here — and the case for reducing Infosys becomes even stronger for concentration reasons independent of alpha.

Aditi's Final Recommendation:

Proceed with the revision, but consider (a) trimming Infosys by only 30-35% instead of 50% if STCG will apply, (b) partial redeployment to a Nifty 50 Index Fund alongside RIL and ITC to manage concentration, and (c) documenting the alpha thesis in a Client Advisory Note so both parties acknowledge that the recommendation rests on the assumption of alpha persistence.

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Question 16 — Distressed Securities Strategy: Suryodaya Infrastructure Ltd.

Ritika Malhotra, CFA, is a Portfolio Manager at Kotak Alternate Assets Management (KAAM) specializing in special situations and distressed securities. She has identified an opportunity in Suryodaya Infrastructure Ltd. (SIL), a Delhi-based mid-sized real estate developer that has entered the Corporate Insolvency Resolution Process (CIRP) under the Insolvency and Bankruptcy Code (IBC), 2016. The company has multiple stalled residential projects, strained cash flows, and creditors have approached the National Company Law Tribunal (NCLT) for resolution.

Ritika proposes to construct a distressed securities strategy following the framework described in ICAI SM Section 16.3 — LONG POSITION IN DEBT combined with SHORT POSITION IN EQUITY.

Company & Securities Data:

Security	Face Value	Current Market Price	Details
10% Non-Convertible Debentures (SIL 2028)	₹1,000	₹400 (60% discount to face)	Annual coupon ₹100; matures December 2028 (2 years remaining)
Equity Shares (SIL)	₹10	₹50	Historical dividend yield: 3% of market price; likely nil during CIRP

Proposed Strategy (Self-Funded Long-Short):

- Long Position: Purchase 5,000 SIL NCDs at ₹400 each → Cash outflow of ₹20,00,000
- Short Position: Short-sell 40,000 SIL equity shares at ₹50 each → Cash inflow of ₹20,00,000
- Net cash outflow at initiation = ₹0 (Self-funded arbitrage)
- Holding period: 2 years (until NCD maturity in December 2028)

Required:

(i) State the RATIONALE behind the Long Debt + Short Equity strategy for distressed securities as described in ICAI SM Section 16.3. Explain why this strategy is capable of generating profit under both improvement and deterioration scenarios.

(ii) Compute the profit or loss under SCENARIO A: Company successfully reorganizes under NCLT proceedings. NCDs redeemed at face value at maturity; equity price rises from ₹50 to ₹100.

(iii) Compute the profit or loss under SCENARIO B: Company enters liquidation. NCDs recovered at 30% of face value (₹300); equity crashes to ₹5. Assume interest received for only 1 year before default.

(iv) Compute the profit or loss under SCENARIO C: Muddled outcome — resolution not achieved even after 2 years. NCD price stagnates at ₹400; equity partially recovers to ₹60. Interest continues to be paid but no dividend on equity.

(v) Analyze the FOUR types of risks associated with distressed securities investment as per ICAI SM Section 16.3, applying each to the specific SIL case.

(vi) Discuss the practical considerations and constraints of executing this strategy in the Indian regulatory environment.

Solution

(i) Rationale for the Long Debt + Short Equity Strategy

Per ICAI SM Section 16.3, the distressed securities strategy is designed to generate profit under BOTH improvement and deterioration scenarios by exploiting the fundamental hierarchy of claims in a company's capital structure:

A. If Company's Condition IMPROVES (Successful Resolution):

The investor will get his INTEREST PAYMENT (on the long debt position), which shall be MORE THAN the DIVIDEND on his short position in equity shares. This creates a positive carry throughout the holding period. Additionally, at exit, the

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debt will be redeemed at face value (or higher), producing a capital gain that typically exceeds the short-side loss on equity because the debt was purchased at deep discount.

B. If Company's Condition FURTHER DETERIORATES (Liquidation):

The value of BOTH the shares AND the debentures goes down. However, the investor will make GOOD PROFIT from his short position — because equity is at the bottom of the claim hierarchy and is often wiped out completely in liquidation, while debt (being higher in the claim hierarchy) still recovers a meaningful portion of its face value under the IBC waterfall of payments.

Why This Constitutes "Arbitrage":

The arbitrage exists because debt holders have PRIORITY of claim over equity holders under IBC Section 53 (Waterfall Mechanism). This asymmetry means the long-debt-short-equity position is structurally protected — debt cannot fall more than a certain amount while equity can be wiped out. The strategy captures the value differential embedded in the priority hierarchy.

(ii) Scenario A — Company Successfully Reorganizes

Long Debt Position (5,000 NCDs):

Cost of purchase: 5,000 × ₹400 = ₹20,00,000

Redemption at face value: 5,000 × ₹1,000 = ₹50,00,000

Gain on debt: ₹50,00,000 – ₹20,00,000 = ₹30,00,000

Short Equity Position (40,000 shares):

Short sale proceeds: 40,000 × ₹50 = ₹20,00,000

Cost to close short (buy back at ₹100): 40,000 × ₹100 = ₹40,00,000

Loss on short: ₹40,00,000 – ₹20,00,000 = ₹20,00,000

Interim Carry (over 2 years):

Interest received on NCDs: 5,000 × ₹100 × 2 years = ₹10,00,000

Dividend paid on shorted equity: 40,000 × ₹1.50 (3% × ₹50) × 2 years = ₹1,20,000

Net Interim Carry: ₹10,00,000 – ₹1,20,000 = ₹8,80,000

Cash Flow Component	Amount (₹)
Gain on Long Debt Position	+ 30,00,000
Loss on Short Equity Position	− 20,00,000
Interest Received (2 years)	+ 10,00,000
Dividend Paid on Short (2 years)	− 1,20,000
NET PROFIT — SCENARIO A	**+ ₹18,80,000**

(iii) Scenario B — Company Enters Liquidation

Long Debt Position (5,000 NCDs):

Cost of purchase: ₹20,00,000

Recovery at 30% of face value: 5,000 × ₹300 = ₹15,00,000

Loss on debt: ₹20,00,000 – ₹15,00,000 = ₹5,00,000

Short Equity Position (40,000 shares):

Short sale proceeds: ₹20,00,000

Cost to close short (equity crashes to ₹5): 40,000 × ₹5 = ₹2,00,000

Gain on short: ₹20,00,000 – ₹2,00,000 = ₹18,00,000

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Interim Carry (1 year of interest before default):

Interest received on NCDs (1 year): 5,000 × ₹100 × 1 = ₹5,00,000

Dividend paid on shorted equity: ₹0 (no dividends during distress)

Net Interim Carry: ₹5,00,000

Cash Flow Component	Amount (₹)
Loss on Long Debt Position	− 5,00,000
Gain on Short Equity Position	+ 18,00,000
Interest Received (1 year only)	+ 5,00,000
Dividend Paid on Short	0
NET PROFIT — SCENARIO B	**+ ₹18,00,000**

Notably, Scenario B produces almost the same profit as Scenario A (₹18 lakh vs ₹18.8 lakh). This demonstrates the ICAI-described arbitrage — the short equity position captures large profit when equity crashes, offsetting the moderate loss on debt.

(iv) Scenario C — Muddled Outcome (No Clear Resolution)

Long Debt Position (5,000 NCDs):

Cost of purchase: ₹20,00,000

Sale at end of Year 2 (price unchanged at ₹400): 5,000 × ₹400 = ₹20,00,000

Gain/Loss on debt: Zero

Short Equity Position (40,000 shares):

Short sale proceeds: ₹20,00,000

Cost to close short (equity recovers to ₹60): 40,000 × ₹60 = ₹24,00,000

Loss on short: ₹24,00,000 − ₹20,00,000 = ₹4,00,000

Interim Carry:

Interest received on NCDs (2 years, still paid despite distress): ₹10,00,000

Dividend paid on shorted equity: ₹0 (no dividend during CIRP)

Net Interim Carry: ₹10,00,000

Cash Flow Component	Amount (₹)
Gain on Long Debt Position	0
Loss on Short Equity Position	− 4,00,000
Interest Received (2 years)	+ 10,00,000
Dividend Paid on Short	0
NET PROFIT — SCENARIO C	**+ ₹6,00,000**

Comparative Summary Across All Three Scenarios:

Scenario	Net Profit (₹)	Primary Profit Driver
A. Revival	+ 18,80,000	Long debt capital gain + interim carry
B. Liquidation	+ 18,00,000	Short equity crash gain, protecting against debt loss
C. Muddled	+ 6,00,000	Interest carry (positive over 2 years) covers small equity loss

The strategy delivers positive profit under ALL THREE outcomes — this is the essence of the ICAI-described "arbitrage" in distressed securities. However, magnitudes vary significantly across scenarios.

(v) Analysis of the Four Types of Risks (ICAI SM Section 16.3)

1. Liquidity Risk

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Per ICAI SM: "These securities may not be saleable in the market."

Application to SIL: Once a company enters CIRP, both debt and equity trading typically becomes highly restricted. The SIL NCDs may trade only in the OTC market with wide bid-ask spreads (5-10% typical for distressed paper). If Ritika needs to exit the position before maturity, she may face significant impact costs or be unable to find counterparty at any price. The equity shorted may become subject to trading suspension by the exchange, which would force short covering at unfavourable prices.

2. Event Risk

Per ICAI SM: "Any event that particularly affects the company, not economy as a whole."

Application to SIL: Specific corporate events that could adversely affect the strategy include: (a) sudden adverse NCLT ruling (e.g., resolution plan rejected requiring restart), (b) discovery of undisclosed liabilities during due diligence, (c) key management departure or fraud allegations, (d) large litigations from apartment buyers under RERA. Any such event could disrupt both the debt recovery and equity price simultaneously.

3. Market Risk

Per ICAI SM: "This is another type of risk though it is not important."

Application to SIL: Broader market conditions affect distressed securities to a lesser degree because their pricing is dominated by company-specific factors rather than systematic factors. However, extreme market movements can still influence timing of resolution — a market crash may reduce willingness of bidders to pay in the NCLT resolution auction, deepening the discount on debt recovery.

4. Human Risk

Per ICAI SM: "The judge's decision on the company in distress also plays a big role."

Application to SIL: This is the most unique risk in distressed securities investing. The NCLT judge's discretion on: (a) approving or rejecting the resolution plan, (b) determining haircut on debt claims, (c) ruling on inter-creditor priorities, (d) accepting or rejecting extension applications by resolution professional — all directly affect the outcome. Judicial delays in Indian NCLT proceedings often stretch to 300-400 days beyond the statutory 180+90 day IBC timeline, creating substantial timing uncertainty.

(vi) Practical Considerations for the Indian Regulatory Environment

Ritika must be aware of several practical constraints when executing this strategy in Indian markets:

(i) SHORT-SELLING RESTRICTIONS: Retail cash-segment short-selling in India is limited to intraday transactions. Positional short-selling requires derivatives access (F&O). However, F&O contracts for distressed companies are often DISCONTINUED by NSE/BSE once the company enters CIRP or trading is restricted. This may make the equity short leg of the strategy IMPOSSIBLE to execute in practice for smaller mid-cap distressed companies like SIL.

(ii) SUBSTITUTES FOR EQUITY SHORT: If F&O is unavailable, Ritika could use: (a) put options if available, (b) synthetic short via inverse ETFs, (c) sector-based short (short a real-estate ETF as a proxy). However, these introduce basis risk — the proxy may not move in lockstep with SIL equity.

(iii) SEBI RESTRICTIONS ON CIRP-STAGE TRADING: SEBI has issued restrictions on trading in shares of companies in the final stages of CIRP. Circular SEBI/HO/CFD/DIL2/CIR/P/2020/47 restricts trading in certain circumstances. Ritika must monitor SIL's regulatory status and be prepared to close short positions if trading restrictions are imposed.

(iv) CATEGORY OF INVESTOR: The distressed securities strategy is typically permitted only for institutional investors and AIF Category III funds. It is not available to retail mutual funds due to SEBI Mutual Fund Regulations restricting short-selling. Ritika's KAAM operates as an AIF, providing regulatory authorization for the strategy.

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(v) CAPITAL EFFICIENCY: The strategy is described as "self-funded" (₹0 net cash outflow) but in practice requires MARGIN for the short position (30-50% of short value typical). If short margin is 40%, capital tied up = ₹20L (long) + ₹8L (short margin) = ₹28L. Returns should be computed against this deployed capital: Scenario A return = ₹18.8L / ₹28L = 67% over 2 years (~34% p.a.) — an attractive return commensurate with the elevated risk.

(vi) TIMING OF EXIT: Ritika should have a clear exit strategy for each scenario — hold-to-maturity for debt (2 years), or opportunistic sale if resolution timeline extends. The strategy assumes ability to hold through the CIRP timeline; capital lockup during this period is a real constraint.

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CHAPTER 7 — SECURITIZATION

Question 1 — NBFC Auto Loan Securitization — End-to-End Case Study

Aakash Mehta is the Group CFO of Bajaj Growth Finance Ltd. (BGFL), a mid-sized Non-Banking Financial Company headquartered in Pune with substantial exposure to auto loans. The company's rapid balance sheet growth has stretched its capital adequacy ratio to close to the RBI-mandated minimum, restricting its ability to originate new loans. Aakash has decided to execute a securitization transaction to release capital and reduce cost of funds.

Transaction Parameters:

Parameter	Details
Auto Loan Portfolio Size (Pool)	₹500 crore
Average Loan Tenure	4 years (weighted average)
Average Loan Interest Rate (Yield to BGFL)	12.00% p.a.
Historical Portfolio Default Rate	2.00%
Current Cost of Direct Borrowing (BGFL AA rated)	9.00% p.a.
Target Rating for Securitized Instrument	AA+
Expected Investor Yield on Securitized Instrument	8.00% p.a.
Servicing Fee (BGFL retains as servicer)	0.50% p.a. of outstanding pool
Structuring & Advisory Fees (one-time)	₹2.50 crore
Credit Enhancement — Over-collateralization	10.00% (₹50 crore excess collateral)

Required:

(i) Identify all Primary and Secondary Participants in the proposed securitization transaction.

(ii) Trace the seven-step Securitization Mechanism as applied to BGFL's auto loan portfolio.

(iii) Recommend the appropriate securitization instrument (PTC vs PTS vs Stripped Securities) and justify.

(iv) Quantify the annual benefit to BGFL from the securitization transaction.

(v) Analyze the 10% over-collateralization credit enhancement vs alternative third-party bank LC.

Solution

(i) Primary and Secondary Participants

PRIMARY PARTICIPANTS:

Participant	Party in the Deal	Role
Originator	Bajaj Growth Finance Ltd (BGFL)	Sells the auto loan portfolio to the SPV and receives upfront ₹500 crore. Transfers legal and beneficial interest to SPV.
Special Purpose Vehicle (SPV)	BGFL Auto Loan Trust — Series 2026	Holds legal title to transferred assets. Issues PTCs to investors. Ring-fences assets from BGFL's balance sheet (bankruptcy-remote).
Investors	MFs (HDFC MF, Kotak MF), Insurance (LIC, HDFC Life), Pension funds (EPFO, NPS)	Purchase PTCs issued by SPV. Receive interest and principal repayments.

SECONDARY PARTICIPANTS:

Participant	Party in the Deal	Role
Obligors	~25,000-30,000 individual auto loan borrowers	The underlying borrowers whose EMIs form the cash flow source of the PTCs.
Rating Agency	CRISIL and/or ICRA	Assigns AA+ rating conditional on 10% over-collateralization.

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Participant	Party in the Deal	Role
Receiving and Paying Agent (Servicer)	BGFL (retains role for 0.50% fee)	Continues to collect EMIs and transfer collections to SPV monthly.
Trustee	IDBI Trusteeship Services Ltd	Oversees all parties. Represents investors. Enforces Trust Deed.
Credit Enhancer	BGFL (via 10% over-collateralization)	Absorbs first 10% of losses. Enables AA+ rating.
Structurer/Arranger	Kotak Investment Banking / Axis Capital	Brings parties together; ensures legal, regulatory, tax, accounting compliance.

(ii) Seven-Step Securitization Mechanism

Step 1 — Creation of Pool of Assets

BGFL segregates ₹500 crore of auto loans meeting homogeneity criteria: similar interest rate band (11-13%), similar residual tenure (3-5 years), similar credit quality (CIBIL > 700), geographic diversification across 15 states.

Step 2 — Transfer to SPV

BGFL constitutes the SPV as "BGFL Auto Loan Trust — Series 2026" (registered under the Indian Trusts Act). Legal title transferred to SPV via Trust Deed. TRUE SALE ensures bankruptcy-remoteness from BGFL.

Step 3 — Sale of Securitized Papers

SPV designs Pass-Through Certificates (PTCs) with face value of ₹500 crore (adjusted for 10% over-collateralization). PTCs marketed to institutional investors. AA+ rating from CRISIL/ICRA is critical for institutional acceptability.

Step 4 — Administration of Assets

BGFL as Receiving and Paying Agent (RPA) collects monthly EMIs from 25,000+ borrowers using existing infrastructure. Collections pooled monthly and transferred to SPV. BGFL earns 0.50% p.a. servicing fee.

Step 5 — Recourse to Originator

10% over-collateralization from BGFL provides ₹50 crore first-loss buffer. Beyond this, investors bear residual credit risk. Partial-recourse structure via Credit Enhancement Agreement.

Step 6 — Repayment of Funds

Monthly EMIs distributed to PTC investors as interest (8%) and principal repayments through waterfall: (a) servicing fee to BGFL, (b) trust expenses, (c) interest to investors, (d) principal to investors, (e) residual to BGFL.

Step 7 — Credit Rating of Instruments

CRISIL/ICRA issues AA+ rating on PTCs considering: (a) obligor diversification, (b) 2% historical default rate, (c) 10% over-collateralization providing 5x coverage of expected losses, (d) legal ring-fencing, (e) BGFL's servicing track record. Rating allows PTC pricing at 8% (vs BGFL's own 9% cost of borrowing).

(iii) Recommended Instrument — Pass-Through Certificate (PTC)

Justification for PTC:

(i) Nature of Cash Flows: Auto loans generate predictable, amortising EMI cash flows over 4 years. PTC structure passes all cash flows to investors on pro-rata basis.

(ii) Simplicity and Investor Acceptance: PTCs are the most straightforward securitization structure. Indian institutional investors (LIC, EPFO, MFs) are more comfortable with PTCs than tranched PTS.

(iii) Regulatory Ease: PTCs enjoy well-established treatment under RBI Master Directions on Securitisation of Standard Assets (2021).

(iv) Prepayment Risk Neutrality: Auto loan prepayment is limited in Indian market. PTC's exposure to prepayment risk is modest. Stripped Securities (IO/PO) only appropriate when prepayment is major variable (MBS context).

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(v) BGFL's Objective: Primary goal is capital release, not yield stripping or maturity restructuring. PTC delivers this most efficiently.

(iv) Quantification of Annual Benefit

Interest Spread Analysis:

Component	Amount (₹ crore)	Calculation
Interest earned by SPV from auto loans	60.00	₹500 crore × 12.00%
Interest paid by SPV to investors	(40.00)	₹500 crore × 8.00%
Gross spread retained by BGFL via SPV waterfall	20.00	60 − 40

Total Annual Benefit to BGFL:

Benefit Component	Amount (₹ crore)
Servicing fee (0.50% of ₹500 crore)	2.50
Residual interest spread through waterfall	17.50
Gross Post-Securitization Income	**20.00**
Less: Pre-securitization spread (12% − 9% × 500)	(15.00)
Direct Annual Gain	**5.00**
Less: Amortised structuring cost (₹2.5cr / 4 years)	(0.625)
NET ANNUAL BENEFIT	**4.375**

Additional Non-Quantified Benefits:

- Capital Release: ₹500 crore of RWA moved off-balance-sheet → releases ~₹75 crore Tier 1 capital → supports new lending of ₹500 crore → additional ~₹15 crore income potential.
- Improved Financial Ratios: Debt-Equity ratio improves; ROE improves proportionally.
- Diversification of Funding Sources: BGFL taps mutual fund, insurance, pension fund capital via securitization.

(v) Credit Enhancement — Over-Collateralization vs Bank LC

How 10% Over-Collateralization Works:

BGFL transfers ₹550 crore of loans (₹500 crore PTC face value + ₹50 crore excess). First ₹50 crore of losses absorbed by BGFL's retained tranche. Historical default = 2% = ₹10 crore expected loss → 5x coverage → AA+ rating basis.

Comparison Matrix:

Dimension	Over-Collateralization	Third-Party Bank LC
Cost to BGFL	Opportunity cost of ₹50cr foregone lending (~₹5cr/yr)	LC fee 0.5-1.0% p.a. = ₹2.5-5cr/yr
Rating Impact	Suitable for AA rating (linked to BGFL credit)	Can achieve AAA if LC bank is AAA-rated
Balance Sheet Impact	₹50cr still on BGFL's balance sheet (partial de-recognition)	Cleaner de-recognition; only contingent LC exposure
Speed of Execution	Structural — part of trust deed	Requires separate LC negotiation (2-3 weeks)

Recommendation:

For a FIRST securitization transaction, over-collateralization by BGFL is generally appropriate — signals BGFL's confidence in underwriting quality, establishes market-standard structure, and is less expensive than bank LC over deal life. For subsequent transactions, a hybrid structure (5% BGFL over-collateralization + 5% bank LC from SBI/HDFC) could achieve AAA rating.

Question 2 — PTC vs PTS vs Stripped Securities — Comparative Analysis

HDFC Bank Ltd. proposes to securitize its home loan pool of ₹300 crore. The bank's Treasury team is evaluating three alternative instrument structures per ICAI SM Section 7: Pass-Through Certificate (PTC), Pay-Through Security (PTS),

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and Stripped Securities. As external advisor, you are asked to analyse the cash flow distribution under each structure and recommend the appropriate one.

Pool Data:

Parameter	Details
Pool Size	₹300 crore
Number of Home Loans	3,500 loans
Weighted Average Interest Rate	9.00% p.a. (fixed for simplicity)
Weighted Average Residual Maturity	12 years
Servicing Fee (HDFC retains)	1.00% p.a.
Expected First-Year Principal Amortization	₹30 crore (10% of pool)

Year 1 Pool Cash Flows:

- Total Interest Collected: 9% × ₹300 crore = ₹27 crore
- Total Principal Amortization: ₹30 crore
- Total Pool Cash Inflow: ₹57 crore

Required:

(i) Explain the structural differences between PTC, PTS, and Stripped Securities per ICAI SM Section 7.

(ii) Compute Year 1 cash flows to investors under each of the three alternative structures.

(iii) Identify which investor type is best suited to each instrument.

(iv) Recommend the most appropriate structure for HDFC Bank's home loan securitization and justify.

Solution

(i) Structural Differences

A. Pass-Through Certificate (PTC):

Investors receive a PRO-RATA SHARE of ALL cash flows from the underlying pool as and when collected. Both interest AND principal repayments (including prepayments) flow directly to PTC holders proportional to their holding. The SPV acts as a mere "pass-through" conduit. Investors bear both credit risk AND prepayment risk. The instrument has an unpredictable but declining balance and matures based on actual pool amortization.

B. Pay-Through Security (PTS):

A more structured instrument where the SPV pays a FIXED COUPON to investors regardless of exact pool cash flow timing. Any excess collections over the fixed obligation are RETAINED by the SPV (or diverted to reserve accounts, subordinated tranches, or the originator's retained interest). This provides investors more PREDICTABLE cash flows but less prepayment upside. Structurally similar to a bond — with defined interest rate and maturity.

C. Stripped Securities (IO/PO):

The pool cash flows are split into two separate instruments: (a) Interest-Only (IO) Strip — receives all interest payments from the pool, (b) Principal-Only (PO) Strip — receives all principal payments from the pool. IO investors bet on slower prepayments (interest keeps flowing). PO investors bet on faster prepayments (principal returned sooner at par). This structure caters to investors with specific views on prepayment behavior. Common in the US MBS market.

(ii) Year 1 Cash Flow Distribution to Investors

A. Under PTC Structure:

Cash Flow Component	Amount (₹ crore)	Distribution to Investors
Interest collected	27.00	27.00 (100% to PTC investors)
Principal amortization	30.00	30.00 (100% to PTC investors)
Less: Servicing Fee to HDFC	(3.00)	(1% of ₹300cr)

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Cash Flow Component	Amount (₹ crore)	Distribution to Investors
Net Distribution to PTC Investors (Year 1)	**54.00**	**Interest ₹24cr + Principal ₹30cr**

B. Under PTS Structure (assuming 7.5% fixed coupon on ₹300cr):

Cash Flow Component	Amount (₹ crore)	Comment
Fixed Coupon to PTS Investors	22.50	7.50% × ₹300cr
Scheduled Principal Repayment	30.00	Same amortization
Total Fixed Distribution to Investors	52.50	Interest + Principal
Servicing Fee (HDFC)	3.00	1% of ₹300cr
Excess Retained by SPV/Originator	**1.50**	**27 – 22.5 – 3 = 1.5**
Investor Cash Flow (Year 1)	**52.50**	**Predictable payments**

C. Under Stripped Securities (IO + PO):

Component	Distribution	Investor Class
Interest-Only (IO) Strip	₹24 crore (after ₹3cr servicing)	Investors receive interest as long as pool has principal outstanding
Principal-Only (PO) Strip	**₹30 crore (Year 1 principal)**	**Investors receive scheduled + prepaid principal until fully paid down**
Total Distribution	**₹54 crore**	**Split between two investor classes**

Note: IO holders benefit from SLOW prepayment (interest continues flowing). PO holders benefit from FAST prepayment (principal returned quicker at par vs discounted price at issuance).

(iii) Investor Suitability by Instrument

Instrument	Ideal Investor Profile	Rationale
PTC	Institutional investors seeking market rate returns with acceptance of prepayment risk (MFs, EPFO)	Straightforward structure; participates fully in pool economics; passive exposure
PTS	Insurance companies and pension funds seeking predictable income streams	Fixed coupon matches ALM needs; predictable duration; less prepayment volatility
IO Strip	Investors with view that prepayments will be SLOW; hedge fund arbitrageurs	Value increases if pool amortizes slowly; complex derivative-like exposure
PO Strip	Investors with view that prepayments will be FAST; opportunistic buyers of discounted paper	Fixed face value returned faster; benefit from acceleration of principal

(iv) Recommendation for HDFC Bank

Recommended Structure: Pass-Through Certificate (PTC)

For HDFC Bank's ₹300 crore home loan securitization, PTC is the appropriate choice for the following reasons:

(i) Indian Market Depth: PTCs dominate the Indian securitization market (over 85% of PSL Direct Assignment/PTC issuance per ICRA data). Standardised structure reduces marketing effort and time-to-close.

(ii) Regulatory Framework: RBI Master Direction on Securitisation of Standard Assets (2021) provides clear regulatory framework for PTCs including MRR (Minimum Retention Requirement) and MHP (Minimum Holding Period).

(iii) Priority Sector Lending: Housing loans qualify as PSL. Purchase by other banks satisfies their PSL targets — creates natural buyer base for PTCs.

(iv) Prepayment Risk in Indian Housing: Actual prepayment in Indian home loans is modest (5-8% CPR typical). This is manageable within PTC's pass-through mechanism without needing IO/PO complexity.

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(v) Stripped Securities Unavailability: The Indian securitization market has virtually no IO/PO trading infrastructure. Stripped Securities are largely US MBS market instruments. Not suitable for Indian issuance.

(vi) PTS Considerations: PTS could work but requires more complex documentation and reserve account maintenance. Not worth the marginal benefit given PTC's dominance.

Question 3 — Waterfall Tranching Structure and Loss Absorption

State Bank of India Ltd. proposes to securitize a ₹1,000 crore home loan portfolio using a tranched structure with three risk classes. The Treasury team has designed a Senior/Mezzanine/Junior tranche structure and requests your analysis of the waterfall mechanics and loss absorption capacity under different credit scenarios.

Tranche Structure:

Tranche	Face Value	Rating	Coupon Rate	% of Pool
Senior Tranche	₹700 crore	AAA	8.00% p.a.	70%
Mezzanine Tranche	₹200 crore	A	11.00% p.a.	20%
Junior (Equity) Tranche	₹100 crore	Unrated	Residual (variable)	10%
Total Pool	**₹1,000 crore**			**100%**

Pool Year 1 Cash Flows (Before Losses):

- Total Interest Collected: 9% × ₹1,000 crore = ₹90 crore
- Total Principal Amortization: ₹100 crore (10% of pool)
- Total Pool Cash Inflow (Before Losses): ₹190 crore
- Servicing Fee: 0.50% × ₹1,000 crore = ₹5 crore

Three Loss Scenarios to Analyze:

- Base Case: 0% loss (no defaults) — expected/best-case
- Adverse Case: 5% pool loss = ₹50 crore of expected principal not received
- Severe Case: 12% pool loss = ₹120 crore of expected principal not received

Required:

(i) Explain the concept of tranching and the waterfall priority mechanism used in securitization.

(ii) Compute Year 1 cash flows to each tranche under the BASE CASE (0% loss).

(iii) Compute Year 1 cash flows and loss absorption under the ADVERSE CASE (5% pool loss).

(iv) Compute Year 1 cash flows and loss absorption under the SEVERE CASE (12% pool loss).

(v) Discuss which type of investor is suited to each tranche and how the tranched structure enables risk-based pricing.

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Solution

(i) Tranching Concept and Waterfall Priority

Tranching (or Structural Subordination):

The pool cash flows are divided into multiple securities (tranches) with different risk-return profiles. The SENIOR tranche has first claim on cash flows and thus lowest risk (highest rating, lowest yield). The MEZZANINE tranche has secondary claim (medium risk, medium yield). The JUNIOR/EQUITY tranche receives only what remains after Senior and Mezzanine claims — first to absorb losses (highest risk, highest expected return).

Waterfall Priority Order:

Priority	Payment Item
1st	Servicing Fee (top of waterfall)
2nd	Senior Tranche Interest

Priority	Payment Item
3rd	Mezzanine Tranche Interest
4th	Senior Tranche Principal
5th	Mezzanine Tranche Principal
6th	Junior Tranche Distributions (residual)

Losses are absorbed in REVERSE ORDER of priority — Junior first, then Mezzanine, then Senior. This creates "credit enhancement" for Senior via structural subordination of lower tranches.

(ii) Base Case — 0% Loss

Available Cash after Servicing: ₹190 – ₹5 = ₹185 crore

Waterfall Item	Required (₹ cr)	Paid (₹ cr)	Balance (₹ cr)
Available after Servicing			185.00
Senior Interest (8% × ₹700cr)	56.00	56.00	129.00
Mezzanine Interest (11% × ₹200cr)	22.00	22.00	107.00
Senior Principal (70% × ₹100cr amortization)	70.00	70.00	37.00
Mezzanine Principal (20% × ₹100cr)	20.00	20.00	17.00
Junior Principal + Residual (10% × ₹100cr = ₹10cr principal + ₹7cr surplus)	17.00	17.00	0.00

Base Case Result: All tranches receive full contractual payments. Junior tranche receives ₹17 crore (including ₹7 crore residual surplus).

(iii) Adverse Case — 5% Loss (₹50 crore)

Available Cash after Losses: ₹190 – ₹50 = ₹140 crore

After Servicing Fee: ₹140 – ₹5 = ₹135 crore

Waterfall Item	Required (₹ cr)	Paid (₹ cr)	Balance (₹ cr)
Available after Servicing			135.00
Senior Interest	56.00	56.00	79.00
Mezzanine Interest	22.00	22.00	57.00
Senior Principal	70.00	57.00	0.00
Mezzanine Principal	20.00	0.00	0.00
Junior Distributions	17.00	0.00	0.00

Loss Absorption Analysis (Adverse Case):

Tranche	Contractual Payment (₹ cr)	Received (₹ cr)	Shortfall (₹ cr)	% Loss on Tranche
Senior (₹700 cr face)	126.00 (Int + Principal)	113.00	13.00	1.86% (principal shortfall)
Mezzanine (₹200 cr face)	42.00	22.00	20.00	10.00% (full principal loss)
Junior (₹100 cr face)	17.00	0.00	17.00	100.00% (fully wiped out)

In the Adverse Case, the ₹50 crore loss cascades up the tranches: Junior loses full ₹17 crore expected distribution + its principal share of ₹10 crore. Mezzanine loses its entire ₹20 crore principal share. Senior faces a small ₹13 crore principal shortfall (carried forward to next year in real deal, but shown here as immediate impact).

(iv) Severe Case — 12% Loss (₹120 crore)

Available Cash after Losses: ₹190 – ₹120 = ₹70 crore

After Servicing Fee: ₹70 – ₹5 = ₹65 crore

Waterfall Item	Required (₹ cr)	Paid (₹ cr)	Balance (₹ cr)
Available after Servicing			65.00

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Waterfall Item	Required (₹ cr)	Paid (₹ cr)	Balance (₹ cr)
Senior Interest	56.00	56.00	9.00
Mezzanine Interest	22.00	9.00	0.00
Senior Principal	70.00	0.00	0.00
Mezzanine Principal	20.00	0.00	0.00
Junior Distributions	17.00	0.00	0.00

Loss Absorption Analysis (Severe Case):

Tranche	Contractual (₹ cr)	Received (₹ cr)	% Loss on Tranche
Senior	126.00	56.00	10.00% principal loss (₹70cr)
Mezzanine	42.00	9.00	78.6% loss (partial interest only)
Junior	17.00	0.00	100% (fully wiped out)

In the Severe Case, losses cascade through Junior (100% wiped), Mezzanine (near-total loss), and BEGIN to impact Senior (principal not paid this year, ₹70 crore shortfall). Senior's AAA rating is threatened at this loss level. This is why the tranche sizing (₹700/200/100) is designed such that reasonable expected losses (2-5%) are absorbed by Junior alone, protecting Senior's rating.

(v) Investor Suitability and Risk-Based Pricing

Tranche	Coupon	Ideal Investor	Rationale
Senior (AAA)	8.0%	Insurance companies, pension funds, PSL-seeking banks	AAA-rating meets regulatory investment requirements; predictable cash flows for ALM
Mezzanine (A)	11.0%	Mutual funds, private banks, wealth management for HNIs	Higher yield compensates for moderate credit risk; still investment grade
Junior (Unrated)	Residual	AIF Category III, hedge funds, originator retention	First-loss capital; equity-like returns in good scenarios; total loss in stress scenarios

How Tranching Enables Risk-Based Pricing:

By creating multiple risk classes, tranching allows the pool's overall economics to be sold at different prices to different investors matched to their risk appetite. Total yield paid by the pool = weighted average of tranche yields. Investors self-select into the tranche matching their mandate. Senior investors accept low yield in exchange for AAA rating and structural protection. Junior investors accept concentrated risk in exchange for equity-like returns. The originator (SBI) can retain the Junior tranche as a first-loss buffer, which also satisfies RBI's MRR (Minimum Retention Requirement) of 5-10% of pool value.

Question 4 — Weighted Average Life (WAL) and Prepayment Impact

ICICI Bank has securitized a home loan pool of ₹500 crore and issued a Pass-Through Certificate. The instrument has a projected principal repayment schedule but faces prepayment risk — one of the key "problems in securitization" per ICAI SM Section 6. Sanjay Gupta, an investor considering purchase, asks you to compute the Weighted Average Life (WAL) of the instrument under two scenarios: (a) scheduled repayment (no prepayment), and (b) with 20% prepayment in Year 1.

Scheduled Principal Repayment (No Prepayment):

Year	Scheduled Principal Repayment (₹ crore)
1	100
2	125
3	100
4	100
5	75

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Year	Scheduled Principal Repayment (₹ crore)
Total	500

Scenario B — With 20% Prepayment in Year 1:

An additional 20% of Year 1 opening balance (₹100 crore) is prepaid in Year 1, reducing pool balance faster and shifting all future repayments earlier.

Required:

(i) Define Weighted Average Life (WAL) and explain its importance for securitization investors.

(ii) Compute the WAL of the PTC under the scheduled repayment schedule (no prepayment).

(iii) Recompute the WAL assuming 20% prepayment in Year 1 (₹100 crore additional prepayment).

(iv) Discuss the impact of prepayment risk on investor yield and the challenges it poses for fixed-income portfolio management.

Solution

(i) Weighted Average Life (WAL) — Concept

Definition:

Weighted Average Life is the WEIGHTED AVERAGE TIME UNTIL PRINCIPAL REPAYMENT, using each principal repayment amount as the weight and the time of repayment as the value. Formally:

WAL = Σ (Time × Principal Repayment at that Time) / Total Principal

Importance to Securitization Investors:

- Duration Proxy: WAL serves as an approximate duration measure for amortising securities, useful for interest-rate risk management.
- Yield Calculation: Bond pricing conventions use WAL as the effective maturity for yield-to-WAL calculations, especially for MBS/ABS.
- Portfolio Duration Matching: Insurance companies and pension funds use WAL to match asset duration to liability duration.
- Prepayment Sensitivity: WAL changes with prepayment assumptions — comparing WAL under different scenarios exposes the instrument's prepayment risk.

(ii) WAL under Scheduled Repayment

Year (t)	Principal Repayment (₹ crore)	Time × Principal (t × P)
1	100	1 × 100 = 100
2	125	2 × 125 = 250
3	100	3 × 100 = 300
4	100	4 × 100 = 400
5	75	5 × 75 = 375
Sum	**500**	**1,425**

WAL = Σ (t × P) / Σ P = 1,425 / 500 = 2.85 years

The scheduled WAL of 2.85 years reflects the weighted average time until the average rupee of principal is returned to investors.

(iii) WAL with 20% Prepayment in Year 1

Revised Repayment Schedule:

Year 1 total repayment = Scheduled ₹100 crore + Additional 20% × ₹500 crore = ₹100 + ₹100 = ₹200 crore

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The additional ₹100 crore prepayment in Year 1 reduces the remaining pool balance, and future scheduled repayments accelerate proportionally. For simplicity, assume the remaining ₹300 crore (₹500cr − ₹200cr) is repaid over Years 2-5 in the same proportional pattern as the original schedule.

Original scheduled Years 2-5 sum = ₹400 crore. Scaled to remaining pool of ₹300 crore, scale factor = 300/400 = 0.75.

Year (t)	Original Schedule (₹ crore)	Scale Factor	Revised Principal (₹ crore)	t × P
1	100 + 100 prepay = 200	1.00	200	200
2	125	0.75	93.75	187.50
3	100	0.75	75.00	225.00
4	100	0.75	75.00	300.00
5	75	0.75	56.25	281.25
Sum			**500.00**	**1,193.75**

WAL with Prepayment = 1,193.75 / 500 = 2.39 years

Impact of Prepayment on WAL:

- WAL reduced from 2.85 years → 2.39 years (about 46 days shorter)
- Reduction magnitude: 16.1% shorter WAL
- Principal returned to investors faster than originally expected

(iv) Impact on Investor Yield and Portfolio Management

A. Yield Impact for Investors:

When the PTC was priced at issuance, investors expected to earn a yield over 2.85 years WAL. With prepayment shortening WAL to 2.39 years:

(i) Reinvestment Risk: Investors receive principal earlier and must reinvest at prevailing (possibly lower) interest rates. If interest rates have fallen since issuance, the reinvestment yield is lower — reducing effective compounded return.

(ii) Premium Amortization Risk: If the PTC was purchased at a premium (above par) expecting to earn interest over 2.85 years, prepayment accelerates principal return at par. The unamortized premium becomes a capital loss faster than expected — hitting the yield.

(iii) Discount Accretion Benefit: Conversely, if PTC was purchased at a discount, prepayment accelerates the return of face value — benefiting the discount investor via faster accretion.

B. Portfolio Management Challenges:

(i) Duration Mismatch: Insurance companies and pension funds set asset duration to match liability duration. Prepayment risk creates duration uncertainty, forcing hedging via interest rate derivatives.

(ii) Cash Flow Predictability: Institutional investors need predictable cash flows for liability matching. Prepayment volatility disrupts this — leading to preference for callable-bond-like structures or PTS over pure PTCs.

(iii) Portfolio Concentration Limits: Regulatory position limits on any single security may be exceeded if reinvestment happens back into the same underlying pool via new PTCs.

(iv) Structural Solutions: Some deals include Prepayment Protection (lockout periods where prepayment is restricted or penalised), yield maintenance charges, or Sequential-Pay structures where prepayments retire the shortest tranche first.

C. Indian Market Prepayment Reality:

Home loan prepayment in India has historically been modest (5-10% CPR — Constant Prepayment Rate). Reasons include: (a) SEBI/RBI rules eliminated home loan prepayment penalties in 2011, (b) rising interest rate environments reduce refinancing benefit, (c) Indian consumer behavior favors reducing debt when surplus funds are available.

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However, prepayment can spike in falling interest rate environments — as happened in India during 2020-21 COVID-era rate cuts. Sanjay should model 15-25% prepayment scenarios as stress cases.

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CHAPTER 8 — MUTUAL FUNDS

Question 1 — Comprehensive Mutual Fund Return Analysis

Kavita Iyer, 32, is a Senior Software Engineer at Wipro Ltd. in Bengaluru. On 1st April 2024, she invested ₹5,00,000 in the Regular Plan of "SBI Bharat Prosperity Fund" — an actively managed diversified equity mutual fund scheme. Kavita held the investment for exactly 3 years and redeemed on 31st March 2027. She wants a comprehensive analysis of her returns and a comparison with what she would have earned had she opted for the Direct Plan instead.

Fund and Investment Data (Regular Plan):

Parameter	Details
Fund Name	SBI Bharat Prosperity Fund
Face Value per Unit	₹10
NAV on 1-Apr-2024 (Purchase Date)	₹40.00
Amount Invested by Kavita	₹5,00,000
Entry Load (Regular Plan)	2.00%
Investment Horizon	3 years (Redemption on 31-Mar-2027)
Exit Load at end of Year 3	0.00% (waived after 12 months)

Fund Performance during Kavita's Holding Period:

Period	NAV at Year End (Cum-Dividend)	Dividend Declared per Unit	NAV Post-Dividend (Ex-Dividend)
Year 1 (End 31-Mar-2025)	₹48.00	₹4.00	₹44.00
Year 2 (End 31-Mar-2026)	₹56.00	₹5.00	₹51.00
Year 3 (End 31-Mar-2027)	₹65.00	₹6.00	₹59.00 (redemption NAV)

Direct Plan Data (for comparison):

- Entry Load (Direct Plan): 0.00% (per SEBI Direct Plan framework)
- Total Expense Ratio (TER) differential: Direct plan is 0.50% p.a. LOWER than Regular Plan
- Assumption: This TER differential translates to Direct Plan NAV outperformance of 0.50% per year

Required:

(i) Compute Kavita's effective purchase price per unit (including entry load) and the number of units allotted at IPO under the Regular Plan.

(ii) Compute the Holding Period Return over 3 years assuming all dividends are received as cash (no reinvestment) and the fund is redeemed at Year 3 ex-dividend NAV.

(iii) Compute the annualized return (CAGR) using the IRR method, considering the timing of dividend cash flows and the terminal redemption.

(iv) Recompute the return assuming all dividends were reinvested in additional units at the ex-dividend NAV each year (i.e., under the Dividend Reinvestment Plan option).

(v) Compute Kavita's return under the Direct Plan (no entry load, 0.5% higher NAV growth per year due to lower TER) assuming dividends are reinvested. Compare with the Regular Plan reinvestment return.

(vi) Apply the r_2 formula, If Kavita could have earned 14% p.a. by investing directly in equity shares, what return should the mutual fund earn to give her a net return of 14%? Assume Regular Plan initial expenses = 2% and annual recurring expenses = 2%.

Solution

(i) Effective Purchase Price and Units Allotted (Regular Plan)

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Effective Purchase Price = NAV × (1 + Entry Load)

Effective Purchase Price = ₹40 × (1 + 0.02) = ₹40 × 1.02 = ₹40.80

Number of Units Allotted:

Units = Investment Amount / Effective Purchase Price

Units = ₹5,00,000 / ₹40.80 = 12,254.90 units

Kavita is allotted 12,254.90 units on 1-Apr-2024. The 2% entry load of ₹10,000 is retained by the AMC as distributor commission — a key differentiator versus the Direct Plan.

(ii) Holding Period Return (No Reinvestment)

Total Dividend Received over 3 years:

Year	Dividend per Unit (₹)	Units Held	Dividend Received (₹)
1	4.00	12,254.90	49,019.60
2	5.00	12,254.90	61,274.50
3	6.00	12,254.90	73,529.40
Total Dividends			**1,83,823.50**

Redemption Value on 31-Mar-2027:

Redemption NAV (ex-dividend Year 3) = ₹59.00

Redemption Value = 12,254.90 × ₹59.00 = ₹7,23,039.10

Total Wealth at End (Dividends + Redemption):

Total = ₹1,83,823.50 + ₹7,23,039.10 = ₹9,06,862.60

Total Gain over 3 Years:

Gain = ₹9,06,862.60 − ₹5,00,000 = ₹4,06,862.60

Holding Period Return (HPR):

HPR = Total Gain / Investment = ₹4,06,862.60 / ₹5,00,000

HPR = 81.37%

(iii) Annualized Return using IRR Method

Compute the IRR that equates the PV of cash inflows to the initial ₹5,00,000 outflow:

Time	Cash Flow (₹)	Description
0 (Purchase)	−5,00,000	Initial investment
Year 1	+ 49,019.60	Dividend received
Year 2	+ 61,274.50	Dividend received
Year 3	+ 7,96,568.50	Dividend ₹73,529.40 + Redemption ₹7,23,039.10

Trial at r = 23%:

PV Y1: 49,019.60 / 1.23 = 39,853

PV Y2: 61,274.50 / 1.5129 = 40,502

PV Y3: 7,96,568.50 / 1.8609 = 4,28,060

Sum of PVs = 5,08,415 → Higher than investment ₹5,00,000 → IRR > 23%

Trial at r = 24%:

PV Y1: 49,019.60 / 1.24 = 39,532

PV Y2: 61,274.50 / 1.5376 = 39,850

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PV Y3: 7,96,568.50 / 1.9066 = 4,17,762

Sum of PVs = 4,97,144 → Lower than investment ₹5,00,000 → IRR < 24%

Interpolation between 23% and 24%:

At 23%: Excess = 5,08,415 − 5,00,000 = + ₹8,415

At 24%: Excess = 4,97,144 − 5,00,000 = − ₹2,856

IRR = 23% + [8,415 / (8,415 + 2,856)] × 1%

= 23% + 0.747% = 23.75%

(iv) Return with Dividend Reinvestment

If dividends are reinvested each year at the ex-dividend NAV, Kavita accumulates additional units:

Year	Units at Start	Dividend Received (₹)	Ex-Div NAV (₹)	Additional Units	Units at End
1	12,254.90	49,019.60	44.00	49,019.60/44 = 1,114.08	13,368.98
2	13,368.98	66,844.90	51.00	66,844.90/51 = 1,310.68	14,679.66
3	14,679.66	88,077.96	59.00	88,077.96/59 = 1,492.85	16,172.51

Terminal Wealth Under Dividend Reinvestment Plan:

Redemption Value = 16,172.51 units × ₹59 = ₹9,54,178.09

Holding Period Return (Reinvestment):

HPR = (9,54,178.09 − 5,00,000) / 5,00,000 = 4,54,178.09 / 5,00,000

HPR = 90.84%

Annualized Return (CAGR) under Reinvestment:

CAGR = (9,54,178.09 / 5,00,000)^(1/3) − 1

= (1.908356)^(1/3) − 1

= 1.2405 − 1

= 24.05% p.a.

The reinvestment approach adds ₹47,316 to terminal wealth versus cash dividends (₹9,54,178 vs ₹9,06,863) — a compounding benefit worth about 90 bps of CAGR.

(v) Direct Plan Comparison

Direct Plan Advantages (per SEBI framework):

- No entry load: Full ₹5,00,000 invested → 5,00,000 / ₹40 = 12,500 units at start (vs 12,254.90 in Regular)
- Lower TER by 0.50% p.a. → NAV growth 0.50% higher each year

Direct Plan NAV Trajectory (0.5% p.a. NAV uplift):

Period	Regular NAV	Direct NAV (0.5% uplift)
Year 1 End (Cum-Div)	₹48.00	₹48.00 × 1.005 = ₹48.24
Year 1 Ex-Div (Direct div: same ₹4)	₹44.00	₹48.24 − ₹4 = ₹44.24
Year 2 End (Cum-Div, +0.5% additional)	₹56.00	₹56.00 × 1.010 (cumulative) = ₹56.56
Year 2 Ex-Div	₹51.00	₹56.56 − ₹5 = ₹51.56
Year 3 End (Cum-Div)	₹65.00	₹65.00 × 1.015 = ₹65.98
Year 3 Ex-Div (Redemption)	₹59.00	₹65.98 − ₹6 = ₹59.98

Direct Plan with Dividend Reinvestment:

Year	Units at Start	Dividend Received (₹)	Ex-Div NAV (₹)	Additional Units	Units at End
1	12,500.00	50,000.00	44.24	1,130.20	13,630.20

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Year	Units at Start	Dividend Received (₹)	Ex-Div NAV (₹)	Additional Units	Units at End
2	13,630.20	68,151.00	51.56	1,321.78	14,951.98
3	14,951.98	89,711.88	59.98	1,495.70	16,447.68

Direct Plan Terminal Wealth:

Redemption Value = 16,447.68 × ₹59.98 = ₹9,86,533.85

HPR (Direct) = (9,86,533.85 − 5,00,000) / 5,00,000 = 97.31%

CAGR (Direct) = (9,86,533.85 / 5,00,000)^(1/3) − 1 = (1.973068)^(1/3) − 1 = 25.44%

Direct vs Regular Plan Comparison:

Metric	Regular Plan	Direct Plan	Direct Advantage
Units at IPO	12,254.90	12,500.00	+245.10 units
Terminal Wealth	₹9,54,178	₹9,86,534	+₹32,356
HPR (3 years)	90.84%	97.31%	+6.47 pp
CAGR	24.05%	25.44%	+1.39 pp

Recommendation:

The Direct Plan produces ₹32,356 higher terminal wealth over 3 years for the same investment — an economically meaningful advantage compounding over longer horizons. Since Kavita is an informed investor who does not need distributor advisory support (she is a Wipro engineer capable of independent research), she should have chosen the Direct Plan. For future investments, she should route through KFinTech/CAMS directly or via a fee-based investment advisor rather than a distributor. Over a longer 20-year retirement horizon, the 1.39 pp CAGR differential would compound to a materially larger wealth gap (roughly 25-30% higher terminal wealth in the Direct Plan).

(vi) Application of the r_2 Formula

r_2 = [1 / (1 − initial expenses)] × r_1 + recurring expenses

Where:

- r_1 = Return the investor needs (what she could earn directly) = 14%
- Initial Expenses = Entry Load equivalent = 2%
- Recurring Expenses = Annual TER = 2%

Substituting:

r_2 = [1 / (1 − 0.02)] × 0.14 + 0.02

= [1 / 0.98] × 0.14 + 0.02

= 1.02041 × 0.14 + 0.02

= 0.14286 + 0.02

= 0.16286

r_2 = 16.29% per annum

Interpretation:

For Kavita to net a 14% return through the mutual fund (equivalent to what she could earn on her own in equities), the fund's underlying portfolio must earn 16.29% per annum before expenses. The 229 basis point gap between 14% (investor return needed) and 16.29% (fund gross return needed) reflects the combined drag of 2% initial expenses and 2% annual recurring expenses. If the fund cannot consistently earn 16.29% p.a. (which is challenging in the long run), Kavita is better off investing directly.

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This calculation strongly supports the case for the Direct Plan analysed in Part (v): the Direct Plan effectively reduces the recurring expense by 0.5%, bringing the required fund gross return down from 16.29% to approximately 15.79% — a materially easier bar for the fund manager to clear.

Question 2 — NAV Computation of Skyline Prosperity Fund

Skyline Mutual Fund Ltd. launched "Skyline Prosperity Fund" — a balanced hybrid scheme — on 1st April 2025. The scheme issued 14,00,000 units at Face Value of ₹10 each without any entry load, raising a total of ₹1,40,00,000. The AMC deployed the entire corpus across seven asset categories following the balanced fund mandate. You are appointed as the External Auditor for the scheme and must compute the Net Asset Value (NAV) as on 31st March 2026 following prescribed valuation principles.

Portfolio Investments as on 1st April 2025 (At Cost):

Sr. No.	Asset	Cost (₹)	
1	50,000 equity shares of ABC Ltd. @ ₹120 per share	60,00,000	
2	20,000 equity shares of XYZ Ltd. @ ₹150 per share	30,00,000	
3	7% Central Government Securities (Face Value ₹15,00,000)	15,00,000	
4	8% Listed Debentures of MRF Ltd. (Face Value)	12,00,000	
5	10% Unlisted Debentures of Riverdale Estates Ltd.	10,00,000	
6	6% Bank Fixed Deposits (1-year, cumulative)	8,00,000	
7	Cash and cash equivalents	5,00,000	
TOTAL (Matches units issued × face value)			**1,40,00,000**

Transactions and Income During the Year (1-Apr-2025 to 31-Mar-2026):

Item	Details	Amount (₹)
Dividend received on ABC Ltd.	50,000 shares × ₹5 per share	2,50,000
Dividend received on XYZ Ltd.	20,000 shares × ₹6 per share	1,20,000
Interest on 7% G-Sec	7% × ₹15,00,000 (Face Value)	1,05,000
Interest on 8% Listed Debentures	8% × ₹12,00,000 (Face Value)	96,000
Interest on 10% Unlisted Debentures	10% × ₹10,00,000 (Face Value)	1,00,000
Interest on 6% Bank Fixed Deposits	6% × ₹8,00,000 (accrued, not withdrawn)	48,000
Operating expenses paid (custodian, audit, management)	During the year	5,00,000

Year-End Market Data (as on 31st March 2026):

Asset	Valuation Basis	Details
ABC Ltd. Equity Shares	Marked-to-market (quoted)	₹180 per share
XYZ Ltd. Equity Shares	Marked-to-market (quoted)	₹200 per share
7% G-Sec (Listed)	Quoted price % of Face Value	96% of Face Value
8% Listed Debentures (MRF)	Quoted price % of Face Value	92% of Face Value
10% Unlisted Debentures	At cost less diminution in value	20% diminution
Bank Fixed Deposits	At face value (still invested)	₹8,00,000 (unchanged)
Cash and equivalents	At face value	To be computed

Required:

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(i) Compute the total income earned during the year (dividends plus interest).

(ii) Compute the net cash and cash equivalents balance as at 31st March 2026.

(iii) Compute the Net Asset Value (NAV) per unit of Skyline Prosperity Fund as on 31st March 2026 (before any dividend distribution).

(iv) Compute the revised NAV per unit if Skyline had distributed a dividend of ₹0.50 per unit to unit-holders during the year.

(v) Ms. Anita, a retail investor, purchased 1,000 units at the initial public offer on 1-Apr-2025 and continues to hold them on 31-Mar-2026. Compute her Holding Period Return (a) if no dividend was distributed, and (b) if the ₹0.50 dividend was distributed. Explain why both returns are identical.

(vi) Briefly explain the valuation principles applied to each asset category.

Solution

(i) Total Income Earned during the Year

Income Source	Amount (₹)
Dividend on ABC Ltd. (50,000 × ₹5)	2,50,000
Dividend on XYZ Ltd. (20,000 × ₹6)	1,20,000
Sub-total Dividends	**3,70,000**
Interest on 7% G-Sec	1,05,000
Interest on 8% Listed Debentures	96,000
Interest on 10% Unlisted Debentures	1,00,000
Interest on 6% Bank Fixed Deposits	48,000
Sub-total Interest	**3,49,000**
TOTAL INCOME EARNED	**7,19,000**

(ii) Net Cash Balance as on 31st March 2026

Item	Amount (₹)
Opening cash and equivalents (1-Apr-2025)	5,00,000
Add: Total income received in cash during year	+ 7,19,000
Less: Operating expenses paid during year	**– 5,00,000**
NET CASH AND EQUIVALENTS AT YEAR-END	**7,19,000**

Note: The 6% interest on Bank Fixed Deposits (₹48,000) is included in income received in cash. The Bank Deposits themselves (₹8,00,000 principal) remain invested and are separately shown as an asset at year-end. Since the deposits are cumulative with accrued interest already receipted, they carry no additional accrued interest as at 31-Mar-2026.

(iii) NAV per Unit as on 31st March 2026

Compute total assets at market/prescribed values:

Asset	Basis of Valuation	Computation	Value (₹)
ABC Ltd. Equity	Market Price	50,000 × ₹180	90,00,000
XYZ Ltd. Equity	Market Price	20,000 × ₹200	40,00,000
7% G-Sec	Quoted % of Face Value	96% × ₹15,00,000	14,40,000
8% Listed Debentures	Quoted % of Face Value	92% × ₹12,00,000	11,04,000
10% Unlisted Debentures	Cost less 20% Diminution	₹10,00,000 × (1 − 0.20)	8,00,000
Bank Fixed Deposits	At Face Value (unchanged)	As given	8,00,000

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Asset	Basis of Valuation	Computation	Value (₹)		
Cash and Equivalents	At Face Value (from Part ii)	As computed	7,19,000		
TOTAL ASSET VALUE					**1,78,63,000**

NAV per Unit Computation:

Total Asset Value = ₹1,78,63,000

Number of Units Outstanding = 14,00,000

NAV per Unit = ₹1,78,63,000 / 14,00,000 = ₹12.7593 ≈ ₹12.76

(iv) Revised NAV per Unit After Dividend Distribution of ₹0.50 per Unit

Total Dividend Distributed:

= ₹0.50 per unit × 14,00,000 units = ₹7,00,000

Verification of Distribution Capacity:

Distributable Income = Total Income earned during year = ₹7,19,000

Dividend proposed = ₹7,00,000

Dividend as % of income = 7,00,000 / 7,19,000 ≈ 97.4% (within distributable limits) ✓

Revised NAV Computation:

Total Assets before Distribution = ₹1,78,63,000

Less: Dividend Distribution = ₹7,00,000

Net Assets after Distribution = ₹1,71,63,000

Number of Units Outstanding (unchanged) = 14,00,000

Revised NAV per Unit = ₹1,71,63,000 / 14,00,000 = ₹12.2593 ≈ ₹12.26

(v) Investor Return — Ms. Anita's 1,000 Units

Case (a): No Dividend Distribution

Investment Cost = 1,000 units × ₹10 = ₹10,000

Value at Year-End = 1,000 × ₹12.76 = ₹12,760

Gain = ₹12,760 − ₹10,000 = ₹2,760

Holding Period Return (a) = ₹2,760 / ₹10,000 = 27.60%

Case (b): Dividend of ₹0.50 per Unit Distributed

Investment Cost = ₹10,000 (same)

Value at Year-End = 1,000 × ₹12.26 = ₹12,260

Dividend Received = 1,000 × ₹0.50 = ₹500

Total Wealth = ₹12,260 + ₹500 = ₹12,760

Holding Period Return (b) = (₹12,760 − ₹10,000) / ₹10,000 = 27.60%

Why Both Returns Are Identical:

Dividend distribution does NOT create new value for the investor — it simply transfers value from the fund's NAV to the investor's cash. The reduction in NAV by ₹0.50 per unit exactly matches the ₹0.50 cash dividend received. Whether the investor accumulates value in the NAV or receives part of it as cash dividend, the TOTAL WEALTH remains identical. This is a fundamental principle in mutual fund investing — dividends from equity mutual funds are NOT extra returns, but rather a return of the investor's own money in cash form. The choice between Growth Plan (no dividend, NAV

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appreciation) and Dividend Payout Plan (regular dividend) should therefore be based on the investor's cash flow needs and tax considerations, not on "return" comparisons.

(vi) Valuation Principles Applied

Traded / Quoted Equity Shares — At Market Price (MTM)

ABC Ltd. and XYZ Ltd. shares are listed and actively traded. As per SEBI (Mutual Funds) Regulations, listed equity shares are valued at the latest closing market price on the valuation date. This principle marks the equity portion of the portfolio to current market realities and captures both realized gains as well as unrealized appreciation/depreciation.

Listed Debt Instruments — At Quoted Price % of Face Value

The 7% Central Government Securities (traded on the WDM segment of NSE/BSE) and the 8% MRF Listed Debentures are valued at the closing quoted price expressed as a percentage of face value. In this case: G-Sec at 96%, MRF Debentures at 92%. This captures the interest rate risk impact — since both instruments are quoted below par, market yields have risen since acquisition.

Unlisted Debt Instruments — At Cost Less Diminution

The 10% Unlisted Debentures of Riverdale Estates cannot be marked to market due to lack of quoted prices. Per SEBI (Mutual Funds) Regulations, unlisted debt is valued at cost less an assessed diminution in value. The 20% diminution here reflects credit deterioration and/or lack of marketability. This conservative approach prevents overstating the NAV when unlisted holdings deteriorate in credit quality.

Bank Fixed Deposits — At Face Value

Bank Fixed Deposits are valued at face value (principal amount) since they are held to maturity and the credit risk of scheduled commercial banks is treated as minimal. Interest accrued but not yet received would be added separately, but in this case interest is already receipted in cash.

Cash and Cash Equivalents — At Face Value

Cash balances and equivalents (savings bank, current account, T-bills < 91 days) are valued at face value / carrying amount. No mark-to-market adjustment is required due to their liquid, short-term nature.

Question 3 — Open-Ended MF Scheme with Dividend Equalization

HDFC Mutual Fund AMC operates the "HDFC Bharat Vikas Fund" — an open-ended equity scheme. Ranjana Krishnamurthy, the Fund Accountant, needs to compute the issue price, repurchase price, and end-of-quarter NAV for the first quarter of FY 2025-26. The scheme experienced two transactions during the quarter and distributed a Q1 dividend.

Opening Position (1st April 2025):

Parameter	Value
Outstanding Units	400 lakh
Opening NAV per Unit	₹25.00
Opening Assets Under Management (AUM)	400 × 25 = ₹10,000 lakh

Portfolio Performance during Q1 (April-June 2025):

- Portfolio value appreciation for the quarter: ₹500 lakh
- Income earned during April: ₹30 lakh (dividends + interest)
- Income earned during May: ₹36 lakh
- Income earned during June: ₹44 lakh
- Total income earned in Q1: ₹110 lakh

Transactions during Q1:

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Transaction Date	Event	Details
End of April	New Issuance	10 lakh units issued at opening NAV plus 2% entry load, adjusted for dividend equalization
End of May	Repurchase	5 lakh units repurchased at opening NAV less 1.5% exit load, adjusted for dividend equalization
End of June	Dividend Distribution	65% of Q1 income distributed to unit-holders

Required:

(i) Compute the issue price per unit at the end of April.

(ii) Compute the repurchase price per unit at the end of May.

(iii) Compute the income available for distribution at the end of June and the amount distributed as dividend.

(iv) Compute the NAV per unit as on 30th June 2025 (post dividend distribution).

(v) Ms. Vandana Rai held 20 lakh units on 1st April 2025 and continued to hold them throughout the quarter. Compute her holding period return and annualised return.

(vi) Briefly explain the purpose of dividend equalization in mutual fund accounting.

Solution

(i) Issue Price per Unit at End of April

Issue Price = (Opening NAV + Dividend Equalization per Unit) × (1 + Entry Load)

Dividend Equalization at End of April:

Dividend Equalization = April income / Existing units at end of April

= ₹30 lakh / 400 lakh units

= ₹0.075 per unit

Issue Price Computation:

Issue Price = (₹25.00 + ₹0.075) + Entry Load

= ₹25.075 + 0.075

= ₹25.575

≈ ₹25.58 per unit

The new investors pay ₹25.58 per unit at end of April. This price includes: (a) the opening NAV of ₹25, (b) a dividend equalization component of ₹0.075 representing their fair share of income accumulated during April before they joined, and (c) a 2% entry load.

(ii) Repurchase Price per Unit at End of May

Formula:

Repurchase Price = (Opening NAV + Dividend Equalization per Unit) - Exit Load

Units Outstanding at End of April (after new issuance):

= 400 + 10 = 410 lakh units

Dividend Equalization at End of May:

Cumulative income earned during Q1-to-date (April + May) = ₹30 + ₹36 = ₹66 lakh

Units outstanding at end of May (before repurchase) = 410 lakh

Cumulative Dividend Equalization = ₹66 lakh / 410 lakh

= ₹0.1610 per unit

Repurchase Price:

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Repurchase Price = (Opening NAV + Cumulative Div Eq) − Exit Load

= (₹25.00 + ₹0.1610) -0.375

= ₹25.1610 -0.375

= ₹24.786

≈ ₹24.786 per unit

The exiting investor receives ₹24.78 per unit at end of May. This price accommodates: (a) the opening NAV of ₹25, (b) a dividend equalization of ₹0.1610 representing their share of accumulated income during May, less (c) a 1.5% exit load penalty.

(iii) Income Available for Distribution and Dividend Amount

Total Income Earned during Q1:

Month	Income (₹ lakh)
April	30
May	36
June	44
Total Q1 Income	**110**

Dividend Distribution (65% of Q1 Income):

Amount Distributed = 65% × ₹110 lakh = ₹71.50 lakh

Income Retained in the Scheme:

Retained = ₹110 lakh − ₹71.50 lakh = ₹38.50 lakh

Dividend Per Unit:

Units outstanding at end of June (for record date):

= 400 + 10 − 5 = 405 lakh units

Dividend per Unit = ₹71.50 lakh / 405 lakh units

= ₹0.1765 per unit

(iv) NAV per Unit as on 30th June 2025

Step 1: Compute AUM Progression

Component	Amount (₹ lakh)	Comment
Opening AUM (1-Apr-2025)	10,000.00	400 lakh × ₹25
Add: Portfolio Appreciation (Q1)	+ 500.00	Given
Add: Total Income Earned (Q1)	+ 110.00	April + May + June
Add: Issue Proceeds (End April)	+ 255.75	10 lakh × ₹25.575
Less: Repurchase Payout (End May)	− 123.939	5 lakh × ₹24.7878
Less: Dividend Distribution (End June)	**− 71.50**	**65% of Q1 income**
AUM at End June 2025	**10,670.311**	**Net asset value of scheme**

Step 2: Compute Units Outstanding at End June

Units = 400 + 10 − 5 = 405 lakh units

Step 3: Compute NAV per Unit

NAV = AUM / Units Outstanding

= ₹10,670.311 lakh / 405 lakh

= ₹26.3464

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≈ ₹26.35 per unit

The NAV grew from ₹25 (opening) to ₹26.35 (closing) — a quarter-on-quarter increase of 5.40%. This reflects the combined effect of portfolio appreciation (~5%), income earning (~1.1%), less dividend distribution (~0.7%). The two transactions (issuance and repurchase) had minimal impact on the NAV because they occurred at prices approximating the fair value.

(v) Ms. Vandana Rai's Holding Period Return

Investment Details:

Units held: 20 lakh

Opening cost basis: 20 lakh × ₹25.00 = ₹5,00,00,000 (₹5 crore)

Terminal Wealth on 30-June-2025:

Component	Computation	Amount (₹)
Value of units (post-dividend)	20 lakh × ₹26.35	5,26,94,750
Dividend received	20 lakh × ₹0.1765	3,53,000
Total Terminal Wealth		**5,30,47,750**

Holding Period Return (Q1):

Gain = ₹5,30,47,750 − ₹5,00,00,000 = ₹30,47,750

HPR = ₹30,47,750/ ₹5,00,00,000 = 6.11%

Annualised Return (assuming similar quarterly performance):

Annualised = (1 + 0.0611)^4 − 1 = 26.78%

Note: This annualisation assumes the Q1 growth rate continues across all four quarters — which is unlikely for equity funds in reality. A more meaningful annualisation would use actual full-year data if available.

Simple Annualised Rate:

Simple annualised = 6.11% × 4 = 24.44%

(vi) Purpose of Dividend Equalization

Dividend equalization is an accounting mechanism used in open-ended mutual fund schemes to ensure fair distribution of income among unit-holders who join or exit the scheme at different points during the accounting period.

The Problem it Solves:

Consider a mutual fund that has earned ₹100 lakh of income during Q1 and plans to distribute this as dividend at quarter-end. If new investors join in mid-quarter (say June 15) at the current NAV, they would benefit from the accumulated income earned earlier (April, May) even though they were not unit-holders during that period. Conversely, exiting investors who leave in mid-quarter (say May 20) would lose their share of income earned during their holding period.

How Dividend Equalization Solves It:

(i) For NEW ISSUANCE: The issue price is increased by "dividend equalization" — the accumulated income per unit up to that point. New investors PAY for their share of past income (this cash flows INTO the income pool), so all unit-holders end up with equal per-unit claim on the pool.

(ii) For REPURCHASE: The repurchase price is increased by dividend equalization for income earned during the exiting holder's tenure. Exiting investors receive their share of accumulated income embedded in the buyback price (this cash flows OUT of the income pool).

(iii) Net effect: The dividend distribution at end of period is proportionate per unit across all unit-holders present on the record date, but the income pool has been fairly adjusted for the timing of entries and exits.

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Regulatory Basis:

SEBI (Mutual Funds) Regulations 1996 and subsequent circulars require dividend equalization accounting for open-ended schemes to prevent inequitable dividend distribution.

Question 4 — Hedge Fund Fee Structure Analysis

Adityavardhan Singhania, a Delhi-based industrialist with substantial family office assets, invested ₹10.00 crore in "Kotak Alternate Alpha Fund" on 1st April 2022. The fund is registered as a SEBI Category III Alternative Investment Fund (AIF) — India's equivalent of a hedge fund — and follows a long-short equity strategy focused on mid-cap Indian stocks. The fund follows the industry-standard "2 and 20" fee structure with High Water Mark protection. Aditya has asked you to compute the annual fees, net returns, and terminal wealth over the 4-year period ending 31st March 2026, and to compare with an equivalent mutual fund investment.

Fee Structure of Kotak Alternate Alpha Fund:

Component	Details
Fixed Management Fee	2.00% p.a. of opening NAV
Incentive/Performance Fee	20% of profits above High Water Mark
High Water Mark (HWM)	Previous peak NAV — reset when NAV exceeds prior peak
Hurdle Rate	Nil (incentive fee applies on any profit above HWM)
Fee Application Timing	Annually at end of financial year (31st March)

Gross Fund Performance (Before Fees):

Year	Period	Gross Return	Market Context
Year 1	FY 2022-23	+18.00%	Bull market — mid-cap rally
Year 2	FY 2023-24	−10.00%	Correction — mid-cap drawdown
Year 3	FY 2024-25	+12.00%	Partial recovery
Year 4	FY 2025-26	+15.00%	New market high

Required:

(i) Explain the "2 and 20" fee structure and the concept of High Water Mark (HWM) as applied to hedge funds.

(ii) Compute year-by-year: (a) Fixed management fee, (b) Incentive fee (if applicable), (c) Net NAV at year-end, (d) High Water Mark after each year.

(iii) Compute cumulative total fees paid over 4 years and the investor's Compound Annual Growth Rate (CAGR).

(iv) Compare Aditya's outcome with a hypothetical equivalent mutual fund that earns the same gross returns but charges a Total Expense Ratio (TER) of 1.50% p.a. only. Compute fee differential.

(v) Discuss what level of "alpha" (excess gross return) a hedge fund needs to deliver to justify the higher fee structure versus a low-cost mutual fund.

Solution

(i) "2 and 20" Fee Structure and High Water Mark

The "2 and 20" Structure:

The industry-standard hedge fund fee structure consists of two components:

(i) FIXED MANAGEMENT FEE (2%): A fixed charge of 2% per annum on the fund's opening Net Asset Value (NAV), regardless of performance. This fee compensates the fund manager for operating costs, research, and infrastructure. It is charged in BOTH gain and loss years — the investor pays 2% even when the fund declines in value.

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(ii) INCENTIVE (PERFORMANCE) FEE (20%): An incentive fee of 20% of the fund's profits ABOVE the High Water Mark. This fee compensates the manager for generating positive returns above their previous peak performance. The incentive fee is charged ONLY when the fund's NAV exceeds its previous highest recorded value.

The High Water Mark (HWM) Concept:

HWM is the highest NAV level achieved by the fund at the end of any prior period. The purpose of HWM is to protect investors from paying incentive fees on RECOVERY of losses that they have already borne. Key principles:

(i) If the fund's NAV at year-end EXCEEDS the previous HWM: The manager charges 20% incentive fee on the profit ABOVE the HWM. The new NAV becomes the new HWM.

(ii) If the fund's NAV at year-end is BELOW the previous HWM: NO incentive fee is charged, regardless of the current year's gross positive return. The HWM stays at the previous peak.

(iii) This means that after a drawdown, the manager must first recover losses AND surpass the previous HWM before earning any incentive fee. Without this protection, an investor whose NAV drops from ₹100 to ₹80 and recovers to ₹95 would face incentive fees on the ₹15 recovery, even though the investor is still down ₹5 net.

(ii) Year-by-Year Fee Computation and NAV Evolution

YEAR 1 (FY 2022-23) — Gross Return +18%

Step	Computation	Value (₹ crore)
Opening NAV (1-Apr-22)	As invested	10.00
Gross NAV after +18% return	10.00 × 1.18	11.80
Less: Fixed Fee (2% of opening)	2% × 10.00	− 0.20
Post-Fixed-Fee NAV	11.80 − 0.20	11.60
Prior HWM (start of Year 1)	Original investment	10.00
Profit above HWM	11.60 − 10.00	1.60
Less: Incentive Fee (20% × 1.60)	**20% × 1.60**	**− 0.32**
Net NAV at End Year 1	**11.60 − 0.32**	**11.28**
NEW HIGH WATER MARK	**Reset to end NAV**	**11.28**

YEAR 2 (FY 2023-24) — Gross Return −10%

Step	Computation	Value (₹ crore)
Opening NAV (1-Apr-23)	From end Year 1	11.28
Gross NAV after −10% return	11.28 × 0.90	10.152
Less: Fixed Fee (2% of opening)	2% × 11.28	− 0.2256
Post-Fixed-Fee NAV	10.152 − 0.2256	9.9264
Prior HWM	From end Year 1	11.28
Check: Is NAV above HWM?	**9.93 < 11.28 → NO**	**—**
Incentive Fee	**NIL (below HWM)**	**0.00**
Net NAV at End Year 2		**9.93 (approx)**
HIGH WATER MARK (unchanged)	**Stays at prior peak**	**11.28**

YEAR 3 (FY 2024-25) — Gross Return +12%

Step	Computation	Value (₹ crore)
Opening NAV (1-Apr-24)	From end Year 2	9.9264
Gross NAV after +12% return	9.9264 × 1.12	11.1176
Less: Fixed Fee (2% of opening)	2% × 9.9264	− 0.1985
Post-Fixed-Fee NAV	11.1176 − 0.1985	10.9191

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Step	Computation	Value (₹ crore)
Prior HWM	Unchanged	11.28
Check: Is NAV above HWM?	**10.92 < 11.28 → STILL NO**	**—**
Incentive Fee	**NIL (still below HWM)**	**0.00**
Net NAV at End Year 3		**10.92 (approx)**
HIGH WATER MARK (unchanged)	**Still ₹11.28 crore**	**11.28**

Important Observation for Year 3:

Even though the fund earned a POSITIVE 12% gross return in Year 3, NO incentive fee is charged because the net NAV (₹10.92 crore) is still below the HWM (₹11.28 crore). This is the HWM protection at work — the manager cannot charge incentive fee for merely recovering losses. Aditya has benefited from this protection: without HWM, the manager would have charged 20% × (₹10.92 − ₹9.93) = ₹0.198 crore of incentive fee on Year 3's positive performance.

YEAR 4 (FY 2025-26) — Gross Return +15%

Step	Computation	Value (₹ crore)
Opening NAV (1-Apr-25)	From end Year 3	10.9191
Gross NAV after +15% return	10.9191 × 1.15	12.5570
Less: Fixed Fee (2% of opening)	2% × 10.9191	− 0.2184
Post-Fixed-Fee NAV	12.5570 − 0.2184	12.3386
Prior HWM	Unchanged	11.28
Check: Is NAV above HWM?	12.34 > 11.28 → YES	—
Profit above HWM	12.3386 − 11.28	1.0586
Less: Incentive Fee (20% × 1.0586)	**20% × 1.0586**	**− 0.2117**
Net NAV at End Year 4	**12.3386 − 0.2117**	**12.1269 ≈ 12.13**
NEW HIGH WATER MARK	**Reset to end NAV**	**12.13**

(iii) Cumulative Fee Summary and Investor CAGR

Cumulative Fees Paid by Aditya over 4 Years:

Year	Fixed Fee (₹ cr)	Incentive Fee (₹ cr)	Total Fee (₹ cr)
Year 1	0.20	0.32	0.52
Year 2	0.226	0.00	0.226
Year 3	0.199	0.00	0.199
Year 4	0.218	0.212	0.430
TOTAL 4-YEAR FEES	**0.843**	**0.532**	**1.375**

Investor CAGR (Net of Fees):

Terminal NAV = ₹12.13 crore

Initial Investment = ₹10.00 crore

Total Return over 4 years = (12.13 − 10.00) / 10.00 = 21.30%

CAGR = (12.13 / 10.00)^(1/4) − 1

= (1.213)^0.25 − 1

= 1.0495 − 1

= 4.95% p.a.

Gross Return Analysis (Before Any Fees):

Cumulative Gross Multiplier = 1.18 × 0.90 × 1.12 × 1.15 = 1.3679

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Gross Ending Value = ₹10 × 1.3679 = ₹13.68 crore

Gross CAGR = (1.3679)^0.25 − 1 = 8.14% p.a.

Fee Drag Analysis:

Fee Drag = Gross CAGR − Net CAGR

= 8.14% − 4.95%

= 3.19% p.a.

The 3.19% annual fee drag consists of two components: (a) fixed management fee averaging about 2% p.a., (b) incentive fees averaging about 1.2% p.a. (concentrated in Years 1 and 4 when HWM was surpassed).

(iv) Comparison with Equivalent Mutual Fund (1.5% TER)

Assume a hypothetical equity mutual fund earns the same gross returns (18%, −10%, 12%, 15%) but charges only 1.5% Total Expense Ratio annually. Under this MF, the net return each year = gross return − 1.5%.

Year	Gross Return	MF Net Return (Gross – 1.5%)	Opening NAV (₹ cr)	Ending NAV (₹ cr)
Year 1	18.00%	16.50%	10.00	11.65
Year 2	−10.00%	−11.50%	11.65	10.31
Year 3	12.00%	10.50%	10.31	11.39
Year 4	15.00%	13.50%	11.39	12.93

Mutual Fund CAGR:

Terminal Value = ₹12.93 crore

MF CAGR = (12.93 / 10.00)^0.25 − 1 = 6.60% p.a.

Head-to-Head Comparison:

Metric	Kotak Alt. Alpha (Hedge)	Hypothetical MF (1.5% TER)	MF Advantage
Terminal Wealth	₹12.13 crore	₹12.93 crore	+ ₹0.80 crore
Cumulative Return	21.30%	29.30%	+ 8.00 pp
Net CAGR	4.95%	6.60%	+ 1.65 pp per annum
Total 4-Year Fees	₹1.375 crore	₹0.633 crore	MF saves ₹0.742 crore

The mutual fund would have produced ₹0.80 crore MORE terminal wealth than the hedge fund, despite EARNING THE SAME GROSS RETURNS. This is entirely due to the fee structure differential — the mutual fund's 1.5% TER is significantly cheaper than the hedge fund's 2% + 20% structure over this performance path.

(v) Required Alpha to Justify Hedge Fund Structure

For a hedge fund to be worth the higher fee structure, it must generate sufficient GROSS "alpha" (excess return over a comparable benchmark or MF) to overcome the fee differential AND deliver superior net returns to the investor.

Break-Even Alpha Analysis:

From the above analysis, the fee drag differential between the hedge fund and the MF is:

Hedge Fund fee drag = 3.19% p.a.

MF fee drag = 8.14% − 6.60% = 1.54% p.a.

Fee drag differential = 3.19% − 1.54% = 1.65% p.a.

For the hedge fund to MATCH the MF's net return of 6.60% p.a., its GROSS return must be 6.60% + 3.19% = 9.79% p.a.

Since our hedge fund earned gross CAGR of 8.14% (less than 9.79%), it UNDERPERFORMED the MF on a net basis. The hedge fund manager needed to generate an additional 1.65 pp of gross alpha per annum to justify the fee structure.

General Rule:

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For a hedge fund to be attractive versus a passive MF, it must generate GROSS ALPHA (over the benchmark) of AT LEAST 2-3 percentage points per annum, sustained over multiple years. This is a high hurdle — global research (Malkiel, Sharpe, various academic studies) suggests that only a small minority of hedge funds achieve this on a persistent basis after fees. This makes hedge funds a high-risk, high-cost proposition suitable only for sophisticated investors who can rigorously vet manager skill.

Practical Guidance for Aditya:

(i) For his remaining family office allocation, prefer LOW-COST passive vehicles (index funds, ETFs) for the CORE portfolio (60-70% of assets).

(ii) Reserve HEDGE FUND allocation for SATELLITE positions (10-20% of portfolio), and ONLY where the manager has demonstrated persistent alpha over 5+ year track record.

(iii) Insist on structural safeguards: high water mark (present here), hurdle rate (missing from Kotak's structure — should be added), fee crystallisation on cash basis only.

(iv) Monitor the fee-to-alpha ratio ANNUALLY. If gross alpha falls below 3 percentage points over the benchmark for 2 consecutive years, reduce or exit the position.

Question 5 — Dividend Reinvestment Plan: Solve for NFO NAV

Vikas Patel, a Bengaluru-based professional, invested ₹1,00,000 in the New Fund Offer (NFO) of "Aditya Birla Sun Life Bharat Vikas Fund" on 1st April 2023. He opted for the DIVIDEND REINVESTMENT PLAN — all dividends are automatically reinvested at the ex-dividend NAV to purchase additional units. Vikas did not maintain a record of the NFO NAV (whether ₹10 par or a different value) or the number of units originally allotted. He does have records of the dividend history and the final portfolio value on 31st March 2026.

Available Records — Dividend History:

Year End	Dividend per Unit (₹)	Ex-Dividend NAV (₹)
31-Mar-2024 (Year 1)	3.00	30
31-Mar-2025 (Year 2)	3.50	35
31-Mar-2026 (Year 3)	4.00	40

Total Portfolio Value on 31st March 2026 (immediately after Year 3 dividend reinvestment): ₹2,12,960

Initial Investment on 1st April 2023: ₹1,00,000

Required:

(i) Let X be the number of units subscribed by Vikas at the NFO. Derive an algebraic expression for the total units held at the end of Year 3, and then for the total portfolio value at end of Year 3, in terms of X.

(ii) Set up the equation using the given final portfolio value and solve for X to determine the number of units subscribed at the NFO.

(iii) Determine the NFO NAV at which Vikas subscribed.

(iv) Compute the CAGR of Vikas's investment over the 3-year holding period.

(v) Decompose the CAGR into two components: (a) NAV appreciation, and (b) additional benefit from dividend reinvestment.

Solution

(i) Algebraic Expression for Total Units and Terminal Value in Terms of X

Let X = Number of units subscribed at the NFO.

End of Year 1 (Dividend ₹3, Ex-div NAV ₹30):

Dividend received = X × ₹3 = ₹3X

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Additional units purchased (reinvested at ex-div NAV ₹30) = ₹3X / ₹30 = 0.10X

Total units after Year 1 = X + 0.10X = 1.10X

End of Year 2 (Dividend ₹3.50, Ex-div NAV ₹35):

Dividend received = 1.10X × ₹3.50 = ₹3.85X

Additional units purchased (reinvested at ex-div NAV ₹35) = ₹3.85X / ₹35 = 0.11X

Total units after Year 2 = 1.10X + 0.11X = 1.21X

End of Year 3 (Dividend ₹4, Ex-div NAV ₹40):

Dividend received = 1.21X × ₹4 = ₹4.84X

Additional units purchased (reinvested at ex-div NAV ₹40) = ₹4.84X / ₹40 = 0.121X

Total units after Year 3 = 1.21X + 0.121X = 1.331X

Observation: The unit multiplier is $(1.10)^3 = 1.331$

This occurs because in each year, the dividend yield (Dividend / Ex-div NAV) is constant at 3/30 = 3.50/35 = 4/40 = 10%. So each year the units multiply by 1.10, and over 3 years by $1.10^3 = 1.331$.

Terminal Value Expression:

Total value on 31-Mar-2026 = Total units × Ex-div NAV at Year 3

= 1.331X × ₹40

= ₹53.24 X

(ii) Solve for X

Given: Total portfolio value on 31-Mar-2026 = ₹2,12,960

Set up equation:

53.24 X = ₹2,12,960

Solving:

X = ₹2,12,960 / 53.24

X = 4,000 units

Vikas subscribed to 4,000 units at the NFO.

(iii) NFO NAV Determination

NFO NAV = Initial Investment / Number of Units

= ₹1,00,000 / 4,000

= ₹25 per unit

Verification (Step-by-Step Unit Progression):

Date	Opening Units	Dividend Received (₹)	Ex-Div NAV (₹)	Additional Units	Total Units
1-Apr-2023 (NFO)	0	—	25	4,000.00	4,000.00
31-Mar-2024	4,000.00	12,000.00	30	400.00	4,400.00
31-Mar-2025	4,400.00	15,400.00	35	440.00	4,840.00
31-Mar-2026	4,840.00	19,360.00	40	484.00	5,324.00

Terminal Value Verification: 5,324 units × ₹40 = ₹2,12,960 ✓

(iv) CAGR Computation over 3 Years

CAGR Formula:

CAGR = (Final Value / Initial Value)^(1/n) − 1

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= (₹2,12,960 / ₹1,00,000)^(1/3) − 1

= (2.1296)^(1/3) − 1

= 1.2866 − 1

= 28.66% per annum

(v) Decomposition of CAGR

The total return of 2.1296x can be decomposed into two components — NAV appreciation and dividend reinvestment boost — that COMPOUND multiplicatively:

Component 1: NAV Appreciation

NAV grew from ₹25 (NFO) to ₹40 (end of Year 3 ex-div NAV)

NAV Growth Multiplier = 40 / 25 = 1.60

NAV Appreciation CAGR = 1.60^(1/3) − 1 = 1.1696 − 1

= 16.96% per annum

Component 2: Dividend Reinvestment Boost

Unit count grew from X to 1.331X due to reinvestment

Reinvestment Multiplier = 1.331 = $(1.10)^3$

Reinvestment Boost = 10% per annum (annual dividend yield)

Combined Total Return Multiplier:

Total Multiplier = NAV Growth × Reinvestment Multiplier

= 1.60 × 1.331

= 2.1296 ✓

Combined CAGR (multiplicative):

(1 + Total CAGR) = (1 + NAV CAGR) × (1 + Reinvestment Boost)

= 1.1696 × 1.10

= 1.2866

Total CAGR = 28.66% per annum ✓

Summary Decomposition:

Component	Multiplier	Annual Return
NAV Appreciation (₹25 → ₹40)	1.60	16.96% CAGR
Dividend Reinvestment Boost	1.331 (over 3 years)	10.00% per annum
Combined (multiplicative)	**2.1296**	**28.66% CAGR**

Note: The two CAGRs do NOT add arithmetically (16.96% + 10% = 26.96% ≠ 28.66%). They compound multiplicatively because the reinvestment boost applies to a growing NAV base, creating a cross-effect. This is analogous to how a stock earning 10% capital gain AND 5% dividend yield produces a 15.5% total return, not exactly 15%.

Question 6 — Sortino Ratio with Backward Derivation of Fund Parameters

Priyanka Malhotra, Head of Manager Research at Nuvama Wealth, evaluates two mutual fund schemes based on risk-adjusted performance metrics. Some data is available directly from fund fact sheets, but other parameters must be derived through backward computation. Priyanka has particular interest in the Sortino Ratio, which focuses on downside risk — a critical measure often overlooked in favor of Sharpe or Treynor.

Available Data (Trailing 3-Year Annualized):

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Parameter	Fund A	Fund B
Fund Name	SBI Focused Equity Fund	Kotak Emerging Equity Fund
Sharpe Ratio	0.60	0.50
Treynor Ratio	9.00	7.00
Sortino Ratio	(to be computed)	0.75
Downside Deviation (DD)	12.00%	(to be computed)
Beta (β)	1.00	0.90
Standard Deviation (σ)	(to be computed)	(to be computed)
Expected Return (Ri)	(to be computed)	(to be computed)

Market Parameters:

- Risk-Free Rate (Rf — 10-yr G-Sec): 6.00%
- Market Return (Rm — Nifty 50 TRI): 12.00%
- Correlation between Fund A and Fund B: ρAB = 0.60

Required:

(i) For Fund A: Using the given Sharpe Ratio, Treynor Ratio, and Beta, derive the expected return and standard deviation. Then compute the Sortino Ratio and Jensen's Alpha.

(ii) For Fund B: Using the given Sharpe Ratio, Treynor Ratio, Sortino Ratio, and Beta, derive the expected return, standard deviation, downside deviation, and Jensen's Alpha.

(iii) Present a comparison table of all four performance metrics for both funds and rank them under each metric.

(iv) Analyze the ratio of Downside Deviation to Standard Deviation (DD/σ) for each fund. Explain what this ratio reveals about the return distribution and downside characteristics of each fund.

(v) Construct a 50:50 portfolio of Fund A and Fund B. Compute the portfolio's expected return, beta, standard deviation, and Sharpe Ratio (given correlation ρAB = 0.60).

(vi) Advise Priyanka: If her key concern is DOWNSIDE PROTECTION during equity market drawdowns, which fund should she favor and why?

Solution

(i) Fund A — Derivation of Missing Parameters

From Treynor Ratio, Derive Expected Return:

Treynor Ratio = (Ri − Rf) / β

9.00 = (RA − 6) / 1.00

RA − 6 = 9.00

RA = 15.00%

From Sharpe Ratio, Derive Standard Deviation:

Sharpe Ratio = (Ri − Rf) / σ

0.60 = (15 − 6) / σA

σA = 9.00 / 0.60

σA = 15.00%

Compute Sortino Ratio (using given Downside Deviation of 12%):

Sortino Ratio = (Ri − Rf) / Downside Deviation

Sortino_A = (15 − 6) / 12

Sortino_A = 0.75

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Compute Jensen's Alpha:

Jensen α = Ri − [Rf + βi × (Rm − Rf)]

α_A = 15 − [6 + 1.00 × (12 − 6)]

= 15 − [6 + 6]

α_A = 3.00%

(ii) Fund B — Derivation of Missing Parameters

From Treynor Ratio, Derive Expected Return:

Treynor Ratio = (Ri − Rf) / β

7.00 = (RB − 6) / 0.90

RB − 6 = 7.00 × 0.90 = 6.30

RB = 12.30%

From Sharpe Ratio, Derive Standard Deviation:

0.50 = (12.30 − 6) / σB

σB = 6.30 / 0.50

σB = 12.60%

From Sortino Ratio, Derive Downside Deviation:

0.75 = (12.30 − 6) / DD_B

DD_B = 6.30 / 0.75

DD_B = 8.40%

Compute Jensen's Alpha:

α_B = 12.30 − [6 + 0.90 × (12 − 6)]

= 12.30 − [6 + 5.40]

= 12.30 − 11.40

α_B = 0.90%

(iii) Complete Metrics Comparison and Ranking

Complete Performance Metrics Summary:

Metric	Fund A	Fund B	Winner
Expected Return (Ri)	15.00%	12.30%	Fund A (higher)
Standard Deviation (σ)	15.00%	12.60%	Fund B (lower risk)
Beta (β)	1.00	0.90	Fund B (lower)
Downside Deviation (DD)	12.00%	8.40%	Fund B (lower)
Sharpe Ratio	0.60	0.50	Fund A
Treynor Ratio	9.00	7.00	Fund A
Sortino Ratio	0.75	0.75	TIE
Jensen's Alpha	3.00%	0.90%	Fund A

Ranking Analysis:

- Fund A wins on 3 out of 4 risk-adjusted metrics (Sharpe, Treynor, Jensen).
- The Sortino Ratio TIES at 0.75 — this is the key insight of the question.
- The tie in Sortino despite Fund A winning Sharpe is unusual and reveals something important about the return distributions, explored in Part (iv).

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(iv) DD/σ Ratio Analysis — Distribution Insights

Compute DD/σ Ratio for Each Fund:

Fund	Std Dev (σ)	Downside Dev (DD)	DD/σ Ratio
Fund A	15.00%	12.00%	0.80
Fund B	12.60%	8.40%	0.667

Interpretation of DD/σ Ratio:

The DD/σ ratio measures the PROPORTION of total volatility that comes from downside movements. It ranges from 0 to 1 (roughly):

- Ratio ≈ 0.71 (= 1/√2): Suggests SYMMETRIC return distribution — upside and downside volatility are balanced. Approximately half of the variance comes from below-mean deviations.
- Ratio > 0.71: NEGATIVELY SKEWED distribution — more of the volatility comes from downside movements. Fund is prone to occasional large losses.
- Ratio < 0.71: POSITIVELY SKEWED distribution — more of the volatility comes from upside movements. Fund experiences occasional large gains but limited downside.

Fund A (DD/σ = 0.80):

Slightly negatively skewed or symmetric. Downside movements contribute 80% as much as total volatility (in std dev terms). This is typical for concentrated equity funds — occasional sharp drawdowns when concentrated positions correct.

Fund B (DD/σ = 0.667):

POSITIVELY SKEWED distribution. Downside movements contribute only 67% of total volatility. Fund B has limited downside relative to its overall volatility — it experiences occasional upside jumps but relatively contained losses. This is characteristic of quality-tilt or defensive-growth strategies (e.g., Kotak Emerging's exposure to compounding mid-caps with quality filters).

Why the Sortino Ratios Tie Despite Different Sharpe Ratios:

Fund A: Sharpe = 0.60, σ = 15%, DD = 12% → Sortino = (15−6)/12 = 0.75

Fund B: Sharpe = 0.50, σ = 12.60%, DD = 8.40% → Sortino = (12.30−6)/8.40 = 0.75

Even though Fund A has HIGHER Sharpe (better total-risk-adjusted return), Fund B has BETTER downside characteristics (lower DD/σ). The two effects EXACTLY OFFSET in the Sortino computation, producing a tie.

Key Insight:

Sharpe treats upside and downside volatility SYMMETRICALLY (both bad). Sortino treats them ASYMMETRICALLY (only downside is bad; upside is good). Fund B's more positively-skewed distribution means its "volatility" is largely benign upside — Sortino recognizes this and gives it credit that Sharpe does not.

(v) 50:50 Portfolio Construction

Portfolio Return:

Rp = wA × RA + wB × RB

= 0.50 × 15 + 0.50 × 12.30

= 13.65%

Portfolio Beta:

βp = wA × βA + wB × βB

= 0.50 × 1.00 + 0.50 × 0.90

= 0.95

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Portfolio Variance:

$\sigma p^2 = wA^2 \times \sigma A^2 + wB^2 \times \sigma B^2 + 2 \times wA \times wB \times \rho AB \times \sigma A \times \sigma B$

$= (0.50)^2 \times (15)^2 + (0.50)^2 \times (12.60)^2 + 2 \times 0.50 \times 0.50 \times 0.60 \times 15 \times 12.60$

$= 0.25 \times 225 + 0.25 \times 158.76 + 0.30 \times 189$

$= 56.25 + 39.69 + 56.70$

$= 152.64$

Portfolio Standard Deviation:

$\sigma p = \sqrt{152.64}$

$= 12.35\%$

Portfolio Sharpe Ratio:

$Sharpe_p = (13.65 - 6) / 12.35$

$= 7.65 / 12.35$

$= 0.619$

Diversification Benefit:

Portfolio Sharpe (0.619) EXCEEDS both Fund A (0.60) and Fund B (0.50) Sharpe Ratios. This is the classic diversification benefit — combining two imperfectly correlated funds (ρ = 0.60) produces a portfolio with a better risk-return trade-off than either fund alone.

(vi) Recommendation on Downside Protection

If Priyanka's Key Concern is DOWNSIDE PROTECTION, Recommend Fund B.

Rationale:

(i) Lower Downside Deviation: Fund B's DD is 8.40% vs Fund A's 12.00%. In absolute terms, Fund B experiences LESS painful losses during market drawdowns.

(ii) Positively Skewed Distribution: Fund B's DD/σ ratio of 0.667 indicates a return distribution where downside is CONTAINED relative to total volatility. Investors experience occasional big upside gains but limited losses.

(iii) Lower Beta: Fund B's β of 0.90 (vs 1.00 for Fund A) means it declines LESS than the market during broad drawdowns. In a Nifty 50 crash of −20%, Fund B is expected to decline ~18% while Fund A declines ~20%.

(iv) Lower Absolute Volatility: Fund B's σ of 12.60% is meaningfully lower than Fund A's 15%. The overall investment experience is smoother.

Caveat — Trade-off:

Fund A delivers superior RETURNS (15% vs 12.30%) and superior Sharpe/Treynor/Jensen. Choosing Fund B for downside protection means SACRIFICING 2.70 pp of expected return per year. For a client with a long investment horizon (10+ years) and no near-term liquidity needs, this trade-off may not be worthwhile — the long-run compounding benefit of Fund A's higher return exceeds the short-run pain of larger drawdowns.

Best of Both Worlds — Portfolio Approach:

The 50:50 portfolio computed in Part (v) offers a compelling compromise: Sharpe of 0.619 (higher than either fund), moderate downside characteristics (portfolio DD would be between the two funds), and diversification. For most clients, this middle-ground allocation is superior to picking either fund exclusively.

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Question 7 — SIP vs Lump Sum Investment Analysis

Vikram Chaudhary is a 34-year-old software architect at TCS Chennai with an annual bonus of ₹6,00,000 (net of tax) to invest. On 1st April 2020, he had the choice between two mutual fund investment approaches, both targeting HDFC Nifty 500 Index Fund:

- OPTION A — Lump Sum: Invest all ₹6,00,000 upfront on 1-Apr-2020.
- OPTION B — SIP: Invest ₹1,20,000 annually on 1st April of each year from 2020 to 2024 (5 years, ₹6,00,000 total).

Vikram plans to redeem the entire investment on 31-Mar-2025. He wants to know which approach delivers better results in absolute wealth AND on a returns-basis, considering the Indian equity LTCG tax framework.

HDFC Nifty 500 Index Fund NAV Trajectory (2020-2025):

Date	NAV per Unit (₹)	Annual Change	Market Context
1-Apr-2020	100.00	—	COVID crash lows
1-Apr-2021	110.00	+10.00%	V-shaped recovery
1-Apr-2022	95.00	−13.64%	Ukraine war / inflation shock
1-Apr-2023	115.00	+21.05%	Rally on rate stability
1-Apr-2024	135.00	+17.39%	Bull market
31-Mar-2025	150.00	+11.11%	Continued rally

Assumptions:

- No entry load (both plans are Direct Plans post-2013 SEBI reform)
- No exit load if held >12 months (holds true for all 5 SIP tranches and lump sum)
- Indian LTCG on equity mutual funds: 10% on gains above ₹1,00,000 per financial year (Section 112A of Income Tax Act as effective FY 2020-25)
- Ignore SIP monthly granularity; treat SIP as annual investments for simplicity

Required:

(i) Explain the difference between Lump Sum and Systematic Investment Plan (SIP) investment approaches.

(ii) Compute the final portfolio value on 31-Mar-2025 under Option A (Lump Sum) and the corresponding CAGR.

(iii) Compute the units accumulated year-by-year under Option B (SIP) and the total portfolio value on 31-Mar-2025.

(iv) Compute the SIP XIRR (extended internal rate of return) and compare with the Lump Sum CAGR.

(v) Compare absolute gains, return metrics, and calculate the LTCG tax payable under each option (assuming redemption in FY 2024-25). Compute post-tax terminal wealth.

(vi) Recommend when Lump Sum is better and when SIP is better, with practical guidance for Indian investors.

Solution

(i) Lump Sum vs SIP — Conceptual Differences

Lump Sum Investment:

The investor deploys the entire investment amount at a single point in time (typically the moment funds become available — annual bonus, inheritance, property sale proceeds). All capital is exposed to market performance from Day 1, capturing both gains and losses on the full amount immediately.

Systematic Investment Plan (SIP):

The investor commits to invest a fixed amount at regular intervals (monthly, quarterly, or annually) over an extended period. Each tranche is invested at the prevailing NAV — thus purchasing MORE UNITS when NAV is low and FEWER

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UNITS when NAV is high. This mechanism is called "Rupee Cost Averaging" — a behavioral discipline that eliminates market timing decisions.

Key Differences:

Dimension	Lump Sum	SIP
Timing of Investment	Single point (Day 1)	Multiple points over time
Capital Deployment	Full amount immediately	Staggered over months/years
Rupee Cost Averaging	None (single price)	YES — averages purchase price
Market Timing Risk	HIGH (all-or-nothing)	LOW (averaged over time)
Suitable Investor Type	Investors with large one-time surplus	Salaried investors with monthly income
Behavioural Discipline	Requires conviction to invest at once	Automated — reduces temptation to time market

(ii) Option A — Lump Sum Investment Analysis

Investment Details:

Investment date: 1-Apr-2020

Investment amount: ₹6,00,000

Purchase NAV: ₹100 per unit

Units purchased: 6,00,000 / 100 = 6,000 units

Terminal Value (31-Mar-2025):

Ending NAV: ₹150 per unit

Terminal Portfolio Value = 6,000 units × ₹150 = ₹9,00,000

Absolute Gain: ₹9,00,000 – ₹6,00,000 = ₹3,00,000

CAGR (5 years):

CAGR = (9,00,000 / 6,00,000)^(1/5) − 1

= (1.500)^0.20 − 1

= 1.0845 − 1

= 8.45% per annum

Note: This 8.45% CAGR reflects only the NAV movement from ₹100 (start) to ₹150 (end). The intermediate volatility (₹110 → ₹95 → ₹115 → ₹135) had no impact on Lump Sum since the investment was made once and held throughout.

(iii) Option B — SIP Analysis

Year-by-Year Unit Accumulation:

Investment Date	Amount (₹)	NAV (₹)	Units Purchased
1-Apr-2020	1,20,000	100.00	1,200.00
1-Apr-2021	1,20,000	110.00	1,090.91
1-Apr-2022	1,20,000	95.00	1,263.16
1-Apr-2023	1,20,000	115.00	1,043.48
1-Apr-2024	1,20,000	135.00	888.89
TOTAL	**6,00,000**	**Various**	**5,486.44**

Terminal Value (31-Mar-2025):

Total units held: 5,486.44

Ending NAV: ₹150 per unit

Terminal Portfolio Value = 5,486.44 × ₹150 = ₹8,22,966

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Absolute Gain: ₹8,22,966 − ₹6,00,000 = ₹2,22,966

Average Purchase Price (Rupee Cost Averaging):

Average NAV paid = ₹6,00,000 / 5,486.44 units = ₹109.36 per unit

This is BELOW the simple arithmetic average of NAVs (100+110+95+115+135)/5 = ₹111.00, because more units were bought when NAV was low (Y3 at ₹95). This is the rupee cost averaging benefit at work.

(iv) SIP XIRR Computation

XIRR (Extended Internal Rate of Return) accounts for the timing of each cash flow. Cash flow schedule:

Time (Years)	Cash Flow (₹)	Description
0.00 (1-Apr-2020)	− 1,20,000	SIP Year 1
1.00 (1-Apr-2021)	− 1,20,000	SIP Year 2
2.00 (1-Apr-2022)	− 1,20,000	SIP Year 3
3.00 (1-Apr-2023)	− 1,20,000	SIP Year 4
4.00 (1-Apr-2024)	− 1,20,000	SIP Year 5
5.00 (31-Mar-2025)	+ 8,22,966	Redemption

XIRR Equation:

$1,20,000 \times [1 + 1/(1+r) + 1/(1+r)^2 + 1/(1+r)^3 + 1/(1+r)^4] = 8,22,966 / (1+r)^5$

Trial at r = 10%:

LHS = 1,20,000 × (1 + 0.9091 + 0.8264 + 0.7513 + 0.6830)

= 1,20,000 × 4.1698 = ₹5,00,376

RHS = 8,22,966 × 0.6209 = ₹5,10,979

Since LHS < RHS → IRR > 10%

Trial at r = 11%:

LHS = 1,20,000 × (1 + 0.9009 + 0.8116 + 0.7312 + 0.6587)

= 1,20,000 × 4.1024 = ₹4,92,288

RHS = 8,22,966 × 0.5935 = ₹4,88,430

Since LHS > RHS → IRR < 11%

Interpolation:

At 10%: LHS − RHS = −10,603

At 11%: LHS − RHS = +3,858

IRR = 10% + [10,603 / (10,603 + 3,858)] × 1%

= 10% + 0.73%

XIRR ≈ 10.73% per annum

(v) Comparison and Tax Analysis

Pre-Tax Comparison:

Metric	Option A — Lump Sum	Option B — SIP	Winner
Total Investment	₹6,00,000	₹6,00,000	Tie
Terminal Wealth	₹9,00,000	₹8,22,966	Lump Sum (+ ₹77,034)
Absolute Gain	₹3,00,000	₹2,22,966	Lump Sum
Return Metric	CAGR = 8.45%	XIRR = 10.73%	SIP (+ 2.28 pp)
Rupee Cost Averaging	N/A	Effective	SIP (₹109.36 avg vs ₹100 start)

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Metric	Option A — Lump Sum	Option B — SIP	Winner
Market Timing Risk	HIGH	LOW	SIP

Interpretation of Divergence:

Lump Sum WINS on absolute wealth because more capital was deployed for longer (₹6 lakh for 5 years vs SIP's average of only ~2.5 years of deployment). SIP WINS on time-weighted return (XIRR 10.73% vs CAGR 8.45%) because it exploited the Y3 dip effectively — buying 1,263 units at ₹95 was the SIP's best year.

LTCG Tax Computation (Section 112A):

Tax on Lump Sum Redemption:

Gain in FY 2024-25: ₹3,00,000

LTCG exemption limit: ₹1,00,000 per FY

Taxable LTCG: ₹3,00,000 − ₹1,00,000 = ₹2,00,000

Tax @ 10%: ₹2,00,000 × 10% = ₹20,000

Post-Tax Terminal Wealth (Lump Sum): ₹9,00,000 − ₹20,000 = ₹8,80,000

Tax on SIP Redemption:

Gain in FY 2024-25: ₹2,22,966

LTCG exemption limit: ₹1,00,000 per FY

Taxable LTCG: ₹2,22,966 − ₹1,00,000 = ₹1,22,966

Tax @ 10%: ₹1,22,966 × 10% = ₹12,297

Post-Tax Terminal Wealth (SIP): ₹8,22,966 − ₹12,297 = ₹8,10,669

Post-Tax Comparison:

Metric	Lump Sum	SIP	Difference
Post-Tax Terminal Wealth	₹8,80,000	₹8,10,669	+ ₹69,331
Post-Tax Gain	₹2,80,000	₹2,10,669	+ ₹69,331
Post-Tax CAGR	7.96%	N/A (XIRR affected)	Lump Sum wins on absolute

Tax Planning Insight:

The Lump Sum investor loses MORE tax in absolute terms (₹20,000 vs ₹12,297) because gains are higher, but the effective LTCG tax rate is lower relative to the gain (6.67% vs 5.51%). To reduce Lump Sum tax burden, the investor could employ TAX HARVESTING — redeeming approximately ₹1 lakh of gains each year to utilize the exemption, then reinvesting. This strategy could save significant tax over long horizons but requires operational discipline.

(vi) When Lump Sum vs SIP is Better — Practical Recommendations

Lump Sum is BETTER When:

- Investor has a large one-time surplus (annual bonus, property sale, inheritance) that would otherwise sit in low-yield savings.
- Markets are near cyclical lows and expected to trend up (e.g., post-COVID March 2020, post-election corrections).
- Investor has HIGH conviction on the market direction and long horizon (10+ years).
- The alternative to investing is holding cash — the drag of not investing exceeds the risk of investing at a suboptimal moment.

SIP is BETTER When:

- Investor has regular monthly income (salaried professionals) rather than lump sum surplus.
- Markets are near cyclical highs or volatile with unclear direction.

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- Investor is anxious about market timing and wants to reduce psychological stress.
- Investor is new to investing — SIP builds discipline and long-term habits.
- Historical Indian data: over multi-decade horizons, SIP delivers 10-12% XIRR vs 12-14% Lump Sum CAGR in Nifty 50 — but SIP has 40-50% lower psychological stress.

Hybrid Approach (Best of Both Worlds):

For Vikram specifically (annual bonus of ₹6 lakh), the optimal approach is often a hybrid:

(i) Deploy 40-50% of bonus as Lump Sum immediately (₹2.5-3 lakh) to capture initial market exposure.

(ii) Spread the remaining 50-60% (₹3-3.5 lakh) as monthly SIP over 6-9 months. This mitigates timing risk while ensuring capital is deployed within the same fiscal year.

(iii) For future bonuses, split similarly — some markets timing (Lump Sum) plus rupee cost averaging (SIP tail).

(iv) This approach captures the mathematical advantage of Lump Sum in trending markets while providing the psychological comfort of SIP averaging.

Empirical Note:

Studies by SEBI-registered advisors and AMFI research suggest that in Indian markets since 2000, Lump Sum has outperformed SIP in ~70% of 5-year windows (mostly bull market periods) but SIP has outperformed in ~30% of windows (volatile or declining periods). The verdict is therefore NOT deterministic — it depends on the specific market path, which is unknowable in advance. This uncertainty is precisely why many investors choose SIP for its psychological ease despite its slightly lower expected wealth.

Question 8 — Tracking Error and Information Ratio Analysis

Rohan Bhat, a Chartered Accountant working with a family office in Bengaluru, is evaluating two mutual fund schemes for inclusion in a client's model portfolio. Both are benchmarked to the Nifty 50 TRI. The client has a 10-year investment horizon and wants exposure to Indian large-cap equity but is uncertain whether to choose a low-cost passive ETF or an actively-managed fund.

Schemes Under Consideration:

- Fund A: Kotak Nifty 50 ETF — a passive ETF designed to replicate Nifty 50 TRI
- Fund B: HDFC Focused 30 Fund — an active large-cap fund benchmarked to Nifty 50 TRI

Annual Returns Data (Last 5 Financial Years):

Year	Nifty 50 TRI (%)	Fund A — Passive ETF (%)	Fund B — Active (%)
FY 2021-22	12.00	11.90	18.00
FY 2022-23	−5.50	−5.60	−8.00
FY 2023-24	15.00	15.10	20.00
FY 2024-25	8.50	8.60	5.00
FY 2025-26	−3.00	−3.10	2.00

Required:

(i) Define Tracking Error (TE) and explain its significance in mutual fund evaluation.

(ii) Compute the annual excess returns of Fund A and Fund B relative to the Nifty 50 TRI benchmark.

(iii) Compute the Tracking Error of Fund A (Passive ETF). Use sample standard deviation (n − 1 denominator).

(iv) Compute the Tracking Error of Fund B (Active Fund) using the same methodology.

(v) Compute the Information Ratio for both funds. **Formula: IR = Mean Excess Return / Tracking Error**

(vi) Compare the two funds on Tracking Error and Information Ratio. Which fund is doing what it is designed to do? Which is delivering superior risk-adjusted alpha?

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(vii) Advise Rohan on which fund to recommend given the client's 10-year horizon and cost sensitivity.

Solution

(i) Tracking Error

Tracking Error (TE):

Tracking Error is the standard deviation of the fund's excess returns relative to its benchmark. It measures HOW MUCH the fund's return deviates from the benchmark's return, on average, in either direction. A low TE indicates the fund closely tracks the benchmark; a high TE indicates the fund's returns diverge significantly.

Formula: $TE = \sqrt{[\Sigma(ER - \text{Mean ER})^2 / (n - 1)]}$

where ER = Excess Return = Fund Return − Benchmark Return, and n = number of periods.

(ii) Excess Returns for Both Funds

Fund A (Passive ETF) — Excess Returns:

Year	Fund A Return	Nifty 50 TRI	Excess Return
FY 2021-22	11.90%	12.00%	−0.10%
FY 2022-23	−5.60%	−5.50%	−0.10%
FY 2023-24	15.10%	15.00%	0.10%
FY 2024-25	8.60%	8.50%	0.10%
FY 2025-26	−3.10%	−3.00%	−0.10%

Fund B (Active Fund) — Excess Returns:

Year	Fund B Return	Nifty 50 TRI	Excess Return
FY 2021-22	18.00%	12.00%	6.00%
FY 2022-23	−8.00%	−5.50%	−2.50%
FY 2023-24	20.00%	15.00%	5.00%
FY 2024-25	5.00%	8.50%	−3.50%
FY 2025-26	2.00%	−3.00%	5.00%

(iii) Tracking Error of Fund A (Passive ETF)

Step 1 — Mean of Excess Returns:

Mean ER = (−0.10 − 0.10 + 0.10 + 0.10 − 0.10) / 5

= −0.10 / 5

= −0.02%

Step 2 — Deviations from Mean and Squared Deviations:

Year	Excess Return	Deviation from Mean	Squared Deviation
FY 2021-22	−0.10%	−0.10 − (−0.02) = −0.08	0.0064
FY 2022-23	−0.10%	−0.10 − (−0.02) = −0.08	0.0064
FY 2023-24	0.10%	0.10 − (−0.02) = 0.12	0.0144
FY 2024-25	0.10%	0.10 − (−0.02) = 0.12	0.0144
FY 2025-26	−0.10%	−0.10 − (−0.02) = −0.08	0.0064
Sum of Squared Deviations			**0.0480**

Step 3 — Variance and Tracking Error:

Sample Variance = Sum of Squared Deviations / (n − 1)

= 0.0480 / (5 − 1)

= 0.0480 / 4

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= 0.0120

Tracking Error = √Variance

= √0.0120

= 0.1095% ≈ 0.11%

Fund A's Tracking Error is extremely low (0.11%), which is consistent with a well-designed passive ETF. The tiny deviations arise from expense ratio, cash drag, and minor rebalancing timing differences.

(iv) Tracking Error of Fund B (Active Fund)

Step 1 — Mean of Excess Returns:

Mean ER = (6.00 − 2.50 + 5.00 − 3.50 + 5.00) / 5

= 10.00 / 5

= 2.00%

Step 2 — Deviations from Mean and Squared Deviations:

Year	Excess Return	Deviation from Mean	Squared Deviation
FY 2021-22	6.00%	6.00 − 2.00 = 4.00	16.00
FY 2022-23	−2.50%	−2.50 − 2.00 = −4.50	20.25
FY 2023-24	5.00%	5.00 − 2.00 = 3.00	9.00
FY 2024-25	−3.50%	−3.50 − 2.00 = −5.50	30.25
FY 2025-26	5.00%	5.00 − 2.00 = 3.00	9.00
Sum of Squared Deviations			**84.50**

Step 3 — Variance and Tracking Error:

Sample Variance = 84.50 / (5 − 1) = 84.50 / 4

= 21.125

Tracking Error = √21.125

= 4.60%

Fund B's Tracking Error is 4.60% — meaningfully higher than the passive ETF. This is expected for an active fund that intentionally deviates from the benchmark through stock selection and sector allocation.

(v) Information Ratio for Both Funds

Fund A (Passive ETF):

IR_A = Mean Excess Return / Tracking Error

= −0.02% / 0.11%

= −0.18

A near-zero (or slightly negative) IR for a passive ETF is expected — the ETF is not attempting to generate alpha; it aims to track the benchmark. Small negative IR reflects the drag of expense ratio (typically 5-10 bps for large-cap ETFs).

Fund B (Active Fund):

IR_B = 2.00% / 4.60%

= 0.435

Fund B's IR of 0.435 indicates the manager is generating ~0.44 units of excess return per unit of tracking risk. This is at the lower end of the "decent" range (0.5-0.75 is considered good).

(vi) Comparison and Interpretation

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Metric	Fund A (Passive)	Fund B (Active)	Interpretation
Mean Excess Return	−0.02%	2.00%	B generates 2 pp alpha
Tracking Error	0.11%	4.60%	B deviates 42× more
Information Ratio	−0.18	0.435	B has better risk-adjusted alpha
Purpose	Track benchmark	Generate alpha	Both meet their objectives

Is Fund A doing its job?

YES. As a passive ETF, Fund A's mission is to closely replicate Nifty 50 TRI. The TE of 0.11% is excellent — significantly below the 0.5% threshold typically considered good for large-cap index products. The slight negative mean excess (−0.02%) is entirely explained by the ETF's expense ratio (~5-10 bps for large-cap ETFs).

Is Fund B doing its job?

YES, though moderately. As an active fund, Fund B's mission is to generate alpha over Nifty 50 TRI. Mean excess return of +2.00% p.a. over 5 years is meaningful. However, the IR of 0.435 is at the lower end of "decent" — the manager is generating alpha, but with fairly variable results (high TE of 4.60% relative to alpha). An IR > 0.50 would indicate more efficient alpha generation.

(vii) Recommendation for Rohan's Client

Considerations for a 10-Year Horizon, Cost-Sensitive Investor:

Case for Fund A (Passive ETF):

(i) Ultra-low cost: Expense ratio ~0.05-0.10% p.a. vs Fund B's ~1.5-2.0%. Over 10 years, this cost saving compounds to a MEANINGFUL difference.

(ii) Tax efficiency: ETFs have lower portfolio turnover, generating less taxable capital gains distributions.

(iii) Predictable outcome: Client gets Nifty 50 TRI return minus a tiny drag. No manager skill risk.

(iv) Empirical evidence: Global research (Sharpe 1991, SPIVA reports) shows that over 10+ year horizons, 80-90% of active large-cap funds underperform their benchmark AFTER fees. This trend is strengthening in India with better market efficiency.

Case for Fund B (Active):

(i) Realized alpha: Fund B has delivered 2.00% excess return over 5 years, which is not trivial.

(ii) Focused strategy: 30-stock concentrated portfolio may capture idiosyncratic opportunities that index misses.

(iii) Downside protection potential: Active managers may raise cash or shift defensively during market stress (though Fund B's -8% in FY 2022-23 vs Nifty -5.5% suggests otherwise).

Rohan's Recommendation:

For a cost-sensitive 10-year investor, LEAN TOWARDS Fund A (Passive ETF) as the CORE allocation (70-80%). Consider Fund B as a SATELLITE position (20-30%) only if:

- The 5-year alpha of 2% p.a. has been achieved through consistent process (not luck or a single lucky bet)
- The IR of 0.435 has been improving over recent years (not declining)
- The fund manager has demonstrated skill through multiple market cycles

The mathematical reality: Fund B needs to generate ~1.5% MORE gross alpha to justify its higher fees (assuming 1.4% higher TER than the ETF). Over 10 years, even a small alpha shortfall compounds significantly. The 2% observed alpha barely covers the fee differential — a MARGIN OF SAFETY that most rational investors would prefer to be greater before committing significant capital.

Final Answer:

Recommend 70% Fund A + 30% Fund B as a balanced core-satellite structure. This captures the low-cost efficiency of passive investing while retaining some active alpha exposure for potential upside.

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Question 9 — Comparison of Three Mutual Fund Plans with Tax Analysis

Meera Krishnan, a 45-year-old senior banker at HDFC Bank Chennai, is in the 30% income tax slab. On 1st April 2023, she invested ₹1,00,000 in each of the three plans of "ICICI Prudential Bharat Growth Fund" — Growth Plan, Dividend Payout Plan, and Dividend Reinvestment Plan. All three plans hold identical underlying portfolios; the difference is only in cash distribution and tax treatment. She plans to redeem her entire holdings on 31st March 2027 (end of Year 4).

Initial Investment Details (1st April 2023):

Plan	Investment (₹)	NAV per Unit (₹)	Units Allotted
Growth Plan	1,00,000	100	1,000
Dividend Payout Plan	1,00,000	100	1,000
Dividend Reinvestment Plan	1,00,000	100	1,000

Fund Performance and Dividend Declarations (for Dividend Plans):

Year End	Dividend per Unit (₹)	Ex-Dividend NAV (₹)	Growth Plan NAV (₹)
31-Mar-2024 (Year 1)	5.00	110	115
31-Mar-2025 (Year 2)	6.00	120	131
31-Mar-2026 (Year 3)	8.00	135	154
31-Mar-2027 (Year 4)	10.00	150	179

Note on Growth Plan NAV:

The Growth Plan NAV at any given date equals the Ex-Dividend NAV of the Dividend Plan PLUS all previous dividends (since Growth Plan does not distribute dividends — they remain in the fund and drive higher NAV). This is a standard relationship used in CA Final MF questions.

Verification of Growth NAV: End Year 4 = 150 (ex-div div plan NAV) + 5 + 6 + 8 + 10 (cumulative dividends) = ₹179 ✓

Applicable Indian Tax Framework:

- LTCG on Equity Mutual Funds: 10% on gains ABOVE ₹1,00,000 per financial year (Section 112A, Finance Act 2018 onwards). Holding period > 12 months qualifies as long-term.
- Dividend from Mutual Funds: Taxable in the hands of the investor at applicable SLAB RATE (30% for Meera), post-abolition of Dividend Distribution Tax (DDT) w.e.f. 1-Apr-2020.
- Both cash dividends (Payout Plan) AND reinvested dividends (Reinvestment Plan) attract dividend tax at slab rate. Reinvestment does NOT defer tax.
- For Reinvestment Plan: Cost basis for LTCG on the reinvested units = the reinvestment NAV.

Required:

(i) For each of the three plans, compute the terminal wealth on 31-Mar-2027 (pre-tax).

(ii) For each plan, compute the total tax liability (dividend tax + LTCG tax).

(iii) For each plan, compute the post-tax terminal wealth.

(iv) Compare and rank the three plans on post-tax terminal wealth. Recommend which plan is optimal for Meera.

(v) Discuss how the answer would change if Meera were in the 5% tax slab instead of 30%.

Solution

(i) Pre-Tax Terminal Wealth under Each Plan

PLAN 1 — Growth Plan:

Initial units: ₹1,00,000 / ₹100 = 1,000 units

Growth Plan NAV at 31-Mar-2027: ₹179

Terminal wealth = 1,000 × ₹179

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Growth Plan Terminal Wealth = ₹1,79,000

PLAN 2 — Dividend Payout Plan:

Initial units: 1,000 (unchanged throughout — dividends paid in cash)

Year	Dividend per Unit (₹)	Cash Dividend Received (₹)
Year 1	5	5,000
Year 2	6	6,000
Year 3	8	8,000
Year 4	10	10,000
Total Cash Dividends		**29,000**

Redemption value at end of Year 4 (post-dividend Ex-div NAV): 1,000 × ₹150 = ₹1,50,000

Payout Plan Pre-Tax Terminal Wealth = ₹1,50,000 + ₹29,000 = ₹1,79,000

PLAN 3 — Dividend Reinvestment Plan:

Year	Opening Units	Div/Unit (₹)	Total Div (₹)	Ex-Div NAV (₹)	Add. Units	Total Units
Y1	1,000.00	5	5,000.00	110	45.45	1,045.45
Y2	1,045.45	6	6,272.73	120	52.27	1,097.73
Y3	1,097.73	8	8,781.82	135	65.05	1,162.78
Y4	1,162.78	10	11,627.78	150	77.52	1,240.30

Total dividends received (and reinvested): ₹5,000 + ₹6,272.73 + ₹8,781.82 + ₹11,627.78 = ₹31,682.33

Terminal NAV at end of Year 4 (post reinvestment): ₹150

Terminal wealth = 1,240.30 units × ₹150

Reinvestment Plan Pre-Tax Terminal Wealth = ₹1,86,044

Pre-Tax Comparison Table:

Plan	Terminal Wealth (₹)	Ranking (Pre-Tax)
Growth	1,79,000	2 (tied)
Dividend Payout	1,79,000	2 (tied)
Dividend Reinvestment	1,86,044	1

Interesting Observation:

Growth Plan and Dividend Payout Plan produce EQUAL pre-tax wealth of ₹1,79,000. This makes intuitive sense — the underlying portfolio is identical, and the total value is the same whether distributed as cash (Payout) or retained in higher NAV (Growth). The Reinvestment Plan produces HIGHER pre-tax wealth (₹1,86,044) because dividends are reinvested at ex-dividend NAV, and these units subsequently appreciate. The additional ₹7,044 comes from ex-div NAVs being LOWER than subsequent NAVs, capturing incremental gains.

(ii) Tax Computation for Each Plan

Growth Plan:

Cost basis: ₹1,00,000

Redemption value: ₹1,79,000

Long-term Capital Gain: ₹1,79,000 − ₹1,00,000 = ₹79,000

LTCG exemption per FY: ₹1,00,000

Taxable LTCG: max(0, ₹79,000 − ₹1,00,000) = ₹0

LTCG Tax: ₹0

Growth Plan Total Tax = ₹0

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Dividend Payout Plan:

Total dividends received: ₹29,000 (taxable at 30% slab rate)

Dividend Tax: ₹29,000 × 30% = ₹8,700

Cost basis for LTCG: ₹1,00,000

Redemption value: ₹1,50,000

LTCG: ₹1,50,000 − ₹1,00,000 = ₹50,000

Taxable LTCG: max(0, ₹50,000 − ₹1,00,000) = ₹0

LTCG Tax: ₹0

Payout Plan Total Tax = ₹8,700

Dividend Reinvestment Plan:

Total dividends received (and reinvested): ₹31,682.33

Dividend Tax: ₹31,682.33 × 30% = ₹9,504.70

Cost Basis for LTCG on Reinvestment Units:

Batch	Units	Purchase NAV (₹)	Cost (₹)
Original (1-Apr-23)	1,000.00	100	1,00,000.00
Y1 Reinvestment	45.45	110	5,000.00
Y2 Reinvestment	52.27	120	6,272.73
Y3 Reinvestment	65.05	135	8,781.82
Y4 Reinvestment	77.52	150	11,627.78
Total Cost Basis	**1,240.30**	**—**	**1,31,682.33**

Redemption value: 1,240.30 × ₹150 = ₹1,86,044

LTCG: ₹1,86,044 − ₹1,31,682.33 = ₹54,362

Taxable LTCG: max(0, ₹54,362 − ₹1,00,000) = ₹0

LTCG Tax: ₹0

Reinvestment Plan Total Tax = ₹9,505

Note on Holding Period:

For LTCG treatment, units must be held > 12 months. Original units (from 1-Apr-2023) qualify for LTCG for redemption on 31-Mar-2027 (4 years). Reinvested units in Y1, Y2, Y3 also qualify (held ≥ 1 year). Y4 reinvestment (31-Mar-2027) and redemption (31-Mar-2027) is same day — since NAV = redemption NAV, there is no gain on these units regardless of classification. The simplification of all units at LTCG rate is therefore justified.

(iii) Post-Tax Terminal Wealth

Plan	Pre-Tax Wealth (₹)	Total Tax (₹)	Post-Tax Wealth (₹)
Growth Plan	1,79,000	0	1,79,000
Dividend Payout Plan	1,79,000	8,700	1,70,300
Dividend Reinvestment Plan	1,86,044	9,505	1,76,540 (approx)

(iv) Ranking and Recommendation

Post-Tax Ranking:

Rank	Plan	Post-Tax Wealth (₹)	Δ vs Growth Plan
1	Growth Plan	1,79,000	—
2	Dividend Reinvestment	1,76,540	− ₹2,460 (−1.37%)
3	Dividend Payout	1,70,300	− ₹8,700 (−4.86%)

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Recommendation for Meera: GROWTH PLAN

Rationale:

(i) TAX EFFICIENCY: Growth Plan wins because it AVOIDS the annual dividend tax at slab rate. The gain compounds tax-deferred until redemption, when it is treated as LTCG at 10% (with ₹1 lakh exemption). Since her LTCG (₹79,000) is below the exemption, she pays ZERO tax under Growth Plan.

(ii) SIMPLICITY: No annual tax reporting for dividends (which is required for Payout and Reinvestment Plans in Meera's ITR). Growth Plan is simpler to administer and track.

(iii) COMPOUNDING BENEFIT: Undistributed earnings compound tax-free within the fund's NAV, which is the theoretical basis for the fundamental advantage.

(iv) AVOIDS DIVIDEND TAX "LEAKAGE": For high-slab investors (30% here), every rupee of dividend loses 30 paise to tax annually. Over long horizons, this drag compounds significantly.

Why Dividend Reinvestment Beats Payout Post-Tax (Despite Both Having Same Dividend Tax):

Reinvestment Plan's higher pre-tax wealth (₹1,86,044 vs ₹1,79,000) more than compensates for its slightly higher dividend tax (₹9,505 vs ₹8,700). Net post-tax: Reinvestment wins by ₹6,240 over Payout.

(v) What if Meera Were in 5% Tax Slab?

Recomputation with 5% Slab Rate:

Growth Plan (unchanged):

Terminal wealth: ₹1,79,000; Tax: ₹0; Post-tax: ₹1,79,000

Dividend Payout Plan:

Dividend tax: ₹29,000 × 5% = ₹1,450

LTCG tax: ₹0

Post-tax wealth: ₹1,79,000 − ₹1,450 = ₹1,77,550

Dividend Reinvestment Plan:

Dividend tax: ₹31,682.33 × 5% = ₹1,584

LTCG tax: ₹0

Post-tax wealth: ₹1,86,044 − ₹1,584 = ₹1,84,460

Revised Ranking at 5% Slab:

Rank	Plan	Post-Tax Wealth (₹)
1	Dividend Reinvestment	1,84,460
2	Growth Plan	1,79,000
3	Dividend Payout	1,77,550

Key Insight — Slab-Dependent Recommendation:

At 5% slab, the ranking FLIPS: Dividend Reinvestment beats Growth Plan by ₹5,460. Why? At low slab rates, the dividend tax leakage becomes minor, while the compounding benefit of reinvestment at ex-div NAV becomes the dominant factor. The break-even slab rate is approximately where Reinvestment post-tax equals Growth post-tax:

Growth post-tax = ₹1,79,000 (invariant)

Reinvestment post-tax = ₹1,86,044 − 31,682 × slab_rate

Setting equal: 31,682 × slab_rate = 7,044 → slab_rate ≈ 22.2%

So Growth is optimal for slabs ABOVE ~22%. Reinvestment is optimal for slabs BELOW ~22%.

Payout Never Wins:

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Under both slab scenarios, Payout Plan is the worst option. This is because Payout receives dividends in cash (which lose value to tax) but does NOT benefit from reinvestment at ex-div NAVs. Cash sitting outside the fund does not compound at fund returns.

General Rule for Indian Investors:

Tax Slab	Recommended Plan	Reasoning
Above 20%	Growth Plan	Avoids dividend tax leakage
Below 20%	Dividend Reinvestment	Low tax drag, maximum compounding
Never	Dividend Payout	Cash dividends lose reinvestment opportunity

Exception: Dividend Payout Plan MAY be appropriate for retirees seeking regular income, even at higher slabs, because the periodic cash flow serves a consumption need. In such cases, choose Payout despite the tax inefficiency.

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CHAPTER 9 — DERIVATIVES ANALYSIS AND VALUATION

Question 1 — Portfolio Beta Adjustment Using Nifty Futures

Vikramaditya Rathore is the Head of Portfolio Management Services at Motilal Oswal Wealth Management, Mumbai. He manages a discretionary equity portfolio for HNI clients with the following characteristics as on 15th September 2026:

Portfolio Snapshot:

Parameter	Value
Portfolio Market Value	₹80.00 crore
Portfolio Beta (weighted)	1.35
Composition	Large-cap + Mid-cap equity (aggressive tilt)
Benchmark	Nifty 50 TRI

Market Data (15-Sep-2026):

Parameter	Value
Nifty 50 Spot	24,000
Nifty 50 Sep 2026 Futures	24,180
Nifty Futures Lot Size	25 units
Contract Value per Lot	24,180 × 25 = ₹6,04,500

Market Outlook — Vikramaditya's View:

Vikramaditya expects heightened volatility over the next 2-3 months due to (a) upcoming state elections, (b) US Fed policy uncertainty, and (c) FII flows softening. He wants to protect the portfolio without unwinding the cash equity positions (which would trigger churning, transaction costs, and adverse tax implications). He decides to use Nifty 50 futures to adjust his effective portfolio beta.

Required:

(i) Explain the formula for computing the number of index futures contracts required to adjust portfolio beta from a current level (βP) to a target level (βT).

(ii) SCENARIO A: Compute the number of Nifty futures contracts required to FULLY HEDGE the portfolio (target β = 0). Specify direction (long/short).

(iii) SCENARIO B: Compute the number of Nifty futures contracts required to REDUCE portfolio beta to 0.60 (defensive tilt while retaining some market participation). Specify direction.

(iv) SCENARIO C: Compute the number of Nifty futures contracts required to INCREASE portfolio beta to 1.80 (aggressive positioning for a potential year-end rally). Specify direction.

(v) VERIFICATION: Under Scenario A (full hedge), demonstrate the hedge effectiveness by computing the net P&L if Nifty falls by 5% over the next month, assuming the beta relationship holds precisely.

(vi) Comment on why futures-based beta adjustment is preferred over cash-market restructuring for a large equity portfolio.

Solution

(i) Beta Adjustment Formula

Formula for Number of Index Futures Contracts:

N = [(βP − βT) × VP] / [F × Lot Size]

Where:

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- N = Number of futures contracts (positive = SHORT to reduce beta; negative = LONG to increase beta)
- βP = Current portfolio beta
- βT = Target portfolio beta
- VP = Portfolio market value (₹)
- F = Index futures price
- Lot Size = Contract multiplier

Rationale:

The dollar risk of the portfolio is βP × VP (sensitivity of portfolio value to a 1% move in index). Each short futures contract adds negative exposure of F × Lot Size. To move from βP to βT, we must NEUTRALIZE the difference (βP − βT) × VP through futures. The number of contracts needed equals the differential exposure divided by exposure per contract.

Sign Convention:

- If N is POSITIVE → SHORT futures (reduces exposure). Used when βT < βP (defensive).
- If N is NEGATIVE → LONG futures (increases exposure). Used when βT > βP (aggressive).

(ii) Scenario A — Full Hedge (target β = 0)

Given:

- βP = 1.35
- βT = 0
- VP = ₹80,00,00,000
- F × Lot Size = 24,180 × 25 = ₹6,04,500

Computation:

N = (1.35 − 0) × 80,00,00,000 / 6,04,500

= 1.35 × 80,00,00,000 / 6,04,500

= 1,08,00,00,000 / 6,04,500

= 1,786.60 contracts

Rounded: SHORT 1,787 Nifty Sep 2026 Futures contracts

Since N is positive and the objective is to reduce beta from 1.35 to 0, Vikramaditya must SHORT 1,787 Nifty futures. This creates offsetting negative exposure that neutralizes the portfolio's 1.35 beta.

(iii) Scenario B — Defensive Tilt (target β = 0.60)

Computation:

N = (1.35 − 0.60) × 80,00,00,000 / 6,04,500

= 0.75 × 80,00,00,000 / 6,04,500

= 60,00,00,000 / 6,04,500

= 992.56 contracts

Rounded: SHORT 993 Nifty Sep 2026 Futures contracts

Retaining beta of 0.60 means the portfolio still participates in ~44% of market upside (0.60/1.35 = 44%) while cutting downside participation proportionally. This is a partial hedge — appropriate when Vikramaditya wants to reduce risk but not eliminate market exposure entirely.

(iv) Scenario C — Aggressive Tilt (target β = 1.80)

Computation:

N = (1.35 − 1.80) × 80,00,00,000 / 6,04,500

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= (−0.45) × 80,00,00,000 / 6,04,500

= −36,00,00,000 / 6,04,500

= −595.53 contracts

Rounded: LONG 596 Nifty Sep 2026 Futures contracts

The NEGATIVE sign flips the direction — to INCREASE beta from 1.35 to 1.80, Vikramaditya must LONG (buy) 596 Nifty futures. Long futures add positive market exposure, effectively leveraging the portfolio's market participation.

(v) Hedge Effectiveness Verification (Scenario A)

Assumption: Nifty falls 5% over next month.

Step 1 — Expected Portfolio Loss:

Portfolio return (via beta) = βP × Market return

= 1.35 × (−5%)

= −6.75%

Portfolio Loss = ₹80 crore × 6.75% = ₹5.40 crore (LOSS)

Step 2 — Gain on Short Futures Position:

Nifty spot falls 5%: 24,000 → 22,800

Nifty futures (parallel movement): 24,180 → 22,971 (assumed 5% drop for simplicity)

Gain per short contract = (24,180 − 22,971) × 25 = 1,209 × 25 = ₹30,225 per contract

Total gain on 1,787 short contracts:

= 1,787 × ₹30,225

= ₹5,40,12,075 ≈ ₹5.40 crore (GAIN)

Step 3 — Net P&L:

Item	Amount (₹ crore)
Portfolio Loss (Cash Equity)	(5.40)
Gain on Short Nifty Futures (1,787 contracts)	5.40
Net P&L	**~ Nil**

The tiny residual (~₹1,200 due to rounding of 1,786.60 to 1,787) confirms the hedge works. In practice, minor tracking error arises from (a) rounding contracts to integers, (b) beta not being exactly linear/stable, and (c) basis risk between spot and futures.

(vi) Why Futures-Based Beta Adjustment Beats Cash Restructuring

Advantages of Using Index Futures:

(i) Speed of Execution: A large portfolio (₹80 cr) can be beta-neutralized in ONE day via futures. Selling ₹80 cr of cash equity would take days or weeks and create market impact.

(ii) Cost Efficiency: Nifty futures have narrow bid-ask spreads (0.05-0.10 points) and low STT/exchange charges. Selling and rebuying cash equity involves 0.10% STT on both legs plus higher brokerage, typically 25-40 bps roundtrip.

(iii) Tax Efficiency: Selling long-term equity positions triggers LTCG realization. Using futures keeps the cash equity positions UNCHANGED — no capital gains crystallization until the futures position is rolled or unwound.

(iv) Reversibility: Futures positions can be flexibly adjusted (Scenario B → A → C intraday if needed). Cash portfolio restructuring is directional and slow to reverse.

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(v) Preserves Alpha: If Vikramaditya's stock selection generates alpha (say, mid-caps outperforming Nifty), the alpha is PRESERVED because underlying stocks are unchanged. Only market beta is neutralized. Selling stocks would destroy the alpha capture.

(vi) Leverage on Margin: Futures require only 12-15% initial margin (SPAN + Exposure), freeing up ₹68+ crore of capital that would otherwise be tied up in cash equity offset.

Trade-off — Basis Risk and Mark-to-Market:

Futures introduce (a) basis risk (spot and futures may not move in perfect proportion), (b) daily mark-to-market cash calls (need to fund losses if index rises), and (c) roll costs when contracts expire (Sep → Dec roll costs ~0.15% typically). These are minor for a large, liquid contract like Nifty 50 futures with a professional wealth manager.

Question 2 — Stock Futures Arbitrage on Reliance Industries

Rajarshi Sen is Head of Arbitrage Strategy at Edelweiss Alternative Investment Fund, a SEBI Category III AIF running an equity arbitrage book targeting risk-free returns from mispricing between the cash and futures markets. On 15th July 2026, he identifies the following data on Reliance Industries Ltd (RELIANCE):

Market Data (15-Jul-2026):

Parameter	Value
Reliance Industries Spot Price	₹2,800
Reliance Sep 2026 Futures Price (market)	₹2,865
Time to Expiry (26-Sep-2026)	3 months
91-Day Treasury Bill Yield (Rf)	7.00% p.a.
Expected Dividend Announcement	₹8 per share, ex-dividend 15-Sep-2026
NSE Reliance Futures Lot Size	250 shares

Additional Assumptions:

- Borrowing and lending are available at Rf = 7% p.a. (simple interest)
- Short-selling is possible via the Securities Lending and Borrowing (SLB) mechanism
- Transaction costs, margin calls, and stamp duty are ignored for computation purposes
- Rajarshi's fund can execute up to 100 lots per identified arbitrage opportunity

Required:

(i) Explain the Cost-of-Carry model for pricing stock futures and derive the fair futures price formula, accounting for dividends expected before expiry.

(ii) Compute the theoretical (fair) futures price for Reliance Sep 2026 contract.

(iii) Compare the fair price with the market price of ₹2,865. Is the futures OVERPRICED or UNDERPRICED? Identify the appropriate arbitrage strategy.

(iv) Design the step-by-step arbitrage strategy showing cash flows at t = 0, t = 2 months (dividend), and t = 3 months (expiry). Compute the arbitrage profit per share and per lot.

(v) Compute the total arbitrage profit if Rajarshi executes 100 lots. Express the return on capital deployed on both a 3-month and annualized basis.

(vi) SCENARIO B (Comparative Analysis): If the market futures price were ₹2,820 instead of ₹2,865, identify the arbitrage type and design the strategy. Compute profit per share.

(vii) Discuss the real-world constraints that may erode arbitrage profits in practice.

Solution

(i) Cost-of-Carry Model for Stock Futures Pricing

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Fundamental Principle:

The fair price of a futures contract equals the total cost of buying the underlying stock in the spot market AND CARRYING it until the futures expiry date. Carrying costs include (a) financing cost (interest on capital tied up in the stock), minus (b) any income received during the carry period (dividends). This is called the Cost-of-Carry model.

Fair Value Formula (ICAI SM Convention — Discrete Simple Interest):

$F = S \times (1 + r \times T) - Div \times (1 + r \times (T - t))$

Where:

- F = Fair futures price at contract inception
- S = Spot price of the underlying stock
- r = Risk-free interest rate (annualized)
- T = Time to futures expiry (years)
- Div = Expected dividend per share before expiry
- t = Time to ex-dividend date (years) — the dividend is received at time t and reinvested at r for the remaining period (T − t)

Economic Interpretation:

Buying spot and holding until expiry costs S × (1 + rT) — the amount that ₹S invested at r for T years would grow to. Against this, the holder earns dividends. The dividend received at time t is invested at r for the remaining (T − t) period, growing to Div × (1 + r(T − t)). The NET cost of carry (financing minus dividend income) equals the fair futures price.

No-Arbitrage Enforcement:

If market futures price DEVIATES from F:

- Market Futures > Fair Value → OVERPRICED → CASH-AND-CARRY arbitrage (buy spot, sell futures)
- Market Futures < Fair Value → UNDERPRICED → REVERSE CASH-AND-CARRY arbitrage (short spot, buy futures)

Arbitrageurs (like Rajarshi) buy the cheap side and sell the expensive side, locking in a risk-free profit and pushing prices back to fair value.

(ii) Fair Futures Price Computation

Inputs:

- S = ₹2,800
- r = 7% p.a. = 0.07
- T = 3 months = 3/12 = 0.25 years
- Div = ₹8 per share
- t = 2 months (dividend at end of month 2)
- T − t = 1 month = 1/12 years

Step 1 — Financing Cost Component:

$S \times (1 + r \times T)$

$= 2,800 \times (1 + 0.07 \times 0.25)$

$= 2,800 \times 1.0175$

= ₹2,849.00

Step 2 — Dividend Reinvestment Value:

$Div \times (1 + r \times (T - t))$

$= 8 \times (1 + 0.07 \times 1/12)$

$= 8 \times 1.005833$

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= ₹8.0467

Step 3 — Fair Futures Price:

F = ₹2,849.00 − ₹8.0467

F = ₹2,840.95

(iii) Arbitrage Identification

Item	Value (₹)
Market Futures Price	2,865.00
Fair Futures Price (as computed)	2,840.95
Mispricing (Overvaluation)	**+ 24.05**

Conclusion: The market futures price of ₹2,865 EXCEEDS the fair value of ₹2,840.95 by ₹24.05 per share (0.85% overvaluation).

Arbitrage Strategy: CASH-AND-CARRY

Since futures is OVERPRICED, arbitrageur should:

- SELL the expensive side → Short Reliance futures at ₹2,865
- BUY the cheap side → Purchase Reliance shares in cash at ₹2,800 (financed by borrowing)

(iv) Step-by-Step Cash-and-Carry Arbitrage Strategy

t = 0 (Today, 15-Jul-2026):

Step	Action	Cash Flow (₹)
1	Borrow ₹2,800 for 3 months at 7% p.a.	+ 2,800.00
2	Buy 1 share of Reliance in cash market	− 2,800.00
3	Sell 1 Reliance Sep 2026 Futures at ₹2,865 (no upfront cost)	0.00
Net Cash Flow at t=0		**0.00**

Since the strategy requires no net capital deployment at inception (loan proceeds finance the share purchase), any resulting positive cash flow at expiry is a RISK-FREE ARBITRAGE PROFIT.

t = 2 months (15-Sep-2026, Ex-Dividend):

Step	Action	Cash Flow (₹)
4	Receive dividend on 1 share held	+ 8.00
5	Reinvest dividend at 7% for 1 month	0.00 (deferred)

t = 3 months (26-Sep-2026, Futures Expiry):

Step	Action	Cash Flow (₹)
6	Dividend + 1 month interest (₹8 × 1.005833)	+ 8.0467
7	Deliver 1 share against short futures at ₹2,865	+ 2,865.00
8	Repay loan: ₹2,800 × (1 + 0.07 × 0.25) = ₹2,849.00	− 2,849.00
Net Arbitrage Profit (per share)		**+ 24.0467**

Arbitrage Profit per Share = ₹24.05 (matches the mispricing exactly)

Arbitrage Profit per Lot:

Lot size = 250 shares

Profit per lot = ₹24.0467 × 250

Profit per lot = ₹6,011.67

(v) Portfolio-Level Arbitrage Economics (100 Lots)

Total Position — 100 Lots × 250 Shares = 25,000 Reliance Shares:

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Item	Computation	Amount (₹)
Capital deployed (loan)	2,800 × 25,000	7,00,00,000
Short futures notional	2,865 × 25,000	7,16,25,000
Total arbitrage profit	24.0467 × 25,000	6,01,167

Return on Capital Deployed:

Return over 3 months = 6,01,167 / 7,00,00,000 × 100

= 0.859%

Annualized (simple): 0.859% × 4 = 3.44% p.a.

Return Analysis:

On a standalone basis, 3.44% annualized may appear modest. But keep in mind: (a) this is essentially RISK-FREE (both legs perfectly hedged), (b) the actual capital deployed is significantly less than ₹7 crore because futures require only 15-20% margin (not the full notional), so return on ACTUAL equity capital is 4-5× higher (~15-17% annualized). Institutional arbitrage desks typically stack multiple such opportunities across NSE listed stocks to generate 12-18% annualized returns on deployed equity with very low risk.

(vi) Scenario B — Reverse Cash-and-Carry (Underpriced Futures)

Assumption: Market futures = ₹2,820 (instead of ₹2,865)

Mispricing Check:

Fair Value = ₹2,840.95

Market Futures = ₹2,820

Mispricing = 2,820 − 2,840.95 = − ₹20.95 (UNDERPRICED)

Arbitrage Strategy: REVERSE CASH-AND-CARRY

Since futures is UNDERPRICED:

- BUY the cheap side → Long Reliance futures at ₹2,820
- SELL the expensive side → Short-sell Reliance shares in cash market at ₹2,800 (via SLB)

Step-by-Step Cash Flows (per share):

Time	Action	Cash Flow (₹)
t = 0	Short-sell 1 Reliance share (via SLB) at ₹2,800	+ 2,800.00
t = 0	Invest ₹2,800 at 7% for 3 months	− 2,800.00
t = 0	Long 1 Reliance Sep Futures at ₹2,820	0.00
t = 2m	Pay dividend to SLB stock lender: ₹8 (compensation for lost dividend)	− 8.00
t = 3m	Investment matures: 2,800 × 1.0175	+ 2,849.00
t = 3m	Take delivery via long futures at ₹2,820, return share to SLB lender	− 2,820.00
t = 3m	**Compounded dividend cost (₹8 × 1.005833)**	**− 8.0467**
Net Arbitrage Profit (per share)		**+ 20.9533**

Arbitrage Profit per Share = ₹20.95 (matches |mispricing| exactly)

Arbitrage Profit per Lot = ₹20.9533 × 250 = ₹5,238.33

(vii) Real-World Constraints on Arbitrage

The theoretical arbitrage profits of ₹24.05 (cash-and-carry) or ₹20.95 (reverse) per share may erode significantly in practice due to:

(i) Transaction Costs: Brokerage on cash equity (typically 3-5 bps), STT (0.10% on cash sales), stamp duty, GST, and exchange transaction charges collectively can consume 15-20 bps roundtrip — potentially eroding ₹5-6 per share.

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(ii) Margin Requirements: Selling futures requires SPAN + Exposure margin (~15-20% of notional) plus daily mark-to-market cash calls. If Reliance rallies before expiry, MTM losses on shorts must be funded from cash, tying up additional capital.

(iii) Short-Selling Costs: In the reverse arbitrage, SLB borrowing costs (Securities Lending and Borrowing fees) typically 1-3% p.a. of stock value directly erode the arbitrage profit.

(iv) Basis Risk: If the futures price converges to spot NOT smoothly (e.g., jump around dividend announcement), the arbitrage may not close at the exact fair value. The convergence happens gradually as expiry approaches.

(v) Corporate Action Risk: Unexpected changes to dividend amount (e.g., special dividend announced later) or corporate actions (bonus, rights) alter the fair value calculation and may create losses.

(vi) Execution Slippage: Buying 25,000 shares in the cash market may push the price up (impact cost), and selling 100 lots of futures may push the futures price down. Both erode the mispricing.

(vii) Capital Cost vs Rf Assumption: The formula assumes borrowing at Rf. Arbitrage desks actually borrow at their bank's MCLR or Repo + spread, often 100-200 bps above Rf. This raises the true fair value slightly and reduces net arbitrage.

(viii) SEBI/RBI Regulatory Constraints: SLB has volume limits and availability constraints; not all Reliance shares can be borrowed at all times. FPI limits may also apply for foreign arbitrageurs.

Practical Threshold:

Institutional arbitrage desks typically require gross mispricing of at least 0.50-0.75% of spot (i.e., ₹14-₹21 per share on Reliance at ₹2,800) to justify execution after transaction costs. The ₹24 mispricing shown here would clear that threshold with a modest margin of safety, making it a viable trade.

Question 3 — Options Fundamentals on HDFC Bank

Deepa Iyer, a derivative strategist at ICICI Securities in Mumbai, is training a new batch of relationship managers on the fundamental building blocks of options — payoff profiles, moneyness classification, breakeven analysis, and the powerful Put-Call Parity relationship. She uses the following live market data on HDFC Bank Ltd (HDFCBANK) options as of 15th July 2026 for the Sep 2026 expiry:

Market Data on HDFCBANK (15-Jul-2026):

Parameter	Value
HDFC Bank Spot Price (S)	₹1,600
Sep 2026 Expiry Call Option (K = ₹1,600, ATM)	Premium ₹65
Sep 2026 Expiry Put Option (K = ₹1,600, ATM)	Premium ₹45
Time to Expiry (26-Sep-2026)	3 months
91-Day T-Bill Rate (Rf)	7.00% p.a.
Lot Size (HDFCBANK options)	550 shares

Additional strike prices trading in the market:

- Sep 2026 Call at K = ₹1,500 (₹120 premium) and K = ₹1,700 (₹25 premium)
- Sep 2026 Put at K = ₹1,500 (₹20 premium) and K = ₹1,700 (₹105 premium)

Required:

(i) Classify the moneyness (ITM/ATM/OTM) of each of the six options listed above at the current spot price. Also compute the intrinsic value and time value for the ATM call and ATM put.

(ii) Prepare payoff tables (P&L at expiry) for the four basic option positions — Long Call, Short Call, Long Put, Short Put — using the ATM strike (₹1,600). Consider spot prices at expiry: ₹1,400, ₹1,500, ₹1,600, ₹1,700, ₹1,800, ₹1,900. Identify the breakeven point and maximum profit/loss for each position.

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(iii) State the Put-Call Parity (PCP) relationship. Verify whether PCP holds for the ATM (K = ₹1,600) options. If PCP is violated, quantify the mispricing.

(iv) Given the PCP violation in (iii), design a step-by-step arbitrage strategy showing cash flows at t = 0 and t = T (expiry). Demonstrate that the arbitrage profit is locked in at t = 0 regardless of the underlying spot price at expiry.

(v) Using the PCP relationship, express and construct SYNTHETIC positions: (a) Synthetic Long Stock, (b) Synthetic Short Stock, (c) Synthetic Long Call, (d) Synthetic Long Put. Show the components for each.

Solution

(i) Moneyness Classification, Intrinsic and Time Value

Definitions:

- In-The-Money (ITM): Immediate exercise generates positive intrinsic value. Call ITM when S > K; Put ITM when S < K.
- At-The-Money (ATM): Strike equals current spot. S = K.
- Out-of-The-Money (OTM): No positive intrinsic value. Call OTM when S < K; Put OTM when S > K.

Classification at S = ₹1,600:

Option Type	Strike (₹)	Spot (₹)	Moneyness	Intrinsic Value (₹)
Call	1,500	1,600	ITM (S > K)	1,600 − 1,500 = 100
Call	1,600	1,600	ATM (S = K)	0
Call	1,700	1,600	OTM (S < K)	0
Put	1,500	1,600	OTM (S > K)	0
Put	1,600	1,600	ATM (S = K)	0
Put	1,700	1,600	ITM (S < K)	1,700 − 1,600 = 100

Intrinsic Value and Time Value Analysis for ATM Options (K = ₹1,600):

Formula: Premium = Intrinsic Value + Time Value

Option	Premium (₹)	Intrinsic Value (₹)	Time Value (₹)
ATM Call (K = 1,600)	65	max(1,600 − 1,600, 0) = 0	65 − 0 = 65
ATM Put (K = 1,600)	45	max(1,600 − 1,600, 0) = 0	45 − 0 = 45

For ATM options, the ENTIRE premium is time value — no intrinsic value exists because immediate exercise gives zero payoff. The time value reflects two components: (a) time to expiry (more time = more chance for favorable movement), and (b) volatility (higher volatility increases the range of possible outcomes).

Why Call Time Value (₹65) > Put Time Value (₹45)?

Both options are ATM with the same expiry and volatility. The difference reflects the COST OF CARRY:

- Call holder benefits from delayed purchase — the ₹1,600 need not be paid today, saving 3 months of interest (₹1,600 × 7% × 3/12 = ₹28).
- Put holder foregoes interest on the strike payment they will receive later — costs them ₹28.

The ₹20 gap in premiums (₹65 − ₹45) approximately equals this interest saving effect (₹28), less the small dividend yield expected on HDFC Bank during the period. This is exactly the intuition behind Put-Call Parity — verified numerically in Part (iii).

(ii) Payoff Tables for the Four Basic Positions (K = ₹1,600)

(a) LONG CALL — Buy Call at ₹65 premium:

P&L at Expiry = max(ST − K, 0) − Premium

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Spot at Expiry (ST)	max(ST − K, 0)	Premium (₹)	P&L (₹)
1,400	0	−65	−65
1,500	0	−65	−65
1,600	0	−65	−65
1,700	100	−65	+35
1,800	200	−65	+135
1,900	300	−65	+235

- Breakeven: S* = K + Premium = 1,600 + 65 = ₹1,665
- Maximum Loss: ₹65 (premium paid, bounded)
- Maximum Profit: Unlimited (as ST → ∞)

(b) SHORT CALL — Sell Call at ₹65 premium:

P&L at Expiry = Premium − max(ST − K, 0)

Spot at Expiry (ST)	−max(ST − K, 0)	Premium (₹)	P&L (₹)
1,400	0	+65	+65
1,500	0	+65	+65
1,600	0	+65	+65
1,700	−100	+65	−35
1,800	−200	+65	−135
1,900	−300	+65	−235

- Breakeven: same as long call, ₹1,665
- Maximum Profit: ₹65 (premium received, bounded)
- Maximum Loss: Unlimited (as ST → ∞) — this is the DANGEROUS position; SEBI mandates margin requirements to protect against unlimited loss

(c) LONG PUT — Buy Put at ₹45 premium:

P&L at Expiry = max(K − ST, 0) − Premium

Spot at Expiry (ST)	max(K − ST, 0)	Premium (₹)	P&L (₹)
1,400	200	−45	+155
1,500	100	−45	+55
1,600	0	−45	−45
1,700	0	−45	−45
1,800	0	−45	−45
1,900	0	−45	−45

- Breakeven: S* = K − Premium = 1,600 − 45 = ₹1,555
- Maximum Loss: ₹45 (premium paid, bounded)
- Maximum Profit: K − Premium = ₹1,555 (bounded, occurs when ST = 0 — theoretical only)

(d) SHORT PUT — Sell Put at ₹45 premium:

P&L at Expiry = Premium − max(K − ST, 0)

Spot at Expiry (ST)	−max(K − ST, 0)	Premium (₹)	P&L (₹)
1,400	−200	+45	−155
1,500	−100	+45	−55
1,600	0	+45	+45
1,700	0	+45	+45
1,800	0	+45	+45

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Spot at Expiry (ST)	−max(K − ST, 0)	Premium (₹)	P&L (₹)
1,900	0	+45	+45

- Breakeven: same as long put, ₹1,555
- Maximum Profit: ₹45 (premium received, bounded)
- Maximum Loss: K − Premium = ₹1,555 (large but bounded, occurs when ST = 0)

Summary of the Four Positions:

Position	Market View	Max Profit	Max Loss	Breakeven
Long Call	Strongly Bullish	Unlimited	₹65	₹1,665
Short Call	Neutral to Bearish	₹65	Unlimited	₹1,665
Long Put	Strongly Bearish	₹1,555	₹45	₹1,555
Short Put	Neutral to Bullish	₹45	₹1,555	₹1,555

(iii) Put-Call Parity Verification

Put-Call Parity Relationship (for European Options, No Dividend):

C + K / (1 + rT) = P + S

Or equivalently: C − P = S − PV(K)

Where:

- C = Call premium; P = Put premium (both same strike K, same expiry T)
- K = Strike price; r = Risk-free rate; T = Time to expiry
- S = Current spot price
- PV(K) = Present value of strike = K / (1 + rT)

Economic Intuition:

Consider two portfolios:

- Portfolio 1 (LHS): Long Call + Investment of PV(K) at Rf → At expiry, guarantees payoff of max(ST, K) [call for upside; PV(K) matures to K for downside]
- Portfolio 2 (RHS): Long Put + Long Stock → At expiry, guarantees payoff of max(ST, K) [stock for upside; put for downside]

Since both portfolios have identical terminal payoffs regardless of ST, they must have identical costs at inception — otherwise a risk-free arbitrage exists.

Numerical Check for HDFC Bank Options:

PV(K) = 1,600 / (1 + 0.07 × 3/12)

= 1,600 / 1.0175

= ₹1,572.48

LHS = C + PV(K) = 65 + 1,572.48 = ₹1,637.48

RHS = P + S = 45 + 1,600 = ₹1,645.00

Mispricing = RHS − LHS = 1,645.00 − 1,637.48 = ₹7.52

Conclusion: Put-Call Parity IS VIOLATED.

RHS is OVERPRICED by ₹7.52 per share. This creates an arbitrage opportunity — buy the underpriced side (LHS) and sell the overpriced side (RHS), locking in a risk-free profit of ₹7.52 per share.

(iv) Conversion Arbitrage Strategy

Arbitrage Rule: BUY the CHEAP side (LHS), SELL the EXPENSIVE side (RHS).

Strategy Construction:

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Component	Action
Long Call (LHS)	BUY 1 Sep Call K=1,600 at ₹65
Invest PV(K) (LHS)	INVEST ₹1,572.48 at 7% for 3 months
Long Put (RHS mirror)	SHORT (SELL) 1 Sep Put K=1,600, receive ₹45
SHORT SELL STOCK (RHS mirror)	SHORT SELL 1 HDFC Bank share at ₹1,600 (via SLB)

Cash Flow at t = 0 (per share):

Step	Transaction	Cash Flow (₹)
1	Buy Call at ₹65	− 65.00
2	Sell Put, receive ₹45	+ 45.00
3	Short-sell 1 HDFC Bank share, receive ₹1,600	+ 1,600.00
4	Invest ₹1,572.48 at 7% for 3 months	− 1,572.48
Net Cash Inflow at t = 0		**+ 7.52**

Cash Flow at t = 3 months (Expiry) — Two Scenarios:

Scenario A: ST > K (say ST = ₹1,800):

Step	Transaction	Cash Flow (₹)
1	Investment matures: 1,572.48 × 1.0175 = ₹1,600	+ 1,600.00
2	Exercise Long Call: pay K, receive share (1,800 − 1,600) = 200	+ 200.00
3	Short Put expires worthless (ST > K)	0.00
4	Cover short stock at 1,800	− 1,800.00
Net Cash Flow at Expiry		**0.00**

Scenario B: ST < K (say ST = ₹1,400):

Step	Transaction	Cash Flow (₹)
1	Investment matures	+ 1,600.00
2	Long Call expires worthless (ST < K)	0.00
3	Short Put exercised against: pay (K − ST) = 200	− 200.00
4	Cover short stock at 1,400	− 1,400.00
Net Cash Flow at Expiry		**0.00**

Verification:

In BOTH scenarios (ST above or below K), the net cash flow at expiry is EXACTLY zero. The arbitrage profit of ₹7.52 per share captured at t = 0 is therefore LOCKED IN with zero risk. This is the hallmark of a true arbitrage.

Per-Lot Arbitrage Profit:

HDFCBANK options lot size = 550 shares

Profit per lot = ₹7.52 × 550 = ₹4,136

Practical Reality Check:

A ₹7.52 mispricing on a ₹1,600 stock is small (0.47%) and would likely be arbitraged away within seconds by high-frequency trading desks. This example is illustrative — real-world PCP violations exceeding 1% are rare in liquid options like HDFC Bank.

(v) Synthetic Positions from Put-Call Parity

Rearranging the PCP equation C + PV(K) = P + S, we can express any single instrument as a combination of the other three. These are called SYNTHETIC positions — replicating the payoff of one instrument using a portfolio of others.

Rearrangement 1: S = C − P + PV(K)

(a) SYNTHETIC LONG STOCK:

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- Long Call + Short Put + Invest PV(K)
- Cost = 65 − 45 + 1,572.48 = ₹1,592.48 (vs actual stock ₹1,600 — ₹7.52 cheaper, confirming the arbitrage above)
- Payoff at expiry: max(ST − K, 0) − max(K − ST, 0) + K = ST (identical to stock)

Rearrangement 2: −S = −C + P − PV(K), or S(short) = P − C + Borrow PV(K)

(b) SYNTHETIC SHORT STOCK:

- Long Put + Short Call + Borrow PV(K)
- Cost = 45 − 65 − 1,572.48 = − ₹1,592.48 (i.e., net cash inflow, mirroring short-sale proceeds)
- Payoff at expiry: max(K − ST, 0) − max(ST − K, 0) − K = − ST (identical to short stock)

Rearrangement 3: C = P + S − PV(K)

(c) SYNTHETIC LONG CALL:

- Long Put + Long Stock + Borrow PV(K)
- Cost = 45 + 1,600 − 1,572.48 = ₹72.52 (vs actual call ₹65 — ₹7.52 more expensive, confirming call is UNDERPRICED)
- Payoff at expiry: max(K − ST, 0) + ST − K = max(ST − K, 0) — identical to call payoff

Rearrangement 4: P = C − S + PV(K)

(d) SYNTHETIC LONG PUT:

- Long Call + Short Stock + Invest PV(K)
- Cost = 65 − 1,600 + 1,572.48 = ₹37.48 (vs actual put ₹45 — ₹7.52 cheaper, confirming put is OVERPRICED)
- Payoff at expiry: max(ST − K, 0) − ST + K = max(K − ST, 0) — identical to put payoff

Key Insight from Synthetic Analysis:

The PCP mispricing reveals which instrument is over/underpriced:

- Actual Call ₹65 < Synthetic Call ₹72.52 → Call is UNDERPRICED (BUY the actual call, sell the synthetic)
- Actual Put ₹45 > Synthetic Put ₹37.48 → Put is OVERPRICED (SELL the actual put, buy the synthetic)

Both mispricings confirm the same arbitrage strategy from Part (iv) — buy call, sell put, sell stock, invest cash — reinforcing that PCP violations imply a unique arbitrage direction.

Question 4 — Two-Step Binomial Option Pricing on TCS

Aditi Nair, an equity derivatives trader at Nuvama Institutional, is asked to price Sep 2026 European call and put options on Tata Consultancy Services (TCS) using a two-step binomial tree model. The model provides a discrete-time approximation to option prices — a foundational technique that also underpins American option pricing (Q5) and connects to the Black-Scholes framework (Q6). She uses the following market inputs as of 15th July 2026:

Model Inputs:

Parameter	Value
TCS Spot Price (S_0)	₹3,600
Strike Price (K, ATM)	₹3,600
Time to Expiry (T)	6 months
Number of Steps (n)	2
Time per Step (Δt)	3 months = 0.25 years
Up Factor (u)	1.20 (20% up move per step)
Down Factor (d)	0.80 (20% down move per step)
Risk-Free Rate (Rf)	8% p.a. (simple interest)
Option Style	European (exercise only at expiry)

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Required:

(i) State the risk-neutral valuation approach. Derive and compute the risk-neutral probability (p) for a single step of the binomial tree.

(ii) Construct the stock price binomial tree for TCS over the 6-month period (2 steps of 3 months each). Show all node values.

(iii) Compute the European CALL option value at t = 0 by backward induction from the terminal payoffs.

(iv) Compute the European PUT option value at t = 0 by backward induction.

(v) Verify Put-Call Parity holds using the computed call and put values.

(vi) Construct the REPLICATING PORTFOLIO (Δ shares of stock + Borrow B) that mimics the CALL payoff from t = 0 to t = 3 months. Verify that the cost of the replicating portfolio equals the call value.

Solution

(i) Risk-Neutral Valuation Approach

Core Concept:

In the binomial model, an option's fair value is derived NOT from real-world probabilities of up/down moves (which depend on investors' risk preferences and are unobservable), but from the RISK-NEUTRAL probabilities (p and 1−p) that make the underlying stock's expected return equal to the risk-free rate.

Rationale:

Under the risk-neutral measure, the discounted expected value of the option payoff equals its current fair price. This measure exists because we can CONSTRUCT a portfolio of Δ shares plus borrowing that exactly replicates the option payoff. Since the replicating portfolio has a known cost and identical cash flows, the option must have the same value — otherwise arbitrage exists.

Risk-Neutral Probability Formula (ICAI SM Convention, Discrete Simple Interest):

$p = (1 + r \times \Delta t - d) / (u - d)$

Where:

- r = Risk-free rate (annualized)
- Δt = Time per step (years)
- u = Up factor
- d = Down factor

Computation for TCS:

Step interest factor: $(1 + r \times \Delta t) = 1 + 0.08 \times 0.25 = 1.02$

$p = (1.02 - 0.80) / (1.20 - 0.80)$

$= 0.22 / 0.40$

$= 0.55$

$(1 - p) = 0.45$

Interpretation: In the risk-neutral world, TCS has a 55% probability of moving up (to ₹4,320 in 3 months) and 45% probability of moving down (to ₹2,880). These probabilities equalize the stock's expected return with the risk-free rate:

$E[S_1] / S_0 = (0.55 \times 4{,}320 + 0.45 \times 2{,}880) / 3{,}600 = 3{,}672 / 3{,}600 = 1.02 = (1 + r \times \Delta t)$ ✓

(ii) TCS Stock Price Binomial Tree

Node Values:

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Node	Path	Computation	Stock Price (₹)
S_o	Start	3,600	3,600
S_u (t=3m)	Up 1x	3,600 × 1.20	4,320
S_d (t=3m)	Down 1x	3,600 × 0.80	2,880
S_uu (t=6m)	Up 2x	3,600 × 1.20^2	5,184
S_ud = S_du (t=6m)	1 Up, 1 Down	3,600 × 1.20 × 0.80	3,456
S_dd (t=6m)	Down 2x	3,600 × 0.80^2	2,304

Tree Structure (visualized):

₹5,184 (Suu)
↗
₹4,320 (Su)
↗ ↘
₹3,600 (S_o) ₹3,456 (Sud = Sdu)
↘ ↗
₹2,880 (Sd)
↘
₹2,304 (Sdd)

Note: The tree is RECOMBINING — Sud = Sdu = ₹3,456. This structural property makes the tree computationally efficient because the number of nodes grows linearly (not exponentially) with steps.

(iii) European CALL Option Value (K = ₹3,600)

Step 1 — Terminal Payoffs at t = 6 months:

Node	Stock Price (₹)	Payoff = max(ST − K, 0)	Value (₹)
Cuu	5,184	max(5,184 − 3,600, 0) = 1,584	1,584
Cud	3,456	max(3,456 − 3,600, 0) = 0	0
Cdd	2,304	max(2,304 − 3,600, 0) = 0	0

Step 2 — Backward Induction at t = 3 months:

General Formula: C(node) = [p × C_up + (1 − p) × C_down] / (1 + r × Δt)

U-Node (Cu at S_u = ₹4,320):

Cu = (0.55 × 1,584 + 0.45 × 0) / 1.02

= 871.20 / 1.02

= ₹854.12

D-Node (Cd at S_d = ₹2,880):

Cd = (0.55 × 0 + 0.45 × 0) / 1.02

= ₹0.00

The call is worthless at the down-node because both possible outcomes from there (₹3,456 and ₹2,304) are below the strike ₹3,600 — the call expires OTM in either case.

Step 3 — Backward Induction at t = 0:

C_o = (p × Cu + (1 − p) × Cd) / (1 + r × Δt)

= (0.55 × 854.12 + 0.45 × 0) / 1.02

= (469.76 + 0) / 1.02

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= ₹460.55

European Call Value at t = 0 = ₹460.55

(iv) European PUT Option Value (K = ₹3,600)

Step 1 — Terminal Payoffs at t = 6 months:

Node	Stock Price (₹)	Payoff = max(K − ST, 0)	Value (₹)
Puu	5,184	max(3,600 − 5,184, 0) = 0	0
Pud	3,456	max(3,600 − 3,456, 0) = 144	144
Pdd	2,304	max(3,600 − 2,304, 0) = 1,296	1,296

Step 2 — Backward Induction at t = 3 months:

U-Node (Pu):

Pu = (0.55 × 0 + 0.45 × 144) / 1.02

= 64.80 / 1.02

= ₹63.53

D-Node (Pd):

Pd = (0.55 × 144 + 0.45 × 1,296) / 1.02

= (79.20 + 583.20) / 1.02

= 662.40 / 1.02

= ₹649.41

Step 3 — Backward Induction at t = 0:

P_o = (0.55 × 63.53 + 0.45 × 649.41) / 1.02

= (34.94 + 292.24) / 1.02

= 327.18 / 1.02

= ₹320.76

European Put Value at t = 0 = ₹320.76

(v) Put-Call Parity Verification

PCP: C + PV(K) = P + S_o

Since we have 2 discrete compounding periods, PV(K) is discounted over 2 steps:

$PV(K) = K / (1 + r \times \Delta t)^2 = 3,600 / 1.02^2$

= 3,600 / 1.0404

= ₹3,460.21

LHS = C + PV(K):

LHS = 460.55 + 3,460.21 = ₹3,920.76

RHS = P + S_o:

RHS = 320.76 + 3,600 = ₹3,920.76

LHS − RHS = ₹0.00 ✓ Put-Call Parity holds exactly.

This is not a coincidence — the binomial tree by construction satisfies risk-neutral valuation, which automatically enforces PCP. The verification serves as a computational cross-check.

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(vi) Replicating Portfolio for the CALL Option (t = 0 to t = 3 months)

A replicating portfolio consists of (a) long Δ shares of TCS stock and (b) borrowing B rupees at the risk-free rate, such that the portfolio's value at t = 3 months equals the call's value at both the Up-node and the Down-node.

Call Values at Period-1 Nodes:

Cu = max(S_u − K, 0) = max(4,320 − 3,600, 0) = ₹720

Cd = max(S_d − K, 0) = max(2,880 − 3,600, 0) = ₹0

System of Equations:

At U-node: Δ × 4,320 + B × 1.02 = 720 … (Eq 1)

At D-node: Δ × 2,880 + B × 1.02 = 0 … (Eq 2)

Solve for Δ (Hedge Ratio):

Eq 1 − Eq 2: Δ × (4,320 − 2,880) = 720 − 0

Δ × 1,440 = 720

Δ = 720 / 1,440 = 0.5000

Solve for B (Borrowing):

From Eq 2: 0.5000 × 2,880 + B × 1.02 = 0

1,440 + 1.02 B = 0

B = −1,440 / 1.02 = −₹1,411.76

The negative sign on B indicates BORROWING of ₹1,411.76 at t = 0, which grows to ₹1,440 (= 1,411.76 × 1.02) at t = 3 months.

Cost of Replicating Portfolio at t = 0:

Cost = Δ × S_0 + B

= 0.5000 × 3,600 + (−1,411.76)

= 1,800 − 1,411.76

= ₹388.24

Portfolio Payoffs at t = 3 months:

Node	Δ × Stock (₹)	B × (1+r_Δt) (₹)	Portfolio Value (₹)	Call Value (₹)
U-node	0.5000 × 4,320 = 2,160.00	−1,411.76 × 1.02 = −1,440.00	720.00	720.00
D-node	0.5000 × 2,880 = 1,440.00	−1,440.00	0.00	0.00

Summary:

Item	Value
Hedge Ratio (Δ)	0.5000
Borrowing (B)	₹1,411.76 (indicated by negative sign)
Portfolio Cost at t = 0	₹388.24

Question 5 — American Put Valuation on TCS (Same Tree as Q4)

Continuing from Q4, Aditi Nair now considers the same TCS option contract but with an AMERICAN exercise feature — the holder may exercise the option at ANY time up to and including expiry, not just at expiry (European). This flexibility gives the option additional value in some cases. The market data and binomial tree parameters remain identical to Q4.

Model Inputs (unchanged from Q4):

Parameter	Value
TCS Spot Price (S_0)	₹3,600

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Parameter	Value
Strike Price (K, ATM)	₹3,600
Time to Expiry (T)	6 months
Number of Steps (n)	2
Time per Step (Δt)	3 months
Up Factor (u)	1.20
Down Factor (d)	0.80
Risk-Free Rate (Rf)	8% p.a.
Risk-Neutral Probability (p)	0.55 (as computed in Q4)
European Put Value (from Q4)	₹320.76 (reference benchmark)

Required:

(i) Explain the fundamental difference between European and American options. State the general valuation rule for American options at each node of the binomial tree.

(ii) Value the AMERICAN PUT option using backward induction from t = 6 months to t = 0. At each intermediate node, compare the continuation value (holding) with the intrinsic value (early exercise) and select the higher value.

(iii) Identify at which nodes (if any) EARLY EXERCISE is optimal. Explain the economic rationale.

(iv) Compute the EARLY EXERCISE PREMIUM — the additional value of the American put over the European put — and explain its source.

(v) Value the AMERICAN CALL option on the same tree (K = ₹3,600). Comment on whether early exercise is ever optimal for the American call. State and apply Merton's Theorem.

(vi) Discuss why American puts on non-dividend-paying stocks command an early exercise premium, while American calls on non-dividend-paying stocks do not.

Solution

(i) European vs American Options — General Valuation Rule

Fundamental Difference:

Feature	European Option	American Option
Exercise Timing	ONLY at expiry (t = T)	ANY time from t = 0 to t = T
Right	Passive holding until expiry	Active decision at each node
Valuation	Discounted expected terminal payoff	max(continuation, immediate exercise) at each node

General Valuation Rule for American Options at Each Node:

V(node) = max { Continuation Value, Intrinsic Value }

Where:

- Continuation Value = discounted risk-neutral expected value of holding the option one more step forward = [p × V_up + (1 − p) × V_down] / (1 + r × Δt)
- Intrinsic Value = payoff from immediate exercise at that node = max(K − S, 0) for put; max(S − K, 0) for call

Logic:

At each node, the holder faces a decision — should I exercise NOW or continue holding? The rational holder chooses whichever alternative gives higher value. Backward induction propagates this optimal decision from expiry back to t = 0.

At Terminal Nodes (t = T):

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At expiry, there is no continuation value (no future). So V(T-node) = payoff = max(K − ST, 0) for put, same as European. The American and European values ONLY DIFFER at intermediate nodes where early exercise is possible.

(ii) American Put Backward Induction

Terminal Payoffs at t = 6 months (identical to European Put):

Node	Stock Price (₹)	Payoff = max(K − ST, 0)	Value (₹)
Puu	5,184	max(3,600 − 5,184, 0) = 0	0
Pud	3,456	max(3,600 − 3,456, 0) = 144	144
Pdd	2,304	max(3,600 − 2,304, 0) = 1,296	1,296

Intermediate Node Analysis at t = 3 months:

U-Node Analysis (S_u = ₹4,320):

Step 1 — Continuation Value:

V_cont = (p × Puu + (1 − p) × Pud) / (1 + r × Δt)

= (0.55 × 0 + 0.45 × 144) / 1.02

= 64.80 / 1.02

= ₹63.53

Step 2 — Intrinsic Value (Immediate Exercise):

V_intrinsic = max(K − S_u, 0) = max(3,600 − 4,320, 0)

= ₹0

Step 3 — American Put Value at U-node:

Am_Pu = max(63.53, 0)

= ₹63.53

Decision: HOLD (continuation > intrinsic). The stock is at ₹4,320, well above the strike ₹3,600. Exercising now gives ₹0. Better to wait — there's still a 45% chance of the stock falling to ₹3,456 (moderate put payoff) in the next step.

D-Node Analysis (S_d = ₹2,880):

Step 1 — Continuation Value:

V_cont = (0.55 × 144 + 0.45 × 1,296) / 1.02

= (79.20 + 583.20) / 1.02

= 662.40 / 1.02

= ₹649.41

Step 2 — Intrinsic Value (Immediate Exercise):

V_intrinsic = max(K − S_d, 0) = max(3,600 − 2,880, 0)

= ₹720

Step 3 — American Put Value at D-node:

Am_Pd = max(649.41, 720)

= ₹720 ★ EARLY EXERCISE!

Decision: EXERCISE EARLY (intrinsic > continuation). By exercising immediately, the holder receives ₹720 in cash. Holding for another 3 months yields an expected discounted value of only ₹649.41. Early exercise adds ₹70.59 of value at this node.

Backward Induction to t = 0:

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Now use the ADJUSTED node values Am_Pu = ₹63.53 and Am_Pd = ₹720 (not the European continuation values):

Continuation Value at t = 0:

V_cont = (p × Am_Pu + (1 − p) × Am_Pd) / (1 + r × Δt)

= (0.55 × 63.53 + 0.45 × 720) / 1.02

= (34.94 + 324.00) / 1.02

= 358.94 / 1.02

= ₹351.90

Intrinsic Value at t = 0:

V_intrinsic = max(3,600 − 3,600, 0) = ₹0

American Put Value at t = 0:

Am_P_o = max(351.90, 0)

= ₹351.90

Decision at t = 0: HOLD (continuation > intrinsic). The stock is ATM, so exercising now gives nothing. Better to wait.

Final Result: American Put Value = ₹351.90

(iii) Early Exercise Optimality — Node-by-Node Summary

Node	Stock (₹)	Continuation Value (₹)	Intrinsic Value (₹)	American Put (₹)	Decision
t=0, S_o	3,600	351.90	0	351.90	HOLD
t=1, U-node	4,320	63.53	0	63.53	HOLD
t=1, D-node	2,880	649.41	720	720.00	EXERCISE ★
t=2, Puu	5,184	—	0	0	Terminal
t=2, Pud	3,456	—	144	144	Terminal
t=2, Pdd	2,304	—	1,296	1,296	Terminal

Economic Rationale for Early Exercise at D-node:

(i) The put is DEEP IN-THE-MONEY at the D-node (intrinsic value ₹720 on a strike of ₹3,600, i.e., ~20% ITM). At this level, the option's value is dominated by intrinsic value; time value is minimal.

(ii) By exercising early, the holder receives ₹720 in cash IMMEDIATELY. This ₹720 can be invested at the risk-free rate (7-8% p.a.) to earn additional interest over the remaining 3 months, growing to approximately ₹734.40 by expiry.

(iii) By CONTINUING to hold, the holder gets an expected discounted payoff of ₹649.41. This is LESS than the immediate exercise value because the future expected payoff (weighted average of ₹144 and ₹1,296 outcomes) doesn't fully compensate for the LOST INTEREST on the immediate ₹720 that could have been earned.

(iv) This trade-off — the LOSS OF INTEREST on the strike value K if exercise is delayed — is what makes early exercise valuable for deep-ITM puts on any stock, and even more so on high-rate environments (India's Rf ~7% amplifies this effect vs the 4-5% typical of developed markets).

(iv) Early Exercise Premium

Comparison:

Metric	European Put	American Put
Value at t = 0 (₹)	320.76	351.90
Difference (Early Exercise Premium)	—	₹31.14
Premium as % of European Value	—	9.71%

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Source of the Premium:

The Early Exercise Premium of ₹31.14 arises SOLELY from the option to exercise early at the D-node. In the European case (Q4), the holder was FORCED to wait until expiry, capturing only the discounted expected payoff of ₹649.41 at the D-node. In the American case, the holder captures the higher ₹720 by exercising early. The gain at the D-node is ₹70.59 (720 − 649.41), and this propagates back to t = 0 as:

Gain at t = 0 = (1 − p) × (Gain at D-node) / (1 + r × Δt)

= 0.45 × 70.59 / 1.02

= 31.14

This matches the observed premium exactly, confirming the source is the optimal early exercise decision at the D-node.

(v) American Call Valuation — Merton's Theorem

Setup:

Same tree, same parameters. K = ₹3,600 (ATM). We repeat the backward induction for the CALL, comparing continuation vs immediate exercise at each intermediate node.

Terminal Payoffs (same as European Call from Q4):

- Cuu = ₹1,584 (at S = ₹5,184)
- Cud = ₹0
- Cdd = ₹0

U-Node Analysis (S_u = ₹4,320):

Continuation Value = (0.55 × 1,584 + 0.45 × 0) / 1.02 = ₹854.12

Intrinsic Value = max(S_u − K, 0) = max(4,320 − 3,600, 0) = ₹720

American Call at U-node = max(854.12, 720)

= ₹854.12 → HOLD

D-Node Analysis (S_d = ₹2,880):

Continuation Value = (0.55 × 0 + 0.45 × 0) / 1.02 = ₹0

Intrinsic Value = max(2,880 − 3,600, 0) = ₹0

American Call at D-node = ₹0 (indifferent, but no exercise value)

At t = 0:

Continuation Value = (0.55 × 854.12 + 0.45 × 0) / 1.02 = ₹460.55

Intrinsic Value = max(3,600 − 3,600, 0) = ₹0

American Call = max(460.55, 0)

= ₹460.55 → HOLD (identical to European Call)

Key Observation: American Call = European Call = ₹460.55

Early exercise is NEVER optimal for the American call in this tree. This is not a coincidence — it is a theorem.

Merton's Theorem (1973):

For an American CALL on a NON-DIVIDEND-PAYING stock, early exercise is NEVER OPTIMAL. Therefore:

Am_Call = Eu_Call (for non-dividend stocks)

(vi) Why the Asymmetry Between American Puts and Calls?

The Fundamental Asymmetry:

An American PUT on a non-dividend stock CAN benefit from early exercise. An American CALL on the same stock CANNOT. This asymmetry arises from the difference between what the holder RECEIVES upon exercise:

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Exercising a CALL Early:

- Holder RECEIVES: 1 share of stock (which pays no dividend and does not earn interest as an asset)
- Holder PAYS: Strike K in cash (loses interest on K for remaining T − t)
- Net: NEGATIVE cost of early exercise (paying K NOW instead of at expiry loses interest ~K × r × (T − t))
- Additionally, holder LOSES the OPTIONALITY (right to walk away if stock drops below K by expiry)
- Conclusion: Early exercise of the call is ALWAYS suboptimal (except at expiry itself)

Exercising a PUT Early:

- Holder RECEIVES: Strike K in cash (which EARNS interest at Rf until expiry)
- Holder PAYS: 1 share of stock (which is illiquid to hold and pays no dividend anyway)
- Net: POSITIVE benefit if the stock has fallen deep enough that the interest earned on K exceeds the option's remaining time value
- Conclusion: Early exercise of the put IS OPTIMAL when the put is deep enough ITM

Threshold Condition (Deep-ITM Put):

Early exercise is optimal when:

Interest earned on K over (T − t) > Time value remaining in the put

At the D-node in our example:

- Interest gain on ₹720 over 3 months at 8% = ₹720 × 0.08 × 0.25 = ₹14.40
- Or more precisely, the immediate ₹720 could be invested to grow to ₹734.40 by expiry, whereas holding gives an expected discounted payoff of only ₹649.41
- The difference (₹720 − ₹649.41 = ₹70.59) is captured by exercising early

What Changes This Rule?

If the stock PAYS DIVIDENDS during the option's life, the calculus reverses:

- For CALLS: Early exercise BEFORE dividend may be optimal (capture the dividend that would otherwise reduce ex-dividend stock price)
- For PUTS: Early exercise may be LESS attractive if the stock drops due to dividend payment (holding gains extra put value)

This is why the CBOE distinguishes between American options on non-dividend and dividend-paying stocks with quarterly dividends have more nuanced early exercise decisions in practice.

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Question 6 — Black-Scholes-Merton Valuation on Infosys (INFY)

Vikram Anand, an equity derivatives structurer at Kotak Mahindra Capital, is asked to price 6-month European call and put options on Infosys Limited (INFY) using the Black-Scholes-Merton (BSM) model — the industry standard closed-form solution for European option valuation. The model must be adjusted for Infosys's dividend yield, as the company pays consistent dividends (~₹36 per share annually on a ₹1,800 stock = 2% yield).

Model Inputs (as on 15th July 2026):

Parameter	Symbol	Value
Infosys Spot Price	S	₹1,800
Strike Price (ATM)	K	₹1,800
Time to Expiry (Jan 2027)	T	6 months = 0.50 years
Risk-Free Rate (10-yr G-Sec, continuous)	r	8.00% p.a.
Dividend Yield (continuous)	q	2.00% p.a.
Annualized Volatility (implied from ATM straddle)	σ	28.00% p.a.
Option Style	—	European (index-style)

Standard Normal Distribution Extract (for hand computation):

z	N(z)	z	N(z)	z	N(z)
0.00	0.5000	0.20	0.5793	0.30	0.6179
0.05	0.5199	0.22	0.5871	0.35	0.6368
0.10	0.5398	0.24	0.5948	0.40	0.6554
0.15	0.5596	0.25	0.5987	0.50	0.6915

Required:

(i) State the Black-Scholes-Merton formula for European call and put options on a dividend-paying stock. Define each variable and explain the intuition behind the components.

(ii) Compute d_1 and d_2 using the given parameters. Show each step clearly.

(iii) Look up $N(d_1)$ and $N(d_2)$ from the standard normal table. Interpolate where necessary.

(iv) Compute the European CALL option value using BSM with dividend yield.

(v) Compute the European PUT option value using BSM with dividend yield.

(vi) Verify Put-Call Parity (adjusted for dividend yield). Confirm that the computed call and put values are consistent.

(vii) Compute the Delta of both the call and the put. Explain the intuitive meaning of each.

(viii) Comment on the IMPACT of the 2% dividend yield on option values — how would the call and put values change if Infosys were a non-dividend-paying stock?

Solution

(i) Black-Scholes-Merton Formula (Dividend-Paying Stock)

Call Option Formula:

$$\mathbf{C = S \times e^{(-qT)} \times N(d_1) - K \times e^{(-rT)} \times N(d_2)}$$

Put Option Formula:

$$\mathbf{P = K \times e^{(-rT)} \times N(-d_2) - S \times e^{(-qT)} \times N(-d_1)}$$

Where:

$$\mathbf{d_1 = [\ln(S/K) + (r - q + \sigma^2/2) \times T] / (\sigma \times \sqrt{T})}$$

$$\mathbf{d_2 = d_1 - \sigma \times \sqrt{T}}$$

Variable definitions:

- S = Current spot price of the underlying stock
- K = Strike price of the option
- T = Time to expiry (in years)
- r = Continuously compounded risk-free rate
- q = Continuously compounded dividend yield
- σ = Annualized volatility (standard deviation of log returns)
- N(x) = Cumulative standard normal distribution function evaluated at x

Intuition — Two Components of the Call:

The call formula decomposes elegantly into two economic terms:

- $S \times e^{(-qT)} \times N(d_1)$: PROBABILITY-WEIGHTED VALUE of the underlying stock IF the option finishes in-the-money. The $e^{(-qT)}$ factor adjusts for dividends foregone by the option holder (who doesn't own the stock).
- $K \times e^{(-rT)} \times N(d_2)$: PROBABILITY-WEIGHTED PRESENT VALUE of the strike price the call holder must pay IF exercised. $N(d_2)$ is the RISK-NEUTRAL PROBABILITY that the call expires in-the-money.

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The difference represents the expected NET PAYOFF of the call in present value terms.

Why Dividend Yield (q) Reduces Call Value:

A dividend-paying stock has a DRAG on price appreciation — the stock price is expected to drop by the dividend amount on ex-div dates. Since call holders don't receive dividends but bear the price drag, higher q REDUCES call values (relative to non-dividend stocks) and INCREASES put values.

(ii) Compute d_1 and d_2

Substitute Values into d_1 Formula:

$d_1 = [\ln(1{,}800/1{,}800) + (0.08 - 0.02 + 0.28^2/2) \times 0.5] / (0.28 \times \sqrt{0.5})$

Step-by-Step Computation:

Component 1: $\ln(S/K) = \ln(1{,}800/1{,}800) = \ln(1) = 0$

Component 2: $\sigma^2 / 2 = 0.28^2 / 2 = 0.0784 / 2 = 0.0392$

Component 3: $r - q + \sigma^2/2 = 0.08 - 0.02 + 0.0392 = 0.0992$

Component 4: Numerator $= 0 + 0.0992 \times 0.5 = 0.0496$

Component 5: $\sqrt{T} = \sqrt{0.5} = 0.7071$

Component 6: $\sigma \times \sqrt{T} = 0.28 \times 0.7071 = 0.1980$

$d_1 = 0.0496 / 0.1980 = 0.2505 \approx 0.25$

Compute d_2:

$d_2 = d_1 - \sigma \times \sqrt{T}$

$= 0.2505 - 0.1980$

$d_2 = 0.0525 \approx 0.05$

(iii) $N(d_1)$ and $N(d_2)$ Look-Up

$N(d_1) = N(0.25)$:

Directly from the standard normal table:

$N(0.25) = 0.5987$

$N(d_2) = N(0.05)$:

Directly from the standard normal table:

$N(0.05) = 0.5199$

Complementary Values (for Put Formula):

$N(-d_1) = 1 - N(d_1) = 1 - 0.5987 = 0.4013$

$N(-d_2) = 1 - N(d_2) = 1 - 0.5199 = 0.4801$

(iv) European CALL Value

Discount Factors:

$e^{(-rT)} = e^{(-0.08 \times 0.5)} = e^{(-0.04)} = 0.9608$

$e^{(-qT)} = e^{(-0.02 \times 0.5)} = e^{(-0.01)} = 0.9900$

Apply Call Formula:

$C = S \times e^{(-qT)} \times N(d_1) - K \times e^{(-rT)} \times N(d_2)$

$C = 1{,}800 \times 0.9900 \times 0.5987 - 1{,}800 \times 0.9608 \times 0.5199$

Term 1: 1,800 × 0.9900 × 0.5987

= 1,782 × 0.5987

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= ₹1,066.88

Term 2: 1,800 × 0.9608 × 0.5199

= 1,729.44 × 0.5199

= ₹899.14

C = 1,066.88 − 899.14

C = ₹167.74

European Call Value ≈ ₹167.75

(v) European PUT Value

Apply Put Formula:

$P = K \times e^{(-rT)} \times N(-d_2) - S \times e^{(-qT)} \times N(-d_1)$

$P = 1,800 \times 0.9608 \times 0.4801 - 1,800 \times 0.9900 \times 0.4013$

Term 1: 1,800 × 0.9608 × 0.4801

= 1,729.44 × 0.4801

= ₹830.30

Term 2: 1,800 × 0.9900 × 0.4013

= 1,782 × 0.4013

= ₹715.12

P = 830.30 − 715.12

P = ₹115.18

European Put Value ≈ ₹115.18

(vi) Put-Call Parity Verification (Dividend-Adjusted)

Adjusted PCP for Dividend-Paying Stock:

$C + K \times e^{(-rT)} = P + S \times e^{(-qT)}$

Notice: For dividend stocks, the stock component in PCP is discounted by dividend yield: $S \times e^{(-qT)}$, not the raw S. This reflects that a call holder loses dividends that the stock holder receives.

LHS Computation:

$K \times e^{(-rT)} = 1,800 \times 0.9608 = ₹1,729.44$

$LHS = C + K \times e^{(-rT)} = 167.74 + 1,729.44$

LHS = ₹1,897.18

RHS Computation:

$S \times e^{(-qT)} = 1,800 \times 0.9900 = ₹1,782.00$

$RHS = P + S \times e^{(-qT)} = 115.18 + 1,782.00$

RHS = ₹1,897.18

LHS − RHS = ₹0 ✓ Put-Call Parity holds.

The small differences observed in practice (₹0.02-0.05) arise from rounding of $N(d_1)$, $N(d_2)$, and the exponential discount factors. In exact computation, PCP holds precisely — this is by construction of the BSM model.

(vii) Delta of Call and Put

Delta (Δ) — Definition:

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Delta measures the sensitivity of the option price to a ₹1 change in the underlying stock price. It is the FIRST DERIVATIVE of the option value with respect to S.

Formulas (BSM with Dividend Yield):

Call Delta: $\Delta_c = e^{(-qT)} \times N(d_1)$

Put Delta: $\Delta_p = -e^{(-qT)} \times N(-d_1)$

Computation:

Call Delta = 0.9900 × 0.5987

= 0.5927 ≈ 0.59

Put Delta = − 0.9900 × 0.4013

= − 0.3973 ≈ − 0.40

Intuitive Interpretation:

- Call Delta = 0.59 means: If Infosys rises by ₹1, the call value increases by approximately ₹0.59. If Infosys falls by ₹1, the call value decreases by approximately ₹0.59.
- Put Delta = − 0.40 means: If Infosys rises by ₹1, the put value decreases by approximately ₹0.40. If Infosys falls by ₹1, the put value increases by approximately ₹0.40. The negative sign reflects the put's inverse relationship with the stock price.

Delta Sum Rule:

$|\Delta_c| + |\Delta_p| = 0.59 + 0.40 = 0.99 \approx e^{(-qT)}$

For a non-dividend stock, this would equal exactly 1.00. The 1% shortfall (0.99 vs 1.00) equals the dividend discount factor for 6 months at 2% ($e^{(-0.01)} = 0.99$). This is a clean consistency check.

Hedging Application (Preview for Q8):

To DELTA-HEDGE a long put position (Δ = −0.40) on 1,000 Infosys shares, one must LONG 400 shares of Infosys stock. This neutralizes the price sensitivity — for small stock moves, gains on stock offset losses on put and vice versa. Q8 elaborates on this dynamic hedging application.

(viii) Impact of 2% Dividend Yield vs Zero Dividend

Recompute BSM with q = 0 (Hypothetical Non-Dividend Case):

New d_1 (q = 0):

$d_1_new = [0 + (0.08 - 0 + 0.0392) \times 0.5] / 0.1980$

$= [0.0596] / 0.1980$

$= 0.3010 \approx 0.30$

New d_2 (q = 0):

$d_2_new = 0.30 - 0.1980 = 0.1020 \approx 0.10$

From tables: N(0.30) = 0.6179, N(0.10) = 0.5398

N(−0.30) = 0.3821, N(−0.10) = 0.4602

Call (q = 0):

$C_nodiv = 1{,}800 \times 0.6179 - 1{,}800 \times 0.9608 \times 0.5398$

$= 1{,}112.22 - 933.65$

= ₹178.57

Put (q = 0):

$P_nodiv = 1{,}800 \times 0.9608 \times 0.4602 - 1{,}800 \times 0.3821$

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= 795.77 − 687.78

= ₹107.99

Impact Summary:

Metric	With 2% Div Yield	No Div (q = 0)	Impact of Dividend
Call Value	₹167.75	₹178.57	− ₹10.82 (call decreases)
Put Value	₹115.18	₹107.99	+ ₹7.19 (put increases)

Economic Interpretation:

- Call HURT by dividends (₹10.82 lower): The call holder doesn't receive dividends, but the stock's price appreciation is depressed by the dividend payout. Value transfers from call to actual stock holders.
- Put HELPED by dividends (₹7.19 higher): The put holder benefits from dividend-induced price drops. Every ex-dividend event pushes the stock down, moving the put deeper ITM.
- Note that (₹10.82 − ₹7.19 = ₹3.63) is not zero — the impacts are not symmetric because the price drag from dividends compounds over time and interacts with the discount factors.

Real-World Application:

Indian equity option pricing must adjust for dividend yield, especially for high-yield stocks like Coal India (~10% yield), Hindustan Zinc (~7%), and PSU banks (~4-5%). Ignoring dividends systematically OVERPRICES calls and UNDERPRICES puts. Institutional market makers use expected discrete dividends (not continuous yield) for greater precision, but the continuous-yield BSM adjustment is a solid first-order correction and matches ICAI SM convention.

Question 7 — Computing Options Greeks

Kavita Nair, an Options Analyst at Kotak Institutional Equities, has obtained a chain of HDFC Bank Sep 2026 option prices under different market conditions. The base case pricing shows a Call and Put at strike ₹1,600 when HDFC Bank spot is ₹1,600, along with observed option prices under alternate scenarios (small stock moves, volatility change, time decay, interest rate change). Kavita is required to compute each of the five OPTIONS GREEKS using the finite difference approach of Δ(Option Price) / Δ(Variable)

Base Case (15-Jul-2026):

Parameter	Value
HDFC Bank Spot (S_o)	₹1,600
Strike (K)	₹1,600 (ATM)
Time to Expiry (T)	6 months (Sep 2026 expiry)
Volatility (σ)	25%
Risk-Free Rate (r)	7% p.a.
ATM Call Premium (C_o)	₹85
ATM Put Premium (P_o)	₹75

Observed Option Prices Under Various Scenarios:

Scenario	Change from Base	Call Price (₹)	Put Price (₹)
Base Case	—	85.00	75.00
Stock rises to ₹1,610	ΔS = + ₹10	90.00	70.20
Stock falls to ₹1,590	ΔS = − ₹10	80.20	80.00
Volatility rises to 27%	Δσ = + 2%	90.00	80.00
15 days pass (T = 5.5 months)	Δt = − 15 days	82.00	72.50
Rate rises to 8%	Δr = + 1%	87.00	73.50

Required:

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(i) Compute DELTA for the Call and Put using the change in stock price scenarios.

(ii) Compute GAMMA using the change in delta as the stock moves.

(iii) Compute THETA (per day) for the Call and Put using the 15-day time decay scenario.

(iv) Compute VEGA (per 1% change in σ) for the Call and Put using the volatility scenario.

(v) Compute RHO (per 1% change in r) for the Call and Put using the interest rate scenario.

(vi) Present a consolidated summary of all five Greeks and briefly explain the market interpretation of each.

Solution

(i) DELTA (Δ) Computation

Formula:

Delta = Change in Option Price / Change in Stock Price

= ΔC / ΔS (for Call)

= ΔP / ΔS (for Put)

Call Delta (using upward stock move scenario):

Δ_c = (Call at S = 1,610) − (Call at S = 1,600) / (1,610 − 1,600)

= (₹90.00 − ₹85.00) / ₹10

= ₹5.00 / ₹10

Δ_c = 0.50

Put Delta (using upward stock move scenario):

Δ_p = (Put at S = 1,610) − (Put at S = 1,600) / (1,610 − 1,600)

= (₹70.20 − ₹75.00) / ₹10

= −₹4.80 / ₹10

Δ_p = − 0.48

Verification (Consistency Check):

Sum of absolute deltas = |Δ_c| + |Δ_p| = 0.50 + 0.48 = 0.98 ≈ 1.00 ✓

(For non-dividend stock, this sum should equal 1.00 exactly. Small deviation reflects observation rounding in market prices.)

Interpretation:

- Δ_c = 0.50 → For every ₹1 rise in HDFC Bank, the Call price rises by ₹0.50
- Δ_p = −0.48 → For every ₹1 rise in HDFC Bank, the Put price falls by ₹0.48

(ii) GAMMA (Γ) Computation

Formula:

Gamma = Change in Delta / Change in Stock Price

= ΔΔ / ΔS

Delta at Two Different Stock Ranges:

Delta in "Up Range" (S rising from 1,600 to 1,610):

Δ_up = (Call at 1,610 − Call at 1,600) / (1,610 − 1,600)

= (₹90.00 − ₹85.00) / ₹10

= 0.50

Delta in "Down Range" (S rising from 1,590 to 1,600):

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Δ_down = (Call at 1,600 − Call at 1,590) / (1,600 − 1,590)

= (₹85.00 − ₹80.20) / ₹10

= 0.48

Gamma Computation:

Between these two ranges, the stock price effectively moved from midpoint ₹1,595 to midpoint ₹1,605 — a change of ₹10.

Gamma = (Δ_up − Δ_down) / ₹10

= (0.50 − 0.48) / ₹10

= 0.02 / ₹10

Gamma = 0.002 per ₹1 stock move

Interpretation:

- For every ₹1 rise in HDFC Bank, Delta increases by 0.002
- For a ₹100 rise (say, 1,600 → 1,700), Delta would rise by approximately 0.20 (from 0.50 to 0.70)
- Gamma is the SAME for Call and Put — both change delta at the same rate

(iii) THETA (Θ) Computation

Formula:

Theta = Change in Option Price / Change in Time

= ΔC / Δt

Note on Convention:

Theta is CONVENTIONALLY expressed PER DAY on trading desks and in practitioner reports (Bloomberg, NSE data feeds, Zerodha Sensibull, etc.) — reflecting the daily rate of time decay that traders monitor. This is also the standard CA Final AFM presentation. The per-year value can be derived by multiplying by 365.

Call Theta:

Time elapsed = 15 days (Δt in days = 15)

Change in Call: ₹82.00 − ₹85.00 = − ₹3.00 (Call loses value as time passes)

Theta (per day) = ΔC / Δt (in days)

= − ₹3.00 / 15

Call Theta = − ₹0.20 per day

Annualized (if required):

Theta (per year) = − ₹0.20 × 365 = − ₹73 per year

Put Theta:

Change in Put: ₹72.50 − ₹75.00 = − ₹2.50

Put Theta (per day) = − ₹2.50 / 15

= − ₹0.167 per day

Annualized: − ₹0.167 × 365 = − ₹60.83 per year

Interpretation:

- Both Call and Put have NEGATIVE Theta — the classic "time decay" for long option holders
- Every calendar day passing, the Call loses ₹0.20 and the Put loses ₹0.167 in value
- Theta ACCELERATES near expiry — options lose value fastest in the final few weeks

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(iv) VEGA (v) Computation

Formula:

Vega = Change in Option Price / Change in Volatility

= ΔC / Δσ

Volatility Change: 25% → 27% = 2% (Δσ = 0.02)

Call Vega:

Change in Call: ₹90.00 − ₹85.00 = ₹5.00

Vega (per 1 unit change in σ) = ₹5.00 / 0.02 = ₹250

Vega (per 1% change in σ) = ₹5.00 / 2

Call Vega = ₹2.50 per 1% (0.01) change in σ

Put Vega:

Change in Put: ₹80.00 − ₹75.00 = ₹5.00

Put Vega = ₹5.00 / 2

= ₹2.50 per 1% change in σ

Interpretation:

- Call and Put have the SAME Vega — both benefit equally from rising volatility
- If σ rises from 25% to 26% (1%), both Call and Put values rise by ₹2.50
- Long options are LONG VEGA (benefit from rising vol); short options are SHORT VEGA
- Vega is HIGHEST for ATM options with substantial time to expiry (like this one)

(v) RHO (ρ) Computation

Formula:

Rho = Change in Option Price / Change in Interest Rate

= ΔC / Δr

Interest Rate Change: 7% → 8% = 1% (Δr = 0.01)

Call Rho:

Change in Call: ₹87.00 − ₹85.00 = ₹2.00

Rho (per 1 unit change in r) = ₹2.00 / 0.01 = ₹200

Rho (per 1% change in r) = ₹2.00 / 1

Call Rho = ₹2.00 per 1% (0.01) change in r

Put Rho:

Change in Put: ₹73.50 − ₹75.00 = − ₹1.50

Put Rho = − ₹1.50 / 1

= − ₹1.50 per 1% change in r

Interpretation:

- Call Rho is POSITIVE — higher rates INCREASE call value
- Put Rho is NEGATIVE — higher rates DECREASE put value
- Economic logic: higher rates mean lower PV of strike payment, favoring Call holders and hurting Put holders
- Rho is generally the SMALLEST Greek in magnitude — often ignored for short-dated options

(vi) Consolidated Summary — All Five Greeks

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Greek	CALL	PUT	Formula Used	Interpretation
Delta (Δ)	+ 0.50	− 0.48	ΔC / ΔS	Sensitivity to stock price
Gamma (Γ)	0.002	0.002	ΔΔ / ΔS	Rate of change of Delta
Theta (Θ) per day	− ₹0.20	− ₹0.167	ΔC / Δt (in days)	Time decay per calendar day
Vega (ν) per 1%	+ ₹2.50	+ ₹2.50	ΔC / Δσ	Sensitivity to volatility
Rho (ρ) per 1%	+ ₹2.00	− ₹1.50	ΔC / Δr	Sensitivity to interest rate

Key Practical Applications:

(i) Trading Position Sizing: A trader long 100 Call contracts (lot 550 = 55,000 units) has portfolio delta = 55,000 × 0.50 = +27,500. This is equivalent to being long 27,500 HDFC Bank shares.

(ii) Hedge Ratio: To delta-hedge 55,000 units of long Calls, need to short 27,500 HDFC Bank shares.

(iii) P&L Attribution: If in one day, HDFC Bank rises ₹5 and vol drops 1%, portfolio P&L = 55,000 × (0.50 × 5 + 0.002/2 × 25 − 2.50 − 0.20) ≈ 55,000 × (2.50 + 0.025 − 2.50 − 0.20) = 55,000 × (−0.175) ≈ − ₹9,625.

(iv) Risk Management: Compute the maximum daily P&L swing under specified stress scenarios using Greeks (e.g., 2-sigma stock move + 3% vol shift).

(v) Adjustment: The Greeks change as market moves. Practical traders REBALANCE hedge positions daily to maintain the desired risk profile (as seen in Q8 Delta Hedging).

Question 8 — Put Option Delta using Two-Step Binomial Tree

Continuing the derivatives analysis on HDFC Bank, Kavita Nair now needs to VALUE a European Put option and COMPUTE ITS DELTA at each node of a two-step binomial tree. Unlike the Black-Scholes-Merton approach (where Delta is computed as e^(−qT) × N(d_1) using a continuous formula), the binomial tree method computes Delta at each node as the DISCRETE RATIO of change in option value to change in stock value.

Given Data:

Parameter	Value
Underlying	HDFC Bank Ltd (HDFCBANK)
Current Spot Price (S_0)	₹1,600
Strike Price (K)	₹1,600 (ATM)
Time to Expiry	1 year (2 periods of 6 months each)
Upward Movement Factor (u)	1.10 (stock rises by 10% per period)
Downward Movement Factor (d)	0.90 (stock falls by 10% per period)
Risk-Free Rate per Period (r)	5% (representing 10% annual with 6-month periods)
Option Type	European Put

Required:

(i) Construct the two-step binomial STOCK PRICE TREE showing all possible stock prices at each node.

(ii) Compute the RISK-NEUTRAL PROBABILITY (p) using the standard binomial formula.

(iii) Compute the PUT OPTION PAYOFFS at the three terminal nodes (Time 2).

(iv) Use BACKWARD INDUCTION to compute Put values at each interior node — first at Time 1 (P_u and P_d), then at Time 0 (P_0).

(v) Compute the DELTA of the Put option AT THE INITIAL NODE (S_0) using the formula: Δ = (P_u − P_d) / (Su − Sd).

(vi) Compute the DELTA at the two Time 1 interior nodes (Δ_u and Δ_d). Comment on how Delta changes as the stock moves.

(vii) Construct the REPLICATING PORTFOLIO at the initial node: how many HDFC Bank shares to hold (short) and how much cash to lend/borrow to replicate one long Put option.

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Solution

(i) Stock Price Binomial Tree

Stock Prices at Each Node:

Time 0: S_o = ₹1,600

Time 1 (after one period):

- If stock rises: S_u = S_o × u = ₹1,600 × 1.10 = ₹1,760
- If stock falls: S_d = S_o × d = ₹1,600 × 0.90 = ₹1,440

Time 2 (after two periods):

- Two consecutive ups: S_uu = ₹1,600 × 1.10 × 1.10 = ₹1,936
- One up + one down: S_ud = ₹1,600 × 1.10 × 0.90 = ₹1,584
- Two consecutive downs: S_dd = ₹1,600 × 0.90 × 0.90 = ₹1,296

Complete Stock Price Tree:

Node	Time 0	Time 1	Time 2 (Expiry)
Up-Up (2 ups)			S_uu = ₹1,936
Up		S_u = ₹1,760	
Up-Down (mixed)			S_ud = ₹1,584
Initial	S_o = ₹1,600		
Down		S_d = ₹1,440	
Down-Down (2 downs)			S_dd = ₹1,296

(ii) Risk-Neutral Probability

Formula:

p = (1 + r − d) / (u − d)

Substituting values:

p = (1 + 0.05 − 0.90) / (1.10 − 0.90)

= (1.05 − 0.90) / (0.20)

= 0.15 / 0.20

p = 0.75

1 − p = 0.25

Interpretation:

Under the RISK-NEUTRAL MEASURE, the probability of an up-move is 0.75 and a down-move is 0.25. These are NOT real-world probabilities — they are ARTIFICIAL PROBABILITIES that make the discounted expected stock price equal to the current spot, ensuring NO ARBITRAGE.

(iii) Put Payoffs at Expiry (Time 2)

European Put Payoff Formula:

Payoff = max(K − S_T, 0)

At each terminal node:

P_uu (Stock at ₹1,936):

Payoff = max(1,600 − 1,936, 0)

= max(−336, 0)

P_uu = ₹0 (OTM at expiry)

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P_ud (Stock at ₹1,584):

Payoff = max(1,600 − 1,584, 0)

P_ud = ₹16

P_dd (Stock at ₹1,296):

Payoff = max(1,600 − 1,296, 0)

P_dd = ₹304

(iv) Put Values at Interior Nodes (Backward Induction)

General Formula:

Put Value at any node = [p × P_up + (1−p) × P_down] / (1 + r)

Put Value at Time 1, Up Node (P_u):

P_u = [p × P_uu + (1−p) × P_ud] / (1 + r)

= [0.75 × 0 + 0.25 × 16] / 1.05

= [0 + 4] / 1.05

P_u = ₹3.81

Put Value at Time 1, Down Node (P_d):

P_d = [p × P_ud + (1−p) × P_dd] / (1 + r)

= [0.75 × 16 + 0.25 × 304] / 1.05

= [12 + 76] / 1.05

= 88 / 1.05

P_d = ₹83.81

Put Value at Time 0 (P_o):

P_o = [p × P_u + (1−p) × P_d] / (1 + r)

= [0.75 × 3.81 + 0.25 × 83.81] / 1.05

= [2.86 + 20.95] / 1.05

= 23.81 / 1.05

P_o = ₹22.68

Complete Put Value Tree:

Node	Stock Price (₹)	Put Value (₹)
Time 0 (Initial)	1,600	22.68
Time 1 Up (P_u)	1,760	3.81
Time 1 Down (P_d)	1,440	83.81
Time 2 Up-Up (P_uu)	1,936	0.00
Time 2 Up-Down (P_ud)	1,584	16.00
Time 2 Down-Down (P_dd)	1,296	304.00

(v) Delta at Initial Node (Δ_o)

Delta Formula (Binomial):

Δ = Change in Option Value / Change in Stock Value

= (P_u − P_d) / (S_u − S_d)

Computation at Time 0:

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$\Delta_o = (P_u - P_d) / (S_u - S_d)$

$= (₹3.81 - ₹83.81) / (₹1,760 - ₹1,440)$

$= - ₹80.00 / ₹320$

$\Delta_o = -0.25$

Interpretation:

- Δ_o is NEGATIVE — as expected for a Put option (Put value moves OPPOSITE to stock)
- $|\Delta_o| = 0.25$ → For every ₹1 rise in HDFC Bank, the Put value falls by ₹0.25
- This is CONSISTENT with our binomial numbers: over ₹320 stock range, Put drops ₹80 → 25% sensitivity

(vi) Delta at Time 1 Interior Nodes

Delta at the Up-Node (Δ_u):

$\Delta_u = (P_{uu} - P_{ud}) / (S_{uu} - S_{ud})$

$= (₹0 - ₹16) / (₹1,936 - ₹1,584)$

$= - ₹16 / ₹352$

$\Delta_u = -0.0455$

Delta at the Down-Node (Δ_d):

$\Delta_d = (P_{ud} - P_{dd}) / (S_{ud} - S_{dd})$

$= (₹16 - ₹304) / (₹1,584 - ₹1,296)$

$= - ₹288 / ₹288$

$\Delta_d = -1.00$

Summary of Delta at All Interior Nodes:

Node	Stock Price (₹)	Put Delta	Interpretation
Time 0 (Initial)	1,600	− 0.25	ATM: moderate downside sensitivity
Time 1 Up-Node	1,760	− 0.0455	OTM: put nearly worthless, low sensitivity
Time 1 Down-Node	1,440	− 1.00	Deep ITM: put behaves like short stock

Key Observations — How Delta Changes:

(i) Delta MOVES from − 0.25 (initial ATM) to either − 0.0455 (if stock rises) or − 1.00 (if stock falls).

(ii) AS STOCK RISES, Put becomes OTM (out of the money), Delta approaches ZERO — put loses sensitivity to further upside.

(iii) AS STOCK FALLS, Put becomes deep ITM, Delta approaches − 1.00 — put behaves like a SHORT STOCK POSITION.

(iv) This DELTA VARIATION is the GAMMA effect — Delta itself is not constant, so a static hedge cannot maintain perfect delta neutrality over time. Dynamic hedging (rebalancing periodically) is required.

(v) In the Down-node, $\Delta_d = -1.00$ exactly because at that node, both terminal Put payoffs (at 1,584 and 1,296) are IN-THE-MONEY. Every ₹1 stock decline translates to ₹1 Put value increase.

(vii) Replicating Portfolio Construction at Time 0

Concept:

The Put option can be REPLICATED using a portfolio of Δ shares of stock and B rupees of borrowing/lending. This is the foundation of NO-ARBITRAGE pricing:

Portfolio composition:

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Long 1 Put = Long Δ shares + Cash B (borrowing/lending)

Since Δ (Put) = – 0.25:

This means: for every 1 Put, hold −0.25 shares (SHORT 0.25 shares) + some cash B.

Solving for Cash Position B:

Value equation at Time 0:

$P_o = \Delta \times S_o + B$

₹22.68 = – 0.25 × ₹1,600 + B

₹22.68 = – ₹400 + B

B = ₹422.68 (INVESTED / LENT)

Verification at Time 1 (Up-Node):

Portfolio value at Time 1 Up = Δ × S_u + B × (1 + r)

= – 0.25 × ₹1,760 + ₹422.68 × 1.05

= – ₹440 + ₹443.81

= ₹3.81 = P_u ✓

Verification at Time 1 (Down-Node):

Portfolio value at Time 1 Down = Δ × S_d + B × (1 + r)

= – 0.25 × ₹1,440 + ₹422.68 × 1.05

= – ₹360 + ₹443.81

= ₹83.81 = P_d ✓

Interpretation:

- The Put option can be REPLICATED by SHORTING 0.25 HDFC Bank shares + LENDING ₹422.68 at the risk-free rate
- This REPLICATING PORTFOLIO produces the SAME PAYOFF as the Put option at every future node
- By NO ARBITRAGE, the cost of the replicating portfolio TODAY (₹22.68) must equal the Put price
- This validates our binomial pricing method — it produces INTERNALLY CONSISTENT prices

For Position Sizing (In Practice):

A trader who wants to sell 100 HDFC Bank Put contracts (lot size 550 = 55,000 units) can HEDGE the position by:

- SHORTING 55,000 × 0.25 = 13,750 HDFC Bank shares
- LENDING 55,000 × ₹422.68 = ₹2.32 crore at 10% annual (5% per period)

At Time 1 (6 months later), the trader will need to REBALANCE — because Delta will have changed from − 0.25 to either − 0.0455 or − 1.00 depending on stock direction. This dynamic rebalancing was analyzed in the earlier version of Q8 but is the SAME CONCEPT as the ratio-based approach used here.

Question 9 — Analysis of Bull Call Spread and Bear Put Spread

Arjun Mehta, a proprietary trader at Motilal Oswal Financial Services, is analyzing two combination options strategies on HDFC Bank Ltd for the Aug 2026 expiry. His research desk has prepared the following NOTES on two VERTICAL SPREAD strategies — the BULL CALL SPREAD (for a moderately bullish view) and the BEAR PUT SPREAD (for a moderately bearish view). Arjun is required to apply these strategy notes to the actual HDFC Bank option prices and DEMONSTRATE the numerical outcomes.

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Strategy Notes Prepared by the Research Desk

A. BULL CALL SPREAD

Definition:

A Bull Call Spread is a combination options strategy created by simultaneously BUYING a call option at a LOWER strike (K1) and SELLING a call option at a HIGHER strike (K2), both on the same underlying and with the same expiry date. It is a DIRECTIONAL strategy that expresses a MODERATELY BULLISH view — the trader believes the underlying will rise but not dramatically.

Construction:

- LONG 1 Call at strike K1 (Lower Strike) → pay premium C1
- SHORT 1 Call at strike K2 (Higher Strike, K2 > K1) → receive premium C2

Net Cost of the Strategy (Net Debit):

Because the lower-strike call is more expensive than the higher-strike call, the strategy has a NET COST at inception:

Net Debit = C1 − C2 (always positive)

Payoff at Expiry:

Net Payoff = max(ST − K1, 0) − max(ST − K2, 0) − Net Debit

Standard Formulas:

Metric	Formula	When it Occurs
Maximum Loss	Net Debit (C1 − C2)	When ST ≤ K1 (both options expire worthless)
Maximum Profit	(K2 − K1) − Net Debit	When ST ≥ K2 (both options fully exercised)
Breakeven Point	K1 + Net Debit	Payoff = 0
Risk-Reward Ratio	Max Profit / Max Loss	Higher = better

Payoff Behavior:

- BELOW K1: Flat maximum loss (both options OTM)
- BETWEEN K1 and K2: Linear rise (long call payoff kicks in)
- ABOVE K2: Flat maximum profit (short call caps the upside)

B. BEAR PUT SPREAD

Definition:

A Bear Put Spread is a combination options strategy created by simultaneously BUYING a put option at a HIGHER strike (K2) and SELLING a put option at a LOWER strike (K1), both on the same underlying and with the same expiry date. It is a DIRECTIONAL strategy that expresses a MODERATELY BEARISH view — the trader believes the underlying will fall but not dramatically.

Construction:

- LONG 1 Put at strike K2 (Higher Strike) → pay premium P2
- SHORT 1 Put at strike K1 (Lower Strike, K1 < K2) → receive premium P1

Net Cost of the Strategy (Net Debit):

Because the higher-strike put is more expensive than the lower-strike put, the strategy has a NET COST at inception:

Net Debit = P2 − P1 (always positive)

Payoff at Expiry:

Net Payoff = max(K2 − ST, 0) − max(K1 − ST, 0) − Net Debit

Standard Formulas:

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Metric	Formula	When it Occurs
Maximum Loss	Net Debit (P2 − P1)	When ST ≥ K2 (both options expire worthless)
Maximum Profit	(K2 − K1) − Net Debit	When ST ≤ K1 (both options fully exercised)
Breakeven Point	K2 − Net Debit	Payoff = 0
Risk-Reward Ratio	Max Profit / Max Loss	Higher = better

Payoff Behavior:

- BELOW K1: Flat maximum profit (both puts ITM)
- BETWEEN K1 and K2: Linear fall (long put payoff shrinks)
- ABOVE K2: Flat maximum loss (both puts OTM)

Market Data (15-Jul-2026):

Parameter	Value
HDFC Bank Spot	₹1,600
Options Expiry	28-Aug-2026 (Aug 2026 contracts)
HDFCBANK Options Lot Size	550 shares per contract

Available Aug 2026 Options Premiums:

Strike (K)	Moneyness	Call Premium (₹)	Put Premium (₹)
1,600	ATM	85	75
1,700	OTM Call / ITM Put	40	135

Required:

Using the strategy notes provided above and the given HDFC Bank option premiums, perform the following analysis:

(i) Construct a BULL CALL SPREAD using K1 = ₹1,600 (Long) and K2 = ₹1,700 (Short). Compute the Net Debit, Maximum Loss, Maximum Profit, and Breakeven point using the standard formulas.

(ii) Prepare a payoff table for the Bull Call Spread at spot levels: ₹1,500 / 1,550 / 1,600 / 1,645 / 1,650 / 1,700 / 1,750 / 1,800. Verify that the outcomes match the formula-based max profit and max loss.

(iii) Construct a BEAR PUT SPREAD using K2 = ₹1,700 (Long) and K1 = ₹1,600 (Short). Compute Net Debit, Maximum Loss, Maximum Profit, and Breakeven.

(iv) Prepare a payoff table for the Bear Put Spread at the same spot levels.

(v) For a proprietary trader with a ₹5 lakh risk budget, compute the maximum number of lots deployable in each strategy. Compute the total maximum profit potential in ₹ terms.

(vi) Compare the Bull Call Spread with a naked Long Call at K = 1,600 (premium ₹85). Discuss the trade-off between reduced entry cost and capped upside.

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Solution

(i) Bull Call Spread — Key Metrics

Strategy Construction:

- LONG 1 Call at K1 = ₹1,600, Premium C1 = ₹85
- SHORT 1 Call at K2 = ₹1,700, Premium C2 = ₹40

Applying the Standard Formulas:

1. Net Debit:

Net Debit = C1 − C2

= ₹85 − ₹40

= ₹45 per share

2. Maximum Loss:

Max Loss = Net Debit

= ₹45 per share (when ST ≤ ₹1,600)

3. Maximum Profit:

Max Profit = (K2 − K1) − Net Debit

= (1,700 − 1,600) − 45

= 100 − 45

= ₹55 per share (when ST ≥ ₹1,700)

4. Breakeven Point:

BE = K1 + Net Debit

= 1,600 + 45

= ₹1,645

5. Risk-Reward Ratio:

R/R = 55 / 45 = 1.22x (favorable — potential profit exceeds risk)

(ii) Bull Call Spread — Payoff Table

Spot at Expiry (ST)	Long K=1,600 Call Payoff	Short K=1,700 Call Payoff	Gross Payoff (₹)	Net P&L = Gross − 45
1,500 (below K1)	0	0	0	− 45 (MAX LOSS)
1,550	0	0	0	− 45
1,600 (at K1)	0	0	0	− 45
1,645 (BE)	45	0	45	0 (Breakeven)
1,650	50	0	50	+ 5
1,700 (at K2)	100	0	100	+ 55 (MAX PROFIT)
1,750	150	− 50	100	+ 55
1,800	200	− 100	100	+ 55

Verification:

- Below ₹1,600: Payoff always − ₹45 = Formula's Max Loss ✓
- At/Above ₹1,700: Payoff always + ₹55 = Formula's Max Profit ✓
- At ₹1,645: Payoff = 0 = Formula's Breakeven ✓

(iii) Bear Put Spread — Key Metrics

Strategy Construction:

- LONG 1 Put at K2 = ₹1,700, Premium P2 = ₹135
- SHORT 1 Put at K1 = ₹1,600, Premium P1 = ₹75

Applying the Standard Formulas:

1. Net Debit:

Net Debit = P2 − P1

= ₹135 − ₹75

= ₹60 per share

2. Maximum Loss:

Max Loss = Net Debit

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= ₹60 per share (when ST ≥ ₹1,700)

3. Maximum Profit:

Max Profit = (K2 − K1) − Net Debit

= (1,700 − 1,600) − 60

= 100 − 60

= ₹40 per share (when ST ≤ ₹1,600)

4. Breakeven Point:

BE = K2 − Net Debit

= 1,700 − 60

= ₹1,640

5. Risk-Reward Ratio:

R/R = 40 / 60 = 0.67x (unfavorable — potential profit is less than risk)

(iv) Bear Put Spread — Payoff Table

Spot at Expiry (ST)	Long K=1,700 Put Payoff	Short K=1,600 Put Payoff	Gross Payoff (₹)	Net P&L = Gross − 60
1,500 (below K1)	200	− 100	100	+ 40 (MAX PROFIT)
1,550	150	− 50	100	+ 40
1,600 (at K1)	100	0	100	+ 40
1,640 (BE)	60	0	60	0 (Breakeven)
1,650	50	0	50	− 10
1,700 (at K2)	0	0	0	− 60 (MAX LOSS)
1,750	0	0	0	− 60
1,800	0	0	0	− 60

Verification:

- At/Below ₹1,600: Payoff always + ₹40 = Formula's Max Profit ✓
- At/Above ₹1,700: Payoff always − ₹60 = Formula's Max Loss ✓
- At ₹1,640: Payoff = 0 = Formula's Breakeven ✓

(v) Position Sizing with ₹5 Lakh Risk Budget

Given: HDFC Bank Options Lot Size = 550 shares

Bull Call Spread:

Max Loss per share = ₹45

Max Loss per lot = ₹45 × 550 = ₹24,750

Lots deployable = ₹5,00,000 / ₹24,750

= 20 lots (approx.)

Total Max Loss (20 lots) = 20 × ₹24,750 = ₹4,95,000 (within budget) ✓

Total Max Profit if trade succeeds = 20 × 550 × ₹55

= ₹6,05,000 (₹6.05 lakh)

Bear Put Spread:

Max Loss per share = ₹60

Max Loss per lot = ₹60 × 550 = ₹33,000

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Lots deployable = ₹5,00,000 / ₹33,000

= 15 lots (approx.)

Total Max Loss (15 lots) = 15 × ₹33,000 = ₹4,95,000 (within budget) ✓

Total Max Profit if trade succeeds = 15 × 550 × ₹40

= ₹3,30,000 (₹3.30 lakh)

Position Sizing Summary:

Strategy	Max Loss/Lot	Lots Deployable	Total Capital at Risk	Total Max Profit
Bull Call Spread	₹24,750	20	₹4,95,000	₹6,05,000
Bear Put Spread	₹33,000	15	₹4,95,000	₹3,30,000

(vi) Bull Call Spread vs Naked Long Call (K = 1,600)

Feature	Naked Long Call K = 1,600	Bull Call Spread
Entry Cost (per share)	₹85	₹45 (47% cheaper)
Maximum Loss	₹85	₹45
Breakeven Point	₹1,685 (K + prem)	₹1,645 (lower BE = easier to reach)
Payoff at ST = ₹1,700	+ ₹15	+ ₹55 (higher for moderate rise)
Payoff at ST = ₹1,800	+ ₹115	+ ₹55 (capped)
Payoff at ST = ₹2,000	+ ₹315 (unlimited)	+ ₹55 (capped)
Best Suited For	Strong bullish; expects big move	Moderate bullish; expects contained rise

Key Trade-Off:

The Bull Call Spread SACRIFICES UNLIMITED UPSIDE (above ₹1,700) in exchange for a LOWER ENTRY COST (₹45 vs ₹85 = 47% cheaper) and a LOWER BREAKEVEN (₹1,645 vs ₹1,685). This is beneficial when the trader has a DEFINED TARGET price in mind:

(i) If Arjun's view is: "HDFC Bank will rise to ₹1,700 by expiry" → Bull Call Spread is superior (₹55 profit vs ₹15 for naked call).

(ii) If Arjun's view is: "HDFC Bank could rally significantly to ₹1,800 or beyond" → Naked Long Call is superior (₹115+ profit vs ₹55 capped for spread).

(iii) If Arjun's view is: "Market may consolidate around ₹1,650-1,680" → Bull Call Spread is still profitable (breakeven at ₹1,645, some profit above) while naked call would be at loss (breakeven at ₹1,685).

For a MODERATE BULLISH view with a DEFINED TARGET, the Bull Call Spread offers superior risk-adjusted returns.

Question 10 — Portfolio Hedging Strategies on ICICI Bank

Meenakshi Krishnan, Head of Portfolio Advisory at ASK Investment Managers, is advising a HNI client Vivek Malhotra (Delhi-based industrialist) who holds a large concentrated position in ICICI Bank Ltd. Vivek acquired the position at ₹800 per share five years ago and is now sitting on a substantial unrealized gain. He is unwilling to sell (LTCG realization, ongoing dividend income, long-term conviction) but wants to manage downside risk over the next 3 months given elevated macro uncertainty. Meenakshi presents three distinct options-based hedging strategies: Protective Put, Covered Call, and Zero-Cost Collar.

Current Position (15-Jul-2026):

Parameter	Value
ICICI Bank Spot	₹1,200
Shares Held	21,000 shares
Position Value	₹2.52 crore

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Parameter	Value
Cost Basis	₹800 per share (2021 acquisition)
Unrealized Gain	₹400 × 21,000 = ₹84 lakh (LTCG if realized)
Hedging Horizon	3 months (Sep 2026 expiry)
ICICI Bank Options Lot Size	700 shares per contract
Lots to Hedge Full Position	21,000 / 700 = 30 lots

Available Sep 2026 Options (3-Month Expiry):

Strike (K)	Moneyness (Current Spot 1,200)	Put Premium (₹)	Call Premium (₹)
1,150	OTM Put / ITM Call	25	80
1,200 (ATM)	ATM	45	60
1,240	OTM Put / OTM Call	35	45
1,250	OTM Put / OTM Call	30	40

Required:

(i) Explain the PROTECTIVE PUT strategy — construction, motivation, breakeven, max loss, and max profit. Compute the payoff profile at spot levels ₹1,000 / 1,100 / 1,150 / 1,200 / 1,240 / 1,250 / 1,300 / 1,400.

(ii) Explain the COVERED CALL strategy. Construct using K = 1,250 call. Compute the payoff profile at the same spot levels. Identify breakeven, max profit, and max loss.

(iii) Explain the ZERO-COST COLLAR. Construct using Long Put K = 1,200 (₹45) + Short Call K = 1,240 (₹45). Compute the payoff profile. Identify max loss, max profit, and the effective "floor" and "ceiling" on returns.

(iv) Present a consolidated comparison of all three strategies alongside the UNHEDGED position at each spot level.

(v) For portfolio-level analysis, compute the TOTAL P&L (in ₹ lakh) under each strategy for two scenarios: (a) ICICI Bank falls to ₹1,100 (bearish), (b) ICICI Bank rises to ₹1,400 (bullish).

(vi) Advise Vivek on which strategy to choose based on three different views: (a) High conviction of downside protection needed, (b) Modest bullishness with income desired, (c) Uncertain but wanting range-bound protection at zero cost.

Solution

(i) PROTECTIVE PUT — Construction and Payoff

Construction:

PROTECTIVE PUT = LONG STOCK + LONG PUT

For Vivek's position:

- Existing Position: LONG 21,000 shares ICICI Bank at ₹1,200
- Hedge: BUY 30 lots (21,000 shares) ATM Put K = 1,200 at ₹45 premium

Cost of Hedge:

Total premium = 30 lots × 700 × ₹45

= ₹9,45,000 (₹9.45 lakh, ~3.75% of position value)

Motivation:

Protective Put functions as an INSURANCE POLICY on the stock. Below the strike (₹1,200), the put's payoff compensates for stock losses. Above the strike, upside is preserved (minus the premium cost). The strategy is directly analogous to buying comprehensive motor insurance — you pay a fixed premium for protection against catastrophic loss while retaining upside from safe operation.

Payoff Analysis (per share at expiry):

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Net P&L = (ST − 1,200) + max(1,200 − ST, 0) − 45

= max(ST − 1,200, 0) − 45

Key Metrics:

- Breakeven: ST = K + Premium = 1,200 + 45 = ₹1,245
- Max Loss (any ST ≤ 1,200): ₹45 per share = ₹9.45 lakh total
- Max Profit: UNLIMITED (as ST → ∞)

Payoff Table:

Spot at Expiry (₹)	Stock P&L (₹)	Put Payoff (₹)	Premium Paid (₹)	Net P&L (₹/share)
1,000 (large fall)	− 200	+ 200	− 45	− 45
1,100	− 100	+ 100	− 45	− 45
1,150	− 50	+ 50	− 45	− 45
1,200 (ATM)	0	0	− 45	− 45
1,240	+ 40	0	− 45	− 5
1,245 (BE)	+ 45	0	− 45	0
1,250	+ 50	0	− 45	+ 5
1,300	+ 100	0	− 45	+ 55
1,400 (large rise)	+ 200	0	− 45	+ 155

(ii) COVERED CALL — Construction and Payoff

Construction:

COVERED CALL = LONG STOCK + SHORT CALL

For Vivek's position:

- Existing Position: LONG 21,000 shares ICICI Bank at ₹1,200
- Overlay: SELL 30 lots (21,000 shares) OTM Call K = 1,250 at ₹40 premium

Premium Received:

Total premium = 30 lots × 700 × ₹40

= ₹8,40,000 (₹8.40 lakh income)

Motivation:

Covered Call generates INCOME from the option premium. The seller believes the stock is unlikely to rise significantly beyond the strike (₹1,250) during the option's life. The premium (₹40 × 21,000 = ₹8.40 lakh over 3 months) is like collecting rent on the stock. In exchange, the seller CAPS the upside above ₹1,250 — any gains beyond this level are forfeited to the call buyer.

Payoff Analysis (per share at expiry):

Net P&L = (ST − 1,200) − max(ST − 1,250, 0) + 40

Key Metrics:

- Breakeven (below current spot): ST = 1,200 − 40 = ₹1,160
- Max Profit (at any ST ≥ 1,250): (1,250 − 1,200) + 40 = ₹90 per share = ₹18.90 lakh total
- Max Loss (in theory): ₹1,160 per share (when ST → 0), less severe than unhedged

Payoff Table:

Spot at Expiry (₹)	Stock P&L (₹)	Short Call Payoff (₹)	Premium Received (₹)	Net P&L (₹/share)
1,000 (large fall)	− 200	0	+ 40	− 160
1,100	− 100	0	+ 40	− 60
1,150	− 50	0	+ 40	− 10

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Spot at Expiry (₹)	Stock P&L (₹)	Short Call Payoff (₹)	Premium Received (₹)	Net P&L (₹/share)
1,160 (BE)	− 40	0	+ 40	0
1,200 (ATM)	0	0	+ 40	+ 40
1,240	+ 40	0	+ 40	+ 80
1,250 (K_call)	+ 50	0	+ 40	+ 90 (MAX)
1,300	+ 100	− 50	+ 40	+ 90
1,400 (large rise)	+ 200	− 150	+ 40	+ 90 (CAPPED)

(iii) ZERO-COST COLLAR — Construction and Payoff

Construction:

ZERO-COST COLLAR = LONG STOCK + LONG PUT + SHORT CALL (with premiums offsetting)

For Vivek's position:

- Existing Position: LONG 21,000 shares ICICI Bank at ₹1,200
- Downside Protection: BUY 30 lots ATM Put K = 1,200 at ₹45 premium
- Financing: SELL 30 lots Call K = 1,240 at ₹45 premium

Cost of Hedge:

Net premium = ₹45 (paid) − ₹45 (received) = ₹0

→ TRUE ZERO-COST HEDGE

Motivation:

Collar creates a NARROW RANGE within which the portfolio P&L is bounded — no downside below the put strike, no upside above the call strike. The put cost is FINANCED by the call sale premium — no cash outlay required. The trade-off is FORFEITED UPSIDE beyond ₹1,240. Ideal for investors seeking capital preservation with modest return participation, at zero explicit cost.

Payoff Analysis (per share at expiry):

Net P&L = (ST − 1,200) + max(1,200 − ST, 0) − max(ST − 1,240, 0) − 0

Piecewise Payoff:

- ST ≤ 1,200: Net P&L = 0 (put fully protects downside)
- 1,200 < ST ≤ 1,240: Net P&L = ST − 1,200 (linear participation)
- ST > 1,240: Net P&L = 40 (call caps upside)

Key Metrics:

- Floor (Max Loss): ₹0 per share (unlimited downside neutralized)
- Ceiling (Max Profit): ₹40 per share = ₹8.40 lakh total
- Return Range: 0% to +3.33% over 3 months (13.3% annualized max)

Payoff Table:

Spot at Expiry (₹)	Stock P&L (₹)	Long Put Payoff (₹)	Short Call Payoff (₹)	Net P&L (₹/share)
1,000 (large fall)	− 200	+ 200	0	0 (FLOOR)
1,100	− 100	+ 100	0	0
1,150	− 50	+ 50	0	0
1,200	0	0	0	0
1,220	+ 20	0	0	+ 20
1,240 (K_call)	+ 40	0	0	+ 40 (MAX)
1,250	+ 50	0	− 10	+ 40
1,300	+ 100	0	− 60	+ 40

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Spot at Expiry (₹)	Stock P&L (₹)	Long Put Payoff (₹)	Short Call Payoff (₹)	Net P&L (₹/share)
1,400 (large rise)	+ 200	0	− 160	+ 40 (CAPPED)

(iv) Consolidated Comparison

Spot at Expiry (₹)	Unhedged (₹/sh)	Protective Put (₹/sh)	Covered Call (₹/sh)	Zero-Cost Collar (₹/sh)
1,000	− 200	− 45	− 160	0
1,100	− 100	− 45	− 60	0
1,150	− 50	− 45	− 10	0
1,200 (ATM)	0	− 45	+ 40	0
1,240	+ 40	− 5	+ 80	+ 40
1,250	+ 50	+ 5	+ 90	+ 40
1,300	+ 100	+ 55	+ 90 (capped)	+ 40 (capped)
1,400	+ 200	+ 155	+ 90 (capped)	+ 40 (capped)

Key Observations:

- PROTECTIVE PUT: Best when stock rallies (retains full upside beyond BE ₹1,245) but has fixed hedge cost that reduces mild-scenario returns.
- COVERED CALL: Best when stock stays FLAT or rises MODESTLY (income harvest) but performs WORST in a sharp decline (only ₹40 cushion vs stock's full loss).
- ZERO-COST COLLAR: Provides the most CERTAINTY of outcome (P&L bounded in ₹0 to ₹40 range) at ZERO explicit cost, but caps upside most aggressively.

(v) Portfolio-Level P&L Analysis (21,000 shares)

Scenario A: ICICI Bank Falls to ₹1,100 (Bearish, − 8.3%)

Strategy	P&L per Share (₹)	Total P&L (₹ lakh)
Unhedged	− 100	− 21.00
Protective Put	− 45	− 9.45
Covered Call	− 60	− 12.60
Zero-Cost Collar	0	0.00

Downside Protection Effectiveness (vs Unhedged):

- Protective Put: Saves ₹11.55 lakh (55% of unhedged loss avoided)
- Covered Call: Saves ₹8.40 lakh (40% of loss avoided — least effective downside protection)
- Zero-Cost Collar: Saves ₹21.00 lakh (100% of loss avoided) — BEST DOWNSIDE PROTECTION

Scenario B: ICICI Bank Rises to ₹1,400 (Bullish, + 16.7%)

Strategy	P&L per Share (₹)	Total P&L (₹ lakh)
Unhedged	+ 200	+ 42.00
Protective Put	+ 155	+ 32.55
Covered Call	+ 90 (capped)	+ 18.90
Zero-Cost Collar	+ 40 (capped)	+ 8.40

Upside Participation (vs Unhedged):

- Protective Put: Captures ₹32.55 lakh (77.5% of unhedged gain) — BEST UPSIDE
- Covered Call: Captures ₹18.90 lakh (45% of gain — cap kicks in)
- Zero-Cost Collar: Captures only ₹8.40 lakh (20% of gain — cap most severe)

Risk-Reward Trade-off Summary:

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Strategy	Downside Protection	Upside Participation	Cost
Protective Put	Good (below ₹1,200 protected)	EXCELLENT (retains upside)	₹9.45 lakh premium
Covered Call	MINIMAL (only ₹8.40L cushion)	Capped at ₹1,250	– ₹8.40 lakh (income)
Zero-Cost Collar	EXCELLENT (fully protected)	Capped at ₹1,240	₹0 (self-financed)

(vi) Strategy Recommendation for Vivek

(a) High Conviction of Downside Protection Needed:

Recommend: ZERO-COST COLLAR

Rationale: Best downside protection (fully floored at ₹0 loss) at NO EXPLICIT COST. If Vivek genuinely fears a correction and doesn't have a strong upside view, the collar provides the psychological comfort of GUARANTEED capital preservation. The forfeited upside (above ₹1,240) is acceptable because Vivek's primary concern is protection, not aggressive appreciation. This is also the most tax-efficient (no dividends taxed on written call as it's a hedge).

(b) Modest Bullishness with Income Desired:

Recommend: COVERED CALL

Rationale: If Vivek believes ICICI Bank will trade sideways-to-modestly higher, the covered call harvests ₹8.40 lakh premium income immediately (about 3.3% quarterly return on his position, ~13% annualized). If stock stays below ₹1,250, he keeps the premium AND the stock; if stock rises above ₹1,250, he's called out at ₹90 profit per share (still ₹18.90 lakh total gain). Downside risk remains, so this is only appropriate if he has HIGH conviction that a large decline (below ₹1,150) is unlikely. Ideal for a moderate bullish view with income focus.

(c) Uncertain, Wanting Range-Bound Protection at Zero Cost:

Recommend: ZERO-COST COLLAR (again)

Rationale: The collar structurally embodies the "uncertain" view — it bounds outcomes in a narrow range (₹0 to ₹40 per share, or 0% to 3.3% over 3 months). It gives Vivek a KNOWN OUTCOME regardless of market direction, at zero net cost. This is exactly what an investor should choose when they have neither strong bullish nor bearish conviction, but need protection because of external factors (macro uncertainty, elections, potential job change requiring liquidity).

Advanced Alternative — Custom Hedge Structuring:

For Vivek's specific situation (LTCG-sensitive, dividend-oriented, long-term conviction), Meenakshi could propose:

- **(i)** Partial Hedge: Collar only 50% of position (10,500 shares via 15 lots). Retain full stock exposure on the other half. Splits the difference between full protection and full participation.
- **(ii)** Wider Collar: Long Put K=1,150 (₹25) + Short Call K=1,300 (₹15). Net cost ₹10, wider range −4.2% to +8.3%. More upside room, minor cost.
- **(iii)** Rolling Strategy: Enter monthly rolling collars — allows tighter strikes with lower vega risk per period. More work, but adaptable to changing views.
- **(iv)** Put Spread instead: Long Put K=1,200 + Short Put K=1,100. Costs less than protective put (~₹20 net premium instead of ₹45), but only protects against moderate declines (down to ₹1,100), not crash scenarios.

Question 11 — Gold Inventory Hedging at Titan Company Ltd

Ravindra Iyer, CFO of Titan Company Limited (Tata Group), heads a company with dual exposure to gold — as India's largest branded jeweller (Tanishq, Zoya, CaratLane), Titan maintains a significant gold inventory to fabricate and stock jewellery, and simultaneously faces the risk that gold prices could fall between procurement and final consumer sale. On 15th July 2026, Ravindra reviews the Western India Region's inventory position with the treasury team and decides to hedge the price risk using MCX Gold futures ahead of the peak Onam and Ganesh Chaturthi season (August-September 2026).

Titan's Physical Position (15-Jul-2026):

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Parameter	Value
Gold Inventory (Chennai warehouse)	100 kg = 1,00,000 grams
Spot Gold Price (Ahmedabad benchmark)	₹65,000 per 10 grams (₹6,500 per gram)
Inventory Value at Spot	₹65.00 crore
Expected Sale Period	August-September 2026 (Onam + Ganesh Chaturthi festivals)
Risk Concern	Gold price could fall before sale completion

MCX Gold Sep 2026 Contract Specifications:

Parameter	Value
Contract Symbol	GOLDMSEP2026 (MCX)
Contract Size	1 kg (1,000 grams)
Price Quotation	Per 10 grams
Tick Size	₹1 per 10 grams
Current Sep 2026 Futures Price	₹66,000 per 10 grams
Contract Notional Value	100 × ₹66,000 = ₹66,00,000 (₹66 lakh)
Initial Margin (SPAN + Exposure)	~ 7% = ₹4,62,000 per contract
Delivery Basis	Ahmedabad (final settlement)

Contango Structure (Spot to Futures Premium):

Sep Futures ₹66,000 − Spot ₹65,000 = ₹1,000 per 10 grams (approx 1.54% premium for 2 months). This contango reflects:

- Cost of financing gold inventory (~ 7% p.a. × 2/12 ≈ 1.17%)
- Storage, insurance, and refining spreads (~ 0.3-0.5%)
- MCX-COMEX arbitrage transaction costs

Approximate fair value: 65,000 × (1 + 0.09 × 2/12) = ₹65,975 ≈ ₹66,000 ✓ (using 9% blended carry rate)

Required:

(i) Explain the commodity price risk that Titan faces on its gold inventory. Discuss the direction of hedge required (short vs long) and the underlying rationale.

(ii) Design the hedge — compute the number of MCX Gold Sep 2026 futures contracts to fully hedge the 100 kg inventory. Calculate the total margin outlay.

(iii) Analyze the hedged position under THREE scenarios at Sep 2026 expiry: (a) Gold FALLS to ₹63,000/10g, (b) Gold STABLE at ₹65,000/10g, (c) Gold RISES to ₹68,000/10g. Compute the total realization (sale + futures P&L) for each scenario.

(iv) Prove that regardless of gold's direction, Titan LOCKS IN a realization equal to the initial FORWARD price × inventory quantity. Explain the source of the ₹1 crore gain over unhedged spot value.

(v) Discuss BASIS RISK: If Chennai spot at expiry trades ₹200/10g higher than MCX (Ahmedabad) benchmark, compute the impact on the hedge outcome. Explain the concept.

(vi) Discuss two OPERATIONAL considerations: (a) Margin management and mark-to-market obligations, (b) Contract rollover if hedge horizon extends beyond Sep 2026 expiry.

(vii) Compare the futures hedge with two alternative hedging strategies: (a) BUY MCX Gold PUT OPTIONS on Sep 2026, (b) NATURAL HEDGE via customer advance bookings (gold-linked deposit schemes). Discuss trade-offs.

Solution

(i) Commodity Price Risk and Hedge Direction

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Nature of Titan's Gold Price Risk:

Titan holds a LONG PHYSICAL POSITION in gold (inventory). Its financial exposure mirrors a long gold holder:

- If gold prices RISE: Inventory value rises → GAIN to Titan
- If gold prices FALL: Inventory value falls → LOSS to Titan

The Downside Concern:

Between 15-Jul-2026 (today) and the time of final jewellery sale (Aug-Sep), gold prices could DECLINE. Titan's revenue realization (based on then-current spot gold + jewellery-making charges + brand premium) would be LOWER than the inventory cost. This compresses gross margins on jewellery sales.

Historical Context:

- Gold volatility: ~ 12-15% annualized (moderate vs equities)
- Rupee-Dollar movements amplify gold price volatility in ₹ terms
- Global risk-off events (banking crises, geopolitical tensions) can cause 5-10% moves within days
- India's total gold demand ~800-900 tonnes p.a.; Titan (Tanishq) is ~5% market share

Hedge Direction: SHORT FUTURES

To offset the long physical position's downside risk, Titan must take an OFFSETTING SHORT POSITION in MCX Gold futures:

- If gold falls: Inventory loses value BUT short futures gain equivalent amount → NET NEUTRAL
- If gold rises: Inventory gains value BUT short futures lose equivalent amount → NET NEUTRAL

This is a SHORT HEDGE — the classic strategy for INVENTORY holders (jewellers, oil refiners, agricultural warehousers). Users of commodities (jewellery manufacturers who don't yet own gold, oil marketing companies who plan future purchases) would use a LONG HEDGE (buy futures) instead.

(ii) Hedge Construction — Number of Contracts and Margin

Number of Contracts:

Physical inventory: 100 kg = 1,00,000 grams

MCX Gold contract size: 1 kg = 1,000 grams

Number of contracts = Inventory Quantity / Contract Size

= 100 kg / 1 kg per contract

= 100 contracts (all SHORT)

Notional Value of Hedge:

Per contract: 100 units × ₹66,000/10g = ₹66,00,000 (₹66 lakh)

Total: 100 contracts × ₹66 lakh = ₹66 crore

Initial Margin Requirement:

MCX SPAN + Exposure margin for Gold: ~ 7% of contract notional

Per contract: ₹66,00,000 × 7% = ₹4,62,000

Total: 100 × ₹4,62,000

= ₹4,62,00,000 (₹4.62 crore)

Additional Margin Buffer:

Prudent treasury practice: maintain 30-50% buffer above initial margin to withstand adverse mark-to-market. Recommended cash cushion: ₹6.5 crore (₹4.62 crore initial + ₹1.85 crore buffer).

(iii) Scenario Analysis at Sep 2026 Expiry

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At Expiry, Futures Converge to Spot (basis approaches zero at delivery point)

SCENARIO A: Gold FALLS to ₹63,000/10g (a 3.1% decline)

Component	Computation	Value (₹ crore)
Inventory Sale Realization	1,00,000 grams × ₹6,300	63.00
Change vs Initial Inventory Value	63.00 − 65.00	− 2.00 (LOSS)
Futures Short Position P&L	**(66,000 − 63,000) × 100 × 100 = ₹3 cr**	**+ 3.00 (GAIN)**
Total Realization (Sale + Futures)		**66.00**

SCENARIO B: Gold STABLE at ₹65,000/10g

Component	Computation	Value (₹ crore)
Inventory Sale Realization	1,00,000 grams × ₹6,500	65.00
Change vs Initial Inventory Value	0	0.00
Futures Short Position P&L	**(66,000 − 65,000) × 100 × 100 = ₹1 cr**	**+ 1.00 (GAIN)**
Total Realization (Sale + Futures)		**66.00**

SCENARIO C: Gold RISES to ₹68,000/10g (a 4.6% rally)

Component	Computation	Value (₹ crore)
Inventory Sale Realization	1,00,000 grams × ₹6,800	68.00
Change vs Initial Inventory Value	68.00 − 65.00	+ 3.00 (GAIN)
Futures Short Position P&L	**(66,000 − 68,000) × 100 × 100 = − ₹2 cr**	**− 2.00 (LOSS)**
Total Realization (Sale + Futures)		**66.00**

(iv) The Locked-In Realization Insight

Consolidated Result Across All Scenarios:

Scenario	Spot at Expiry (₹/10g)	Sale (₹ cr)	Futures P&L (₹ cr)	Total (₹ cr)
A: Fall	63,000	63.00	+ 3.00	66.00
B: Stable	65,000	65.00	+ 1.00	66.00
C: Rise	68,000	68.00	− 2.00	66.00

Key Insight: Total realization is CONSTANT at ₹66 crore in ALL scenarios.

Why ₹66 Crore and Not ₹65 Crore?

The futures price at the time of hedge initiation was ₹66,000 per 10 grams. Titan LOCKED IN THIS FORWARD PRICE, not the current spot of ₹65,000. Multiplying the futures price by the inventory quantity:

Locked-in price = ₹66,000 per 10g = ₹6,600 per gram

Total realization = 1,00,000 × ₹6,600 = ₹66,00,00,000 = ₹66 crore ✓

The ₹1 Crore Contango Premium:

Because the futures were priced HIGHER than spot (₹66,000 vs ₹65,000), Titan effectively SOLD forward at a premium of ₹1,000 per 10g × 1,00,000/10 = ₹1 crore. This premium compensates for the carrying costs (financing, storage, insurance) — economically, Titan has been PAID to hold the gold and deliver it later.

Economic Interpretation:

The hedge converts an UNCERTAIN future sale into a CERTAIN ₹66 crore realization. Titan surrenders the potential upside (if gold rallies beyond ₹66,000) in exchange for eliminating downside (if gold crashes below ₹66,000). This trade-off is exactly what a RISK-AVERSE corporate treasury wants — predictable margins, protection against tail scenarios.

(v) Basis Risk

Concept of Basis Risk:

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Basis Risk arises when the futures price DOES NOT PERFECTLY CONVERGE with the spot price at the LOCATION where the hedger transacts. Sources of basis:

- Location basis: MCX Gold uses Ahmedabad benchmark; Chennai gold may trade at premium/discount due to local demand-supply
- Quality basis: MCX contract specifies 995 purity; jewellery inventory may be 916 (22K) requiring different valuation
- Timing basis: Futures expire on 5th Sep; Titan's actual sales may extend to end-September

Illustration: Chennai Local Premium of ₹200/10g

Suppose at Sep expiry:

- MCX (Ahmedabad) spot converges to ₹63,000/10g (Scenario A)
- Chennai spot: ₹63,200/10g (₹200 local premium due to strong Onam demand)

Recomputed Realization:

Component	Value (₹ crore)
Chennai sale realization: 1,00,000 × ₹6,320	63.20
Futures P&L: (66,000 − 63,000) × 100 × 100	+ 3.00
Total Realization	**66.20**
Target (locked-in at MCX ₹66,000/10g)	66.00
Basis Risk Gain	**+ 0.20**

Interpretation:

Titan gained an EXTRA ₹0.20 crore because Chennai's local premium meant the sale realization exceeded the MCX-based lock-in. Conversely, if Chennai had traded at a DISCOUNT (₹200 below MCX), the total realization would have been ₹65.80 crore — a ₹0.20 crore basis loss.

Managing Basis Risk:

(i) Historical monitoring: Chennai-MCX basis over 12 months averages ₹150-250/10g premium. Titan can factor this into hedge design.

(ii) Location arbitrage: When Chennai premium widens abnormally, Titan can source gold from cheaper markets (Ahmedabad, Delhi) to sell in Chennai.

(iii) Cross-hedging with COMEX Gold (dollar-denominated): Adds forex risk but potentially better convergence in some scenarios.

(iv) Position sizing: For very location-specific inventory, some hedgers under-hedge by 5-10% to leave room for basis mismatch.

(vi) Operational Considerations

(a) Margin Management and Mark-to-Market:

MCX futures are marked-to-market DAILY. Cash flows arise every trading day based on futures settlement price:

- If MCX Gold futures RISE by ₹500/10g: Short position loses ₹500 × 100 × 100 = ₹50 lakh MTM daily — Titan must post additional margin
- If futures FALL: Titan receives MTM inflow

Cash Flow Implication:

Over 2 months, if gold rallies to ₹70,000/10g and back to ₹66,000, Titan may experience temporary MTM losses of ₹4-5 crore (before final convergence). While the FINAL P&L is unaffected, INTERIM cash calls can strain treasury liquidity.

Recommendation:

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Maintain a ₹6-8 crore MARGIN BUFFER above the initial margin (₹4.62 crore). Have committed lines of credit with State Bank of India or ICICI Bank to draw upon in adverse MTM scenarios. Ravindra should present this to Titan's Risk Management Committee alongside the hedge proposal.

(b) Rollover Considerations:

If Titan's actual sale period extends beyond Sep 2026 (e.g., some inventory still held until Nov 2026 for Diwali):

- Sep contracts expire and must be CLOSED (or physically delivered)
- Titan can ROLL the hedge forward by SIMULTANEOUSLY buying back Sep futures AND selling Nov 2026 futures

Rollover Cost/Yield:

If Nov 2026 futures trade at a further premium over Sep (contango), Titan earns ADDITIONAL premium on the roll. If in backwardation (Nov < Sep), rollover costs money. The historical Indian gold futures term structure has been PERSISTENTLY contango, generally favoring rollovers by hedgers.

Example Rollover Math:

Suppose on 1st Sep, Sep 2026 futures = ₹66,500 and Nov 2026 futures = ₹67,000

- Close Sep short at ₹66,500 (initial short at ₹66,000, small MTM loss of ₹500/10g × 1L/10 = ₹50 lakh incurred over the 2 months)
- Open Nov 2026 short at ₹67,000 (₹500/10g additional premium captured for the extended 2-month hedge)
- Net roll cost: ZERO (₹500 loss offset by ₹500 additional premium)

(vii) Alternative Hedging Strategies

Alternative 1: BUY MCX Gold PUT OPTIONS on Sep 2026

Instead of shorting futures, Titan could BUY OTM puts (say K = ₹64,000) at premium ₹500/10g. This provides:

- Downside protection below ₹64,000 (like insurance)
- FULL UPSIDE participation if gold rallies above ₹66,000
- Fixed cost: ₹500 × 100 × 100 = ₹50 lakh premium (vs zero for futures)

Comparison Table:

Feature	Futures Hedge	Put Option Hedge
Cost of Hedge	Zero (may earn contango premium)	₹50 lakh premium
Downside Protection	Perfect at ₹66,000 lock-in	Below K=₹64,000 only
Upside Participation	None (locked in)	Full above ₹64,000
Cash Flow Volatility	Daily MTM required	One-time premium; no MTM
Suitable For	Certainty-preferring treasury	Bullish view with insurance

Alternative 2: NATURAL HEDGE via Gold-Linked Customer Advance Booking Schemes

Tanishq's popular "Golden Harvest" scheme allows customers to pre-book jewellery by paying monthly instalments. The company invests the collections in gold, effectively creating a matched liability (jewellery delivery obligation) against gold reserves.

Mechanism:

(i) Customer pays ₹5,000/month for 11 months = ₹55,000

(ii) Tanishq gives 12th month contribution PLUS the total is used to buy gold at prevailing rate at redemption

(iii) For Tanishq: The customer deposits are used to fund gold purchases IMMEDIATELY — natural hedge

(iv) If gold rises: Deposits grow with gold price, sale price rises, no P&L impact

(v) If gold falls: Deposits inflow continues at same amount but gold cost falls, margins protected

Advantages:

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- ZERO cost — no derivatives margin, no premium outlay
- Balance sheet neutral — matched asset (gold) against liability (customer commitment)
- Enhances customer engagement and loyalty (embedded product)

Limitations:

- Slow ramp-up — depositor base grows over months, not sufficient for large inventory hedge
- Only hedges the SPECIFIC inventory backing the deposits (typically 15-25% of total inventory)
- Regulatory constraints — SEBI and RBI restrictions on customer deposit schemes

Ravindra's Recommendation:

A LAYERED APPROACH is optimal for Titan:

- Base hedge (~60% of inventory): MCX Gold Futures — cost-effective, precise
- Tail-risk hedge (~15%): Deep OTM Puts — insurance against crash scenarios
- Natural hedge (~25%): Golden Harvest scheme — customer-linked, balance sheet neutral
- Reserve unhedged (0-10%): For opportunistic upside if strong bullish view emerges

This blend balances cost, protection, upside, and operational flexibility — aligned with Titan's risk management policy approved by the Board.

Question 12 — Exotic Options on HDFC Bank

Rohini Vashisht, a Senior Vice President in the Structured Products Group at Kotak Wealth Advisors (Mumbai), is designing an Equity-Linked Debenture (ELD) with an exotic option embedded to enhance yield for a HNI client. She uses HDFC Bank as the underlying to illustrate FIVE key exotic option structures and demonstrates their payoff behavior across two distinct price scenarios. Unlike vanilla options (Q3), these exotics have PATH-DEPENDENT payoffs — the value depends not just on the terminal price but on the ENTIRE price trajectory.

Base Setup:

Parameter	Value
Underlying	HDFC Bank Ltd (HDFCBANK)
Spot Price at Inception (S_0)	₹1,600
Strike (K, ATM)	₹1,600
Upper Barrier (B_up)	₹1,750
Option Tenor	6 months (monthly observations at month-end)
HDFCBANK Options Lot Size	550 shares per contract

Two Price Paths for Analysis:

Month-End	Path A (₹)	Path B (₹)
Month 1	1,600	1,650
Month 2	1,620	1,720
Month 3	1,680	1,780
Month 4	1,720	1,690
Month 5	1,640	1,620
Month 6 (Expiry)	1,700	1,700

Path Statistics:

Statistic	Path A	Path B
Final Price (ST)	₹1,700	₹1,700 (SAME)
Average Price (Arithmetic Mean)	₹1,660	₹1,693.33
Maximum Price during Life (S_max)	₹1,720	₹1,780

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Statistic	Path A	Path B
Minimum Price during Life (S_min)	₹1,600	₹1,620
Barrier Breach (₹1,750)?	NO (max 1,720 < 1,750)	YES (1,780 > 1,750 in Month 3)

Key observation: Both paths end at SAME final price ₹1,700, so vanilla European call payoff is IDENTICAL. But exotic options with path dependency will produce very DIFFERENT payoffs across the two paths.

Required:

(i) Introduce EXOTIC OPTIONS. Distinguish between PATH-DEPENDENT and PATH-INDEPENDENT options. Categorize the five types covered in this question.

(ii) Compute the ASIAN (Average Price) CALL payoff under both Path A and Path B. Explain why the payoff differs.

(iii) Compute the UP-AND-IN CALL and UP-AND-OUT CALL payoffs under both paths. Verify the IN-OUT PARITY relationship.

(iv) Compute the FIXED-STRIKE LOOKBACK CALL payoff under both paths. Compare with vanilla.

(v) Compute the CASH-OR-NOTHING DIGITAL (Binary) CALL payoff (fixed payout ₹100 if ITM) under both paths.

(vi) Present a consolidated summary of all five exotic option payoffs alongside the vanilla European call.

(vii) Discuss the practical use of exotic options in Indian STRUCTURED PRODUCTS (Market-Linked Debentures / Equity-Linked Debentures) issued by Kotak, IIFL Wealth, Nuvama, ICICI Direct, etc.

Solution

(i) Exotic Options — Introduction and Categorization

Definition:

An EXOTIC OPTION is any option contract whose payoff structure differs from the standard European or American CALL/PUT (vanilla options studied in Q3-Q7). Exotics were developed to serve specific hedging or investment needs that vanilla options do not address efficiently, and to embed unique payoff structures in structured products.

Path-Independent vs Path-Dependent:

Category	Payoff Depends On	Examples
Path-Independent	ONLY the final price at expiry (ST)	Vanilla Call/Put, Digital Options
Path-Dependent	The ENTIRE trajectory from t=0 to T	Asian, Barrier, Lookback

Five Types Covered in this Question:

(i) Asian Option: Payoff based on the AVERAGE price during the option's life (arithmetic or geometric mean of monthly/weekly observations).

(ii) Barrier Option: Payoff CONDITIONAL on the price crossing (or not crossing) a specified barrier during the option's life. Sub-types: Up-and-In, Up-and-Out, Down-and-In, Down-and-Out.

(iii) Lookback Option: Payoff based on the MAXIMUM or MINIMUM price observed during the option's life. Fixed-strike lookback uses (S_max − K) for calls; floating-strike uses (S_T − S_min).

(iv) Digital (Binary) Option: Pays a FIXED amount (or nothing) if in-the-money at expiry. Also called "all-or-nothing" options.

(v) Chooser Option: Grants the holder the RIGHT TO DECIDE at some future date whether the option becomes a Call or a Put. (Covered conceptually only.)

Why Exotics Exist:

(i) Cost efficiency: Barrier and Asian options are typically CHEAPER than vanilla (constrained payoff → lower premium)

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(ii) Payoff customization: Match a specific hedging need (e.g., an oil marketing company caring about average price, not spot at year-end)

(iii) Structured product design: Wealth managers embed exotics in structured notes to create unique risk-return profiles (capital protection + upside participation)

(iv) Reduced hedging cost for specific views (e.g., barrier options for range-bound views)

(ii) ASIAN (Average Price) CALL

Definition and Payoff Formula:

The Asian Call pays off based on the AVERAGE PRICE during the option's life, not the final price:

Payoff = max(Average − K, 0)

Averaging can be ARITHMETIC (simple mean of observations) or GEOMETRIC (product of observations to the 1/n power). ICAI SM convention uses arithmetic averaging.

Computation Under Path A:

Average = (1,600 + 1,620 + 1,680 + 1,720 + 1,640 + 1,700) / 6

= 9,960 / 6

= ₹1,660

Asian Call Payoff = max(1,660 − 1,600, 0)

= ₹60

Computation Under Path B:

Average = (1,650 + 1,720 + 1,780 + 1,690 + 1,620 + 1,700) / 6

= 10,160 / 6

= ₹1,693.33

Asian Call Payoff = max(1,693.33 − 1,600, 0)

= ₹93.33

Why Payoffs Differ:

Even though both paths have the same final price (₹1,700), Path B has a HIGHER AVERAGE (₹1,693.33 vs ₹1,660 in Path A) because the stock spent more time above the strike during Path B's trajectory. The Asian option "remembers" the entire path and rewards the higher average.

Key Insight — Volatility Dampening:

The Asian option generally has LOWER volatility exposure than vanilla. Averaging smooths out extreme moves, making Asian options CHEAPER than vanilla (typically 60-75% of vanilla premium). This is why they are popular for corporate hedgers with recurring cash flows (e.g., an oil marketing company selling fuel daily cares about the AVERAGE price, not any single day's spot).

(iii) BARRIER OPTIONS — Up-and-In and Up-and-Out Calls

Definitions:

UP-AND-IN CALL (UIC):

The option is DORMANT (has no payoff) at inception. It ACTIVATES only if the underlying price CROSSES the upper barrier B_up at any point during the option's life. If activated, it behaves like a vanilla call from that point on. If the barrier is never breached, the option EXPIRES WORTHLESS.

Payoff:

- If max(S_t) ≥ B_up during (0, T): max(ST − K, 0) [like vanilla call]

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- Otherwise: 0

UP-AND-OUT CALL (UOC):

The option starts ALIVE (behaves like a vanilla call). It gets KNOCKED OUT (becomes worthless) the moment the underlying price CROSSES the upper barrier B_up. If the barrier is never breached, the option pays vanilla call payoff at expiry.

Payoff:

- If max(S_t) < B_up during (0, T): max(ST − K, 0)
- Otherwise: 0

Computation Under Path A (Barrier NOT Breached):

Maximum during Path A = ₹1,720 < B_up = ₹1,750 → Barrier NOT hit.

Option	Barrier Status	Payoff
Up-and-In Call	Never activated (barrier not hit)	₹0
Up-and-Out Call	Stays alive (barrier not hit) → pays vanilla	max(1,700 − 1,600, 0) = ₹100

Computation Under Path B (Barrier BREACHED at Month 3):

Maximum during Path B = ₹1,780 ≥ B_up = ₹1,750 → Barrier hit (in Month 3).

Option	Barrier Status	Payoff
Up-and-In Call	Activated when barrier hit → becomes vanilla call	max(1,700 − 1,600, 0) = ₹100
Up-and-Out Call	Knocked out at Month 3	₹0

IN-OUT PARITY VERIFICATION:

For every price path, UIC + UOC = Vanilla European Call

This must hold because the two options COVER MUTUALLY EXCLUSIVE STATES of the world: either the barrier is hit (UIC pays, UOC is knocked out) or not hit (UIC pays 0, UOC pays vanilla). Together, they replicate the vanilla call.

Path	UIC (₹)	UOC (₹)	Sum (₹)	Vanilla Call (₹)	Parity?
Path A	0	100	100	100	✓
Path B	100	0	100	100	✓

Practical Interpretation of Barrier Choice:

- UIC BUYER expects the stock to RISE STRONGLY (breach the barrier) and continue rallying — a HIGH-CONVICTION bullish bet at a lower premium than vanilla call
- UOC BUYER expects the stock to rise MODERATELY (not breach the barrier) — a CAPPED bullish bet at a lower premium than vanilla call
- Sellers of UIC or UOC can generate income at levels vanilla calls cannot support

(iv) FIXED-STRIKE LOOKBACK CALL

Definition:

The Lookback Call rewards the holder based on the MAXIMUM price observed during the option's life. Two variants:

- FIXED-STRIKE Lookback Call: Payoff = max(S_max − K, 0). Strike is fixed at inception.
- FLOATING-STRIKE Lookback Call: Payoff = max(S_T − S_min, 0). Strike "floats" as the minimum observed.

This question focuses on the FIXED-STRIKE variant.

Payoff Formula (Fixed-Strike Lookback Call):

Payoff = max(S_max − K, 0)

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Computation Under Path A:

Maximum during Path A = ₹1,720

Payoff = max(1,720 − 1,600, 0)

= ₹120

Computation Under Path B:

Maximum during Path B = ₹1,780

Payoff = max(1,780 − 1,600, 0)

= ₹180

Comparison with Vanilla:

Path	Vanilla Call (₹)	Lookback Call (₹)	Premium Ratio
Path A	100	120	Lookback 20% higher
Path B	100	180	Lookback 80% higher

Key Insight:

The Lookback Call ALWAYS pays at least as much as the vanilla call (since S_max ≥ S_T always). It captures the BEST timing of a hypothetical sale — as if the holder had perfect foresight to sell at the peak. Because of this favorable payoff, Lookback options are EXPENSIVE — typically 150-200% of vanilla premium. They are rarely used standalone but appear in structured products where the wealth manager pays extra for the "best-of" feature.

(v) CASH-OR-NOTHING DIGITAL (Binary) CALL

Definition:

The Digital Call pays a FIXED AMOUNT (say ₹100) if the underlying finishes above the strike at expiry, and NOTHING otherwise. It is called BINARY because the payoff is either the fixed cash amount or zero — no continuous gradation.

Payoff Formula:

Payoff = Fixed Payout Q if ST > K

= 0 if ST ≤ K

For this question, we assume Q = ₹100 fixed payout.

Computation Under Both Paths:

Final ST in BOTH paths = ₹1,700 > K = ₹1,600 (option finishes ITM)

Path	Final ST	ITM?	Payoff (₹)
Path A	1,700	Yes	100 (fixed)
Path B	1,700	Yes	100 (fixed)

Key Insight — Path-Independence of Digital:

Unlike Asian, Barrier, and Lookback options, the Digital Call is PATH-INDEPENDENT — it depends only on the FINAL price relative to the strike. The trajectory during the option's life is IRRELEVANT. This makes Digital options similar to vanilla in that respect but different in payoff shape:

- Vanilla Call payoff: LINEAR above strike (unlimited growth)
- Digital Call payoff: STEP FUNCTION (jump from 0 to Q at K, then flat)

Applications of Digital Options:

- Sports/event betting derivatives (binary outcome)
- Structured products with defined "trigger" outcomes
- Compensation contracts (bonus if performance threshold hit)

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- FX barrier products (touch/no-touch derivatives)

(vi) Consolidated Comparison

Payoff Summary (₹ per share):

Option Type	Path A	Path B	Behavior Insight
Vanilla European Call	100	100	Path-independent (same ST)
Asian (Average) Call	60	93.33	Path-dependent; higher avg in B
Up-and-In Call	0	100	Barrier B not hit A / hit in B
Up-and-Out Call	100	0	Knocked out in B (barrier hit)
Fixed-Strike Lookback Call	120	180	Captures max; higher in B
Cash-or-Nothing Digital Call	100	100	Path-independent step payoff

Per-Lot Values (Lot Size 550):

Option Type	Path A (₹)	Path B (₹)
Vanilla Call	55,000	55,000
Asian Call	33,000	51,333
Up-and-In Call	0	55,000
Up-and-Out Call	55,000	0
Lookback Call	66,000	99,000
Digital Call	55,000	55,000

Indicative Premium Ranking (relative to Vanilla ATM Call):

Option	Typical Premium % of Vanilla	Reasoning
Vanilla Call	100% (baseline)	Reference point
Asian Call	60-75%	Averaging smooths payoff, less vol exposure
Up-and-In Call	40-60%	Conditional payoff, only kicks in with barrier
Up-and-Out Call	40-60%	Capped payoff, knocked out beyond barrier
Lookback Call	150-200%	Best-of feature commands premium
Digital Call	Varies with Q	Depends on fixed payout size and probability

(vii) Applications in Indian Structured Products

Market Overview:

Indian STRUCTURED PRODUCTS include Market-Linked Debentures (MLDs), Equity-Linked Debentures (ELDs), and Principal Protected Notes (PPNs). AUM in this segment has grown to over ₹1.5 lakh crore, with major issuers being Kotak, IIFL Wealth, Nuvama, ICICI Prudential, HDFC AMC, and Motilal Oswal. These products embed EXOTIC OPTIONS to create unique risk-return profiles for HNI and institutional investors.

Common Structures:

1. Nifty-Linked Note with Barrier (Autocallable):

Kotak Structured Note: Pays 10% p.a. coupon IF Nifty remains within [current × 0.85, current × 1.15] range. If Nifty breaches upper barrier, note AUTOCALLS at fixed 20% return. If lower barrier breached, coupon suspends and principal at maturity depends on Nifty level.

- Embedded exotics: Up-and-In Digital + Down-and-In Put
- Tenor: 24-36 months
- Target return: 10-14% p.a. vs 7% G-Sec

2. Best-of Basket Note (Lookback):

IIFL Wealth product linked to a basket of 3 stocks (say TCS, Infosys, HDFC Bank). Investor receives the return of the BEST-PERFORMING stock over 3 years, plus principal protection.

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- Embedded exotics: Basket Rainbow Option (max of N assets) + Zero-Coupon Bond
- Pricing: Uses Monte Carlo simulation due to complex payoff

3. Range Accrual Note (Digital + Barrier):

Nuvama product: Pays daily accrual coupon IF Nifty stays within [23,000, 25,000] range. Total coupon = 12% × (days in range) / (total days).

- Embedded exotics: Series of daily digital options
- Attractive when investor expects range-bound market

4. Asian-Averaged Certificate:

Motilal Oswal product: Returns based on AVERAGE Nifty level over final 6 months (not point-to-point). Reduces "expiry-day gaming" risk and provides smoother returns.

- Embedded exotic: Asian Option
- Popular for retiree segment seeking lower volatility

Regulatory Framework:

(i) SEBI's 2020 amendments to Debt Securities Regulations require: (a) minimum investment ₹10 lakh, (b) mandatory disclosure of embedded derivatives and their payoffs, (c) BSE/NSE listing.

(ii) Post-Budget 2023 taxation change: Structured products lost the earlier LTCG advantage. Now taxed at INCOME slab rate on redemption gains. This has moderated retail demand.

(iii) SEBI's MLD guidelines require STRESS TESTING under multiple scenarios (like the exercise in this question) as part of product disclosures.

Rohini's Product Design Recommendation:

For a HNI client seeking equity-linked returns with modest downside protection, Rohini could structure:

- Face value: ₹50 lakh (5-year tenor)
- 100% principal protection at maturity
- Upside participation: 80% of MAX (Nifty return, HDFC Bank return, TCS return) — Rainbow option
- Coupon: 6% p.a. fixed
- Autocall trigger: If any of 3 stocks rises 30% within 2 years, note pays 20% return + principal and terminates

This combination provides: (i) safety through principal protection, (ii) diversified upside via basket-best-of, (iii) fixed income cushion via coupon, (iv) early-payoff optionality via autocall. Pricing requires Monte Carlo simulation of embedded exotics; typical fee structure is 1.5-2.0% distribution charge.

Question 13 — Credit Default Swap on JSW Steel Corporate Bonds

Nikhil Kaushik, Head of Fixed Income Risk at HDFC Bank's Wholesale Banking Group, holds ₹100 crore face value of JSW Steel Ltd's 5-year senior unsecured corporate bonds in the bank's Treasury book. While JSW Steel is a well-established Indian steel major (part of the Sajjan Jindal Group), commodity cycles and global steel demand fluctuations create credit risk concerns. Nikhil decides to hedge the DEFAULT RISK using a Credit Default Swap (CDS) with Goldman Sachs India Ltd as the protection seller. This question examines the CDS structure, cash flows, valuation, and practical considerations.

CDS Contract Details (15-Jul-2026):

Parameter	Value
Reference Entity	JSW Steel Ltd (JSWSTEEL)
Reference Obligation	5-year Senior Unsecured Bond, face value ₹100 crore
Protection Buyer	HDFC Bank Ltd (Nikhil's team)

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Parameter	Value
Protection Seller	Goldman Sachs India Ltd
Notional Value	₹100 crore
CDS Tenor	5 years
CDS Spread (fixed)	250 basis points p.a. = 2.50%
Premium Payment Frequency	Quarterly (on 15-Jul, 15-Oct, 15-Jan, 15-Apr each year)
Recovery Rate (Industry Convention)	40% (of face value)
Loss Given Default (LGD)	60%
Settlement Mode	Physical Delivery (default choice) or Cash Settlement
Credit Events Covered (per ISDA 2014)	Bankruptcy, Failure to Pay, Restructuring

JSW Steel Credit Snapshot:

- Credit rating: CRISIL AA / ICRA AA (Stable) — Investment Grade
- Market cap: ₹2.30 lakh crore (as of 15-Jul-2026)
- Debt/EBITDA: 1.8x (moderate leverage)
- 5-year bond currently trading at 8.2% YTM (G-Sec 6.0% + 220 bps credit spread)

Required:

(i) Explain the STRUCTURE of a Credit Default Swap. Identify the two counterparties, the two cash flow legs, and the trigger events. Draw an analogy to insurance.

(ii) Compute the PREMIUM LEG cash flows: annual premium, quarterly premium, and cumulative premium if no default occurs over the 5-year tenor.

(iii) Compute the CONTINGENT LEG payment structure. Explain physical vs cash settlement in the event of default.

(iv) Analyze three scenarios: (a) JSW Steel SURVIVES the entire 5-year tenor, (b) JSW Steel DEFAULTS at the end of Year 3, (c) JSW Steel DEFAULTS at the end of Year 5. Compute the net P&L for both the buyer (HDFC Bank) and seller (Goldman Sachs).

(v) Derive the MARKET-IMPLIED DEFAULT PROBABILITY for JSW Steel from the observed CDS spread. Provide both annual and 5-year cumulative estimates.

(vi) SCENARIO C — CDS Mark-to-Market: One year later, JSW Steel's credit deteriorates (due to a steel demand slowdown) and market CDS spread widens to 500 bps. Compute the approximate MTM value of Nikhil's existing CDS position and explain the direction of P&L.

(vii) Discuss BASIS RISK between the CDS spread and the underlying bond's credit spread. What factors cause CDS-Bond basis to be non-zero?

(viii) Cover the REGULATORY and PRACTICAL context: RBI CDS Guidelines in India, ISDA Master Agreement, counterparty risk, use cases for CDS (hedging, speculation, funding-cost arbitrage).

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Solution

(i) CDS Structure and Mechanics

Definition:

A CREDIT DEFAULT SWAP (CDS) is a bilateral over-the-counter derivative contract in which the PROTECTION BUYER pays a periodic PREMIUM to the PROTECTION SELLER in exchange for a promise: if the REFERENCE ENTITY (JSW Steel here) suffers a CREDIT EVENT (default, bankruptcy, restructuring), the seller COMPENSATES the buyer for the loss on the reference obligation (typically face value minus recovery).

Insurance Analogy:

CDS Component	Insurance Analogy
Protection Buyer (HDFC Bank)	Policyholder (car owner)
Protection Seller (Goldman Sachs)	Insurance company
CDS Premium (250 bps × 100 cr = ₹2.5 cr/yr)	Annual insurance premium
Credit Event on JSW Steel	Insurable event (car accident)
Contingent Payment (₹60 cr)	Insurance claim payout
Reference Obligation (JSW Steel Bond)	Insured asset (car)

Two Cash Flow Legs:

1. PREMIUM LEG:

- Direction: Buyer → Seller (fixed periodic payments)
- Frequency: Typically quarterly (also can be monthly, semi-annual)
- Amount: Notional × CDS Spread / (Payments per year)
- Continues until MATURITY or CREDIT EVENT (whichever earlier)

2. CONTINGENT LEG:

- Direction: Seller → Buyer (one-time payment on default)
- Amount: Notional × LGD (or physical delivery of bond for face value)
- Triggered only if a Credit Event occurs during the CDS tenor

Credit Events (per ISDA 2014 Definitions):

- Bankruptcy: Insolvency, liquidation, or winding-up proceedings
- Failure to Pay: Missing an interest or principal payment beyond grace period
- Restructuring: Modification of debt terms materially adverse to lenders (extension, principal cut, interest cut, currency change) — some CDS variants exclude this

(ii) Premium Leg Computation

Annual Premium:

Annual Premium = Notional × CDS Spread

= ₹100 crore × 2.50%

= ₹2.50 crore per year

Quarterly Premium (Actual Cash Flow):

Quarterly Premium = ₹2.50 crore / 4

= ₹62.50 lakh per quarter

Total Premium if No Default (5-Year Survival):

Total Cumulative Premium = ₹2.50 crore × 5 years

= ₹12.50 crore (paid by buyer over 5 years)

Payment Schedule (Illustrative First 4 Quarters):

Payment Date	Amount (₹ lakh)	Cumulative (₹ crore)
15-Oct-2026 (Q1 end)	62.50	0.625
15-Jan-2027 (Q2 end)	62.50	1.250
15-Apr-2027 (Q3 end)	62.50	1.875
15-Jul-2027 (Q4 end)	62.50	2.500
... (continued 16 more quarters)	...	...
15-Jul-2031 (Q20 end, maturity)	**62.50**	**12.500**

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(iii) Contingent Leg on Default

Contingent Payment:

Contingent Payment = Notional × Loss Given Default

= ₹100 crore × (1 − Recovery Rate)

= ₹100 crore × (1 − 0.40)

= ₹100 crore × 0.60

= ₹60 crore

Physical Settlement (Default Convention):

(i) Upon Credit Event, HDFC Bank (buyer) DELIVERS the JSW Steel bond (face value ₹100 crore) to Goldman Sachs (seller).

(ii) Goldman Sachs pays HDFC Bank the ₹100 crore FACE VALUE.

(iii) Goldman Sachs is then left holding the defaulted bond, which trades at ~40% of face value (recovery). Goldman's ECONOMIC LOSS = ₹60 crore.

(iv) HDFC Bank has successfully hedged the credit risk on its bond position.

Cash Settlement Alternative:

(i) HDFC Bank keeps the bond (defaulted, worth ₹40 crore recovery).

(ii) Goldman Sachs pays HDFC Bank ₹60 crore CASH (the LGD).

(iii) Economics identical to physical: HDFC receives ₹40 (bond) + ₹60 (cash) = ₹100 (full face value).

Post-Default Auction:

The exact recovery rate is determined by an ISDA-organized AUCTION post-default. Multiple market makers submit bids for the defaulted bonds; the auction-clearing price becomes the recovery rate for CDS settlement. This process ensures a FAIR and OBSERVABLE recovery, avoiding disputes between buyer and seller.

(iv) Three Scenarios — Net P&L Analysis

SCENARIO 1: JSW Steel Survives All 5 Years (No Default)

Party	Cash Flow Item	Amount (₹ crore)
HDFC Bank (Buyer)	Premiums Paid over 5 years	− 12.50
HDFC Bank (Buyer)	Contingent Payment Received	0
HDFC Bank Net P&L		**− 12.50 (LOSS)**
Goldman Sachs (Seller)	Premiums Received	+ 12.50
Goldman Sachs (Seller)	Contingent Payment	0
Goldman Sachs Net P&L		**+ 12.50 (GAIN)**

SCENARIO 2: Default at End of Year 3

Party	Cash Flow Item	Amount (₹ crore)
HDFC Bank (Buyer)	Premiums Paid over 3 years	− 7.50
HDFC Bank (Buyer)	Contingent Payment Received	+ 60.00
HDFC Bank Net P&L		**+ 52.50 (GAIN)**
Goldman Sachs (Seller)	Premiums Received	+ 7.50
Goldman Sachs (Seller)	Contingent Paid Out	− 60.00
Goldman Sachs Net P&L		**− 52.50 (LOSS)**

SCENARIO 3: Default at End of Year 5 (Last Year)

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Party	Cash Flow Item	Amount (₹ crore)
HDFC Bank (Buyer)	Premiums Paid over 5 years	− 12.50
HDFC Bank (Buyer)	Contingent Payment Received	+ 60.00
HDFC Bank Net P&L		**+ 47.50 (GAIN)**

Consolidated Comparison — Buyer's P&L:

Scenario	Buyer Premiums Paid (₹ cr)	Contingent Received (₹ cr)	Net P&L (₹ cr)
1: Survive	− 12.50	0	− 12.50
2: Default Year 3	− 7.50	+ 60.00	+ 52.50
3: Default Year 5	− 12.50	+ 60.00	+ 47.50

Interpretation:

The CDS acts as INSURANCE: HDFC Bank incurs a small "insurance premium" cost (₹12.50 cr over 5 years, or 12.5% of notional, spread evenly). If default occurs, the payout (up to ₹60 cr) DWARFS the premiums paid. If no default, the ₹12.5 cr is the cost of PEACE OF MIND — the price for eliminating credit risk from the balance sheet.

(v) Market-Implied Default Probability

The Fundamental Relationship:

For a fair CDS (initial value = 0), the PV of expected premium payments must equal the PV of expected contingent payments. This yields the fundamental credit pricing relationship:

CDS Spread ≈ Annual Default Probability × Loss Given Default

Solving for Annual PD:

Annual PD = CDS Spread / LGD

= 2.50% / 60%

= 4.17% per annum

The market is implying a ~4.17% probability that JSW Steel defaults in any given year, given the observed CDS spread of 250 bps.

5-Year Cumulative Default Probability:

Assuming constant annual PD and independence across years:

Survival probability (5 years) = (1 − 0.0417)^5

= (0.9583)^5

= 0.8083

Cumulative Default Probability = 1 − 0.8083

= 19.17% (over 5 years)

Approximation (Additive):

Cumulative PD (rough) = 5 × 4.17% = 20.83%

The additive approximation OVERSTATES cumulative PD slightly (20.83% vs 19.17%) because it ignores the survival curve — you can only default in Year 3 if you didn't default in Year 1 or 2.

Real-World Sanity Check:

JSW Steel is rated CRISIL AA (approximately Baa1 international equivalent). Global Moody's data suggests 5-year cumulative default rate for Baa1 credits is ~3-5%. The market-implied 19% cumulative PD is SIGNIFICANTLY HIGHER — reflecting either (a) market pricing in credit risk PREMIUM (excess spread over expected loss), (b) illiquidity premium, (c) counterparty concerns. This gap between MARKET-IMPLIED and RATING-IMPLIED PD is a known phenomenon called the CREDIT RISK PREMIUM.

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(vi) CDS Mark-to-Market — Credit Deterioration Scenario

Setup:

Assume 1 year has passed. JSW Steel's credit deteriorates due to a global steel demand slowdown. Market-observed CDS spread has widened from 250 bps to 500 bps for the remaining 4-year tenor.

Nikhil's Existing Position:

- Originally locked in at 250 bps for 5 years
- 4 years remaining (5 − 1 = 4 years)
- If entering a new CDS today, would pay 500 bps

Analysis:

Nikhil is now paying a LOWER SPREAD (250 bps) than what the market currently requires (500 bps). Effectively, he has a FAVORABLE CONTRACT worth the PV of the spread differential over the remaining tenor.

MTM Calculation (Approximate):

Spread advantage: 500 − 250 = 250 bps p.a.

Value = Notional × Spread Differential × Remaining Tenor (approximate)

= ₹100 cr × 2.50% × 4 years

= ₹10 crore (undiscounted)

Discount Adjustment:

Applying a rough discount factor (average maturity ~2 years at 7-8% discount rate):

PV Factor ≈ 0.90 for a 4-year annuity

MTM Value ≈ ₹9 crore (in favor of Nikhil / HDFC Bank)

Interpretation:

(i) Nikhil's PROTECTION CONTRACT is now MORE VALUABLE because market participants would pay more (500 bps) to buy equivalent protection today.

(ii) In accounting terms: HDFC Bank has an UNREALIZED GAIN of ~₹9 crore on the CDS book.

(iii) Nikhil could theoretically UNWIND the position by SELLING the CDS to another counterparty (or offsetting via a REVERSE CDS trade) and locking in ₹9 crore profit.

(iv) Alternatively, retain the position — the deterioration signals higher probability that the contingent leg will trigger, making the CDS potentially even more valuable.

Regulatory/Accounting Note:

Under Ind AS 109 (Financial Instruments), the CDS is a derivative and must be marked to market through profit or loss. The ₹9 crore unrealized gain flows to HDFC Bank's P&L quarterly, contributing to trading income.

(vii) CDS-Bond Basis Risk

Concept:

The CDS-BOND BASIS = CDS Spread − Bond Credit Spread (over G-Sec)

In an efficient market, these should be equal — both measure credit risk on the same reference entity. In practice, a persistent basis exists.

Illustration for JSW Steel:

Metric	Value (bps)
JSW Steel Bond YTM	820
5-year G-Sec Yield	600

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Metric	Value (bps)
Bond Credit Spread	220
Observed CDS Spread	250
CDS-Bond Basis	**+ 30 (CDS premium)**

Sources of Positive CDS-Bond Basis:

(i) CDS LIQUIDITY PREMIUM: CDS market is more liquid than corporate bonds for institutional buyers seeking hedges, driving CDS spreads higher.

(ii) COUNTERPARTY RISK: CDS buyers pay a premium to hedge default risk, but face RESIDUAL RISK if the CDS seller defaults simultaneously (contagion). Post-2008 Lehman episodes elevated awareness of counterparty risk.

(iii) SUPPLY-DEMAND IMBALANCE: When institutional demand for protection exceeds supply of bonds available for hedging, CDS spread rises independently.

(iv) TAX and REGULATORY EFFECTS: Bond investors may benefit from certain tax exemptions (RBI, PSU banks) that reduce their required yield, keeping bond spreads compressed while CDS spreads remain market-determined.

(v) CTD (Cheapest-to-Deliver) OPTION: Physical settlement CDS has an embedded option — the protection buyer chooses which of many eligible bonds to deliver at par (typically the cheapest trading). This option is valuable and adds to CDS spread.

Basis Trading Strategy:

Sophisticated fixed-income arbitrageurs (Nuvama Institutional Fixed Income, Kotak Institutional, IIFL) trade the basis:

- If basis is POSITIVE (CDS > Bond spread): BUY BOND + BUY CDS PROTECTION (long asset + hedge). Basis income of 30 bps p.a. earned risk-free (approximately).
- If basis is NEGATIVE (unusual): SELL BOND + SELL CDS PROTECTION (short-sell bond, take on default risk indirectly).

(viii) Regulatory and Practical Context

RBI CDS Guidelines in India (2013 and updated 2022):

(i) First formal CDS regulations issued in 2011, with substantive market permission granted in 2013.

(ii) Permitted market makers: Scheduled Commercial Banks (SCBs), Primary Dealers (PDs), NBFCs meeting eligibility criteria (RBI-approved list).

(iii) Permitted users: Foreign Portfolio Investors, insurance companies, mutual funds, NBFCs.

(iv) REFERENCE OBLIGATIONS: Only INR-denominated CORPORATE BONDS listed on stock exchanges. Sovereign CDS is NOT permitted.

(v) Naked shorts (buying CDS protection without owning underlying bond) — INITIALLY prohibited; permitted from 2022 for market makers only.

(vi) Mandatory CENTRAL COUNTERPARTY CLEARING via CCIL (Clearing Corporation of India Ltd) — reduces bilateral counterparty risk.

ISDA Master Agreement:

Every CDS trade globally is governed by the International Swaps and Derivatives Association (ISDA) Master Agreement, which:

- Defines the CREDIT EVENTS uniformly (2014 ISDA Definitions)
- Establishes CLOSE-OUT NETTING (offsetting positions with same counterparty in default)
- Provides for CREDIT SUPPORT ANNEX (CSA) — daily margin exchange to mitigate counterparty risk
- Standardizes DETERMINATION COMMITTEE process for declaring credit events

Use Cases for CDS Beyond Hedging:

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(i) SPECULATION on Credit: Investors with a NEGATIVE view on a company's credit can BUY CDS PROTECTION without owning the bond ("naked CDS"). If default occurs, they profit from the contingent payment without incurring bond capital loss.

(ii) FUNDING COST ARBITRAGE: A bank with an AAA rating can BORROW at G-Sec + 50 bps. If it SELLS CDS PROTECTION on a BBB-rated corporate at 300 bps spread, it earns 250 bps SPREAD ARBITRAGE — using its cheap funding to underwrite corporate credit.

(iii) REGULATORY CAPITAL RELIEF: Banks holding corporate bonds must set aside Basel III risk-weighted capital. Buying CDS protection reduces the risk weight, freeing capital for other uses.

(iv) STRUCTURED PRODUCT ISSUANCE: Investment banks issue Credit-Linked Notes (CLNs) that embed CDS exposure — retail investors buy the CLN, effectively selling CDS protection in exchange for higher coupon.

(v) SYNTHETIC CDO CREATION: A portfolio of CDS positions can be tranched into Synthetic Collateralized Debt Obligations (covered in Q14).

Historical Context — 2008 Financial Crisis:

The CDS market grew explosively pre-2008 to $60+ trillion notional globally. AIG's CDS book losses ($100+ billion) triggered the government bailout; Lehman Brothers' bankruptcy triggered $400 billion in CDS payouts. Post-crisis reforms (Dodd-Frank in US, EMIR in EU, RBI Guidelines in India) mandated central clearing, standardized contracts, and higher margin requirements. Today's CDS market is smaller, safer, and more transparent.

Nikhil's Ongoing Considerations:

(i) Monitor JSW Steel's quarterly earnings, leverage metrics, and industry conditions.

(ii) Track CDS spread movements — significant widening signals credit deterioration; use as early warning system.

(iii) Rebalance the hedge if the bond position changes size (buy more CDS to hedge additional bonds, or unwind partially).

(iv) Coordinate with Treasury and Credit Committee on CDS book limits per counterparty (Goldman Sachs exposure limits).

(v) Ensure CCIL clearing arrangements and margin calls are managed within Bank Treasury's liquidity buffers.

Question 14 — Cash CDO vs Synthetic CDO: Structural Analysis

Kunal Bhatia, Senior Vice President — Structured Finance at Kotak Investment Banking, is designing a Collateralized Debt Obligation (CDO) for a bank client seeking to transfer credit risk on a diversified corporate loan/bond portfolio. Kunal must choose between two structural approaches — CASH CDO (which purchases actual bonds) and SYNTHETIC CDO (which uses Credit Default Swaps as covered in Q13). This question compares the two structures side-by-side using an identical underlying reference portfolio, and demonstrates the waterfall loss absorption mechanics.

Common Reference Portfolio (both structures):

Parameter	Value
Total Notional	₹1,000 crore
Number of Reference Entities	20 corporate credits
Per-Name Notional	₹50 crore each
Sectors	Banking, IT, Telecom, Auto, Steel, Pharma, Consumer, Energy (diversified)
Average Rating	A / A+ (Investment Grade)
Recovery Rate Assumption	40%
Tenor of CDO	5 years

Tranche Structure (identical for both CDOs):

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Tranche	Attachment Point	Notional (₹ cr)	Rating
Senior	0% - 70% of portfolio	700	AAA
Mezzanine	70% - 90% of portfolio	200	BBB
Equity (Junior)	90% - 100% of portfolio	100	Unrated (First-Loss)

Required:

(i) Explain the general concept of a CDO and the WATERFALL structure. Describe how tranches distribute cash flows and absorb losses in a defined order of priority.

(ii) Describe the CASH CDO structure. Compute the annual cash flow waterfall assuming NO defaults (base case). Determine the equity tranche yield.

(iii) Describe the SYNTHETIC CDO structure with unfunded super-senior. Compute the annual cash flow waterfall in the base case. Determine the equity tranche yield.

(iv) Present a side-by-side comparison of the Cash CDO and Synthetic CDO across capital efficiency, income sources, legal/operational complexity, and typical use cases.

(v) Analyze loss absorption under three scenarios: (a) MILD — 2 defaults, (b) MODERATE — 5 defaults, (c) SEVERE — 10 defaults. Show how losses cascade through the waterfall for each tranche.

(vi) Discuss the historical significance of Synthetic CDOs in the 2008 Global Financial Crisis and the resulting regulatory changes. Contextualize the Indian market's approach to structured credit.

(vii) Advise Kunal's client (a mid-sized Indian bank looking to transfer risk on ₹1,000 crore corporate exposure) — which structure (Cash or Synthetic) would you recommend and why?

Solution

(i) CDO Concept and Waterfall Structure

What is a CDO?

A COLLATERALIZED DEBT OBLIGATION (CDO) is a structured finance product that POOLS a portfolio of debt exposures (bonds, loans, or CDS references) and RE-TRANCHES the resulting cash flows and losses into securities with different risk-return profiles. Investors in different tranches receive different priority claims — SENIOR tranches get paid first from cash flows and absorb losses last; JUNIOR (equity) tranches are paid last but absorb losses first.

The Waterfall Structure:

Cash flows and losses "waterfall" through the tranche capital structure in strict priority:

Cash Flow Priority (Payment Waterfall – Top Down):

- Step 1: Senior tranche receives its promised coupon/spread
- Step 2: Mezzanine tranche receives its promised coupon/spread
- Step 3: Equity tranche receives ALL RESIDUAL cash flow (which can vary widely)

Loss Absorption Priority (Loss Waterfall — Bottom Up):

- Step 1: Equity tranche absorbs first losses (up to its notional)
- Step 2: Mezzanine tranche absorbs next losses (only if equity is fully wiped)
- Step 3: Senior tranche absorbs remaining losses (only if mezz is fully wiped)

Why This Structure Matters:

(i) TRANCHING creates SECURITIES OF DIFFERENT RATINGS from the same underlying portfolio. A portfolio rated "A" on average can be tranched to produce AAA (senior) + BBB (mezz) + unrated (equity) securities — expanding the investor base.

(ii) SENIOR investors (banks, pension funds, insurance) get high credit quality with modest yield.

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(iii) EQUITY investors (hedge funds, distressed credit specialists) accept high risk for high yield.

(iv) The bank/originator can OFFLOAD credit risk from its balance sheet while retaining the equity tranche as a "skin in the game" indicator.

(ii) Cash CDO Structure and Base Case Waterfall

Cash CDO Mechanics:

(i) The originating bank (say, Kotak Bank) sells ₹1,000 crore of corporate bonds/loans to a SPV (Special Purpose Vehicle).

(ii) The SPV FUNDS this purchase by ISSUING NOTES to investors: ₹700 cr Senior AAA + ₹200 cr Mezz BBB + ₹100 cr Equity.

(iii) The SPV HOLDS THE ACTUAL BONDS on its balance sheet — direct credit and interest rate risk.

(iv) Bond coupons flow INTO the SPV → distributed via the waterfall to note holders as their promised coupons.

(v) Bond defaults reduce SPV assets → losses cascade through the tranches (equity first).

Base Case Annual Waterfall (No Defaults):

Cash Flow Item	Computation	Amount (₹ crore)
INCOME:		
Bond Coupons Received	₹1,000 cr × 8.00%	+ 80.00
EXPENSES (in waterfall order):		
Senior Coupon (AAA)	₹700 cr × 6.50%	− 45.50
Mezzanine Coupon (BBB)	**₹200 cr × 9.00%**	**− 18.00**
EQUITY RESIDUAL (all remaining)		**+ 16.50**
Equity Tranche Notional	**₹100 crore**	
Equity Tranche Yield	16.50 / 100	**16.50% p.a.**

Interpretation:

- Total SPV FUNDING = ₹1,000 crore (all tranches funded)
- Total SPV ASSETS = ₹1,000 crore actual bonds
- Equity tranche earns 16.50% p.a. residual yield in base case — very attractive vs G-Sec 6%
- Equity is FIRST-LOSS position — will lose money if bond defaults exceed base case assumption

(iii) Synthetic CDO Structure with Unfunded Super-Senior

Synthetic CDO Mechanics:

(i) SPV does NOT buy bonds. Instead, it SELLS CDS PROTECTION on the ₹1,000 crore reference portfolio.

(ii) SPV receives CDS premium (200 bps × ₹1,000 cr = ₹20 cr/year) from the bank buying protection.

(iii) SPV issues only ₹300 cr of funded notes (Mezz ₹200 cr + Equity ₹100 cr).

(iv) The ₹700 cr SENIOR tranche is UNFUNDED — provided by a super-senior CDS counterparty (typically a large bank like State Bank of India or JP Morgan Chase) that earns 50 bps fee on its ₹700 cr notional commitment.

(v) The funded ₹300 cr is invested in HIGH-GRADE COLLATERAL (typically G-Secs) earning ~6% p.a.

(vi) Losses from CDS credit events are paid from the G-Sec collateral, absorbed via tranche waterfall.

Base Case Annual Waterfall (No Defaults):

Cash Flow Item	Computation	Amount (₹ crore)
INCOME:		
CDS Premium Received	₹1,000 cr × 2.00%	+ 20.00
G-Sec Yield on Collateral	₹300 cr × 6.00%	+ 18.00

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Cash Flow Item	Computation	Amount (₹ crore)
Total Income		**+ 38.00**
EXPENSES (in waterfall order):		
Super-Senior CDS Fee (unfunded)	₹700 cr × 0.50%	− 3.50
Mezzanine Coupon	₹200 cr × 11.00%	− 22.00
EQUITY RESIDUAL		**+ 12.50**
Equity Tranche Notional	₹100 crore	
Equity Tranche Yield	**12.50 / 100**	**12.50% p.a.**

Key Observations vs Cash CDO:

- Total FUNDING needed: ONLY ₹300 crore (Cash CDO needed ₹1,000 cr)
- EFFECTIVE LEVERAGE: 1,000/300 = 3.33x — Synthetic CDO creates leveraged credit exposure
- Equity yield: 12.50% (vs 16.50% in Cash) — LOWER because CDS premiums (200 bps) are lower than bond credit spreads (200 bps + risk premium)
- Mezzanine coupon is HIGHER (11% vs 9%) because Synthetic Mezz carries more complex credit risk

(iv) Side-by-Side Structural Comparison

Feature	Cash CDO	Synthetic CDO
Underlying Assets Owned	Actual corporate bonds	None – CDS on reference entities
Total Funding Required	₹1,000 cr (full notional)	₹300 cr (equity + mezz only)
Capital Efficiency	Low	High (3.33x leverage)
Primary Income Source	Bond coupons (8%)	CDS premium (2%) + G-Sec yield
Loss Trigger	Actual bond default	Credit event (per ISDA)
Interest Rate Risk	Yes (bonds have duration)	No (CDS is pure credit)
Legal Complexity	Moderate (SPV, bond transfer)	High (ISDA, CDS documentation)
Operational Complexity	Moderate (bond servicing)	Low (no physical assets)
Rating Agency Approach	Traditional credit analysis	Correlation modeling (Gaussian copula)
Typical Investor Base	Banks, insurance, pension funds	Hedge funds, sophisticated investors
Regulatory Treatment (Basel III)	Requires holding of bonds	Credit derivative treatment
Common Use Case	Balance sheet cleanup for banks	Regulatory capital relief, risk transfer
Base Case Equity Yield	16.50%	12.50%

(v) Loss Absorption Under Three Default Scenarios

Loss per Default:

Loss = Notional × LGD = ₹50 crore × 60% = ₹30 crore per defaulted name

SCENARIO A — MILD: 2 Defaults (₹60 cr Total Loss):

Tranche	Original Notional (₹ cr)	Loss Absorbed (₹ cr)	Remaining Notional (₹ cr)	% Loss
Equity	100	60	40	60%
Mezzanine	200	0	200	0%
Senior	700	0	700	0%
Total	**1,000**	**60**	**940**	

Interpretation: Equity tranche takes 60% loss; mezzanine and senior unaffected. Equity investors lose 60% of principal but the pool has only lost 6% overall — this is the LEVERAGE effect of first-loss position.

SCENARIO B — MODERATE: 5 Defaults (₹150 cr Total Loss):

Tranche	Original Notional (₹ cr)	Loss Absorbed (₹ cr)	Remaining Notional (₹ cr)	% Loss
Equity	100	100 (fully wiped)	0	100%

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Tranche	Original Notional (₹ cr)	Loss Absorbed (₹ cr)	Remaining Notional (₹ cr)	% Loss
Mezzanine	200	50	150	25%
Senior	700	0	700	0%
Total	**1,000**	**150**	**850**	

Interpretation: Equity is FULLY WIPED OUT (₹100 cr loss). Mezzanine absorbs the additional ₹50 cr loss (25% of mezz notional). Senior remains untouched — its AAA rating survives. Pool loss of only 15% causes 100% equity loss AND 25% mezz loss — the leverage cuts both ways.

SCENARIO C — SEVERE: 10 Defaults (₹300 cr Total Loss):

Tranche	Original Notional (₹ cr)	Loss Absorbed (₹ cr)	Remaining Notional (₹ cr)	% Loss
Equity	100	100 (wiped)	0	100%
Mezzanine	200	200 (wiped)	0	100%
Senior	700	0	700	0%
Total	**1,000**	**300**	**700**	

Interpretation: Both Equity AND Mezzanine are FULLY WIPED. Senior still untouched, though its "cushion" (mezz + equity buffer) is now ₹0 vs original ₹300 cr — subsequent defaults directly hit the senior tranche. In a scenario of 15+ defaults (₹450 cr loss), senior would begin to lose principal, potentially triggering rating downgrades from AAA to BB or lower.

Key Insight — Correlation Risk:

The scenarios above assume defaults occur INDEPENDENTLY. In stressed markets, defaults become CORRELATED (systemic downturn) — many names default simultaneously. This was precisely the 2007-2008 dynamic when subprime mortgage CDOs saw catastrophic losses. Rating models based on Gaussian copula assumed correlations of 0.10-0.30 but reality showed correlations of 0.60+ during stress — creating massive underestimation of joint default probability.

(vi) Historical Context — 2008 Crisis and Aftermath

The Synthetic CDO Bubble (2004-2007):

(i) Global Synthetic CDO issuance peaked at ~$2 trillion by 2007.

(ii) Investment banks (Goldman Sachs, Lehman, Merrill Lynch, UBS) created custom CDOs referencing US subprime mortgage-backed securities (RMBS).

(iii) Rating agencies (Moody's, S&P, Fitch) rated the SENIOR tranches AAA using CORRELATION MODELS that assumed diversification benefits within US housing.

(iv) AAA senior CDO tranches yielded 20-50 bps MORE than actual AAA corporate bonds — attracted massive institutional demand from European banks, insurance companies, and money market funds.

The Collapse (2007-2009):

(i) US housing bubble burst; subprime mortgage defaults surged from 5% to 30%+ in some pools.

(ii) CORRELATION ASSUMPTIONS PROVED CATASTROPHICALLY WRONG — housing defaults became highly correlated across states and demographics.

(iii) AAA-rated CDO tranches were downgraded to CCC or worse; many became worthless.

(iv) Investment banks holding CDO inventory suffered massive losses: Lehman Brothers ($40 bn CDO exposure) failed in Sept 2008.

(v) AIG's Financial Products division had written $400 bn of CDS on senior CDO tranches — required US Government $180 bn bailout to prevent systemic collapse.

Post-Crisis Reforms:

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(i) DODD-FRANK ACT (US, 2010): Volcker Rule restricted banks from proprietary trading in structured credit. New capital requirements for CDO exposures.

(ii) EUROPEAN MARKET INFRASTRUCTURE REGULATION (EMIR, 2012): Mandated central clearing of standardized derivatives, position reporting.

(iii) BASEL III (2010, effective 2013-2019): Substantially higher risk weights for structured credit; "skin in the game" requirements for CDO originators (retain 5% of equity tranche).

(iv) SEC/CFTC increased oversight of rating agencies; new rules on issuer-pay conflicts.

(v) Synthetic CDO market shrunk 95%+ from peak. Cash CDOs (CLOs — Collateralized Loan Obligations) revived post-2013 for corporate credit.

Indian Market Context:

(i) India has NEVER had a significant CDO market. Reasons: (a) underdeveloped corporate bond market, (b) SEBI/RBI regulatory caution, (c) limited investor demand for exotic structured credit.

(ii) Related products in India: Pass-Through Certificates (PTCs) backing MBS/ABS (as covered in Ch7), Direct Assignments of loans, Collateralized Bond Obligations (CBOs) on limited basis.

(iii) SEBI's Securitization guidelines (2020, updated) permit securitization of loans with mandatory retention of 10% by originator.

(iv) Post the IL&FS collapse (2018) and subsequent NBFC crisis, there has been GREATER regulatory scrutiny on structured credit products in India — favoring simpler pass-through structures.

(v) Synthetic CDOs are NOT permitted in India — RBI's 2022 credit derivatives framework limits CDS to hedging existing bond positions.

(vii) Advisory Recommendation for Kotak's Bank Client

Client's Situation:

A mid-sized Indian bank (say Federal Bank or Karur Vysya Bank) with ₹1,000 crore corporate loan/bond exposure seeking to transfer credit risk. Objectives may include: capital relief under Basel III, exposure diversification, or freeing up capital for other lending.

Recommendation: CASH CDO (or, more realistically, DIRECT ASSIGNMENT / PTC STRUCTURE)

Rationale:

(i) REGULATORY ACCEPTABILITY: Synthetic CDOs are effectively prohibited in India. Cash CDO / Direct Assignment / PTC issuance are the only viable structures under RBI/SEBI framework.

(ii) OPERATIONAL SIMPLICITY: A Cash CDO based on Direct Assignment of loans to a Trust or issuance of PTCs is standard practice in India (used extensively by Bajaj Finance, Muthoot Finance, IIFL Finance).

(iii) INVESTOR BASE: Indian MFs (mutual funds), NBFCs, insurance companies, and family offices are familiar with PTC/CDO cash structures. Synthetic derivatives-based structures have LIMITED domestic investor demand.

(iv) CAPITAL RELIEF: Under RBI's Master Directions on Securitisation of Standard Assets (2021), assets sold via true-sale receive complete capital relief provided minimum retention (10% subordinate exposure).

(v) PRICING TRANSPARENCY: Cash CDO tranche pricing can be benchmarked against MF investors' target yield expectations (senior at repo + 200-300 bps, mezz at 12-14%, equity at 18-22%). Synthetic pricing would require sophisticated credit-derivative modelling that Indian investors are not familiar with.

(vi) REPUTATION and REGULATORY RISK: Given the 2008 GFC association with synthetic CDOs, any Indian bank pursuing such a structure would face significant regulatory scrutiny and reputational risk. Cash CDO / PTC route is well-established and low-risk from a regulatory standpoint.

Structuring Proposal for the Client:

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- Choose 20 diversified corporate loans of ₹50 cr each
- SPV (Trust vehicle) purchases these loans via Direct Assignment
- Issue PTCs in tranches: Senior AAA ₹700 cr (to mutual fund investors), Mezz A+ ₹200 cr (to NBFCs / insurance), Equity ₹100 cr (retained by originating bank)
- Bank retains 10% (equity + first-loss guarantee) to comply with MRR (Minimum Retention Requirement)
- Estimated all-in cost of funds: ~7-8% blended (vs 8.5% weighted portfolio yield) — creates modest positive carry for the SPV
- Capital relief: 90% of the ₹1,000 cr exposure freed up from Basel III risk-weighted assets

Alternative Consideration:

If the client is more strategically focused, a DIRECT LOAN SALE to a larger commercial bank (SBI, HDFC Bank) or an ARC (Asset Reconstruction Company like Edelweiss ARC or JM Financial ARC) may be simpler than issuing PTCs. This works especially well for the stressed or workout portion of the portfolio.

Question 15 — Electricity Derivatives Hedging at Maruti Suzuki

Case Study — Maruti Suzuki India Ltd (Manesar Plant Power Hedging)

Rakesh Ganguly, CFO of Maruti Suzuki India Ltd, is reviewing electricity procurement for the company's largest manufacturing facility at Manesar, Haryana. Given India's volatile power markets — driven by coal supply disruptions, monsoon variability affecting hydro generation, and rising renewable penetration — Rakesh wants to HEDGE 6 MONTHS of power consumption (Jul-Dec 2026) against price rises. Three alternatives are on the table: (a) OTC Forward with Tata Power Trading Corporation, (b) MCX Electricity Futures, (c) Financial Swap with Adani Power Trading.

Maruti Suzuki's Power Requirement:

Parameter	Value
Facility	Manesar Manufacturing Plant, Haryana
Baseload Consumption	100 MW (24/7 operation)
Monthly Consumption	100 MW × 720 hours = 72,000 MWh
Hedging Period	6 months (Jul 2026 to Dec 2026)
Total Consumption to Hedge	72,000 × 6 = 4,32,000 MWh
Current IEX Day-Ahead Spot (15-Jul-2026)	₹5,000/MWh (₹5.00/kWh)
Baseline Cost (if bought at current spot)	4,32,000 × ₹5,000 = ₹216 crore

Three Hedging Alternatives:

Instrument	Counterparty	Price	Key Feature
(a) FORWARD	Tata Power Trading (OTC)	₹5,200/MWh	Physical delivery, no MTM
(b) FUTURE	MCX (exchange-traded)	₹5,300/MWh	Cash-settled, daily MTM
(c) SWAP	Adani Power Trading (OTC)	₹5,150/MWh Fixed	Pay Fixed / Receive IEX Spot

Scenario Analysis at End of Hedge Period (Dec 2026 Average IEX Spot):

Scenario	Avg IEX Spot (₹/MWh)	Driver
Scenario A: SPOT RISES	6,000	Coal shortage + Summer peak demand
Scenario B: SPOT STABLE	5,000	Normal supply-demand balance
Scenario C: SPOT FALLS	4,500	Strong monsoon → Hydro surplus

Required:

(i) Explain WHY electricity is a unique commodity requiring special derivative structures (versus gold or oil).

(ii) Compute the TOTAL COST OF ELECTRICITY under each of the three hedging alternatives assuming Maruti Suzuki hedges the FULL 4,32,000 MWh consumption. Show computations for each scenario.

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(iii) Compute the total UNHEDGED cost in each scenario for comparison.

(iv) Present a consolidated comparison table showing cost under each strategy across all three scenarios.

(v) For the FUTURES alternative, compute the exact NUMBER OF LOTS Maruti Suzuki must LONG (buy) on MCX to hedge the exposure. Discuss margin requirements.

(vi) Provide a RECOMMENDATION to Rakesh Ganguly. Which hedging instrument should Maruti Suzuki choose, considering operational simplicity, counterparty risk, and cost efficiency?

Solution

(i) Why Electricity is a Unique Commodity

Fundamental Distinguishing Features:

(i) NON-STORABILITY: Electricity generated must be consumed instantaneously. Battery storage exists but is expensive at scale. Contrast with gold/oil/copper — which can be stored for years at modest cost.

(ii) NON-TRANSPORTABILITY: Electricity flows through fixed transmission networks. Cannot be easily shipped between regions or countries. Regional price differences (Southern vs Northern grid) can be substantial.

(iii) REAL-TIME MATCHING: Grid operators must match generation with demand every second — imbalances cause voltage/frequency issues.

(iv) EXTREME PRICE VOLATILITY: Prices can range from ₹0/MWh (surplus renewable at midday) to ₹15,000/MWh (peak demand + supply shortage). Compare to gold's ~15% annual volatility.

(v) HOURLY/DAILY/SEASONAL PATTERNS: Prices vary intra-day (peak 6-10pm), by weekday, by month, and by season.

Implications for Derivative Design:

- Physical delivery contracts must specify delivery point (transmission node), delivery period, and profile (baseload vs peak).
- Financial (cash-settled) contracts reference specific price indices (IEX Day-Ahead) with clearly defined averaging methods.
- Swaps typically settle monthly using monthly weighted average spot prices.

(ii) Total Cost Under Each Hedging Alternative

Total Consumption to Hedge: 4,32,000 MWh

(a) FORWARD Contract at ₹5,200/MWh:

The forward locks in the price regardless of spot movement:

Total Cost = 4,32,000 MWh × ₹5,200/MWh

= ₹2,24,64,00,000 = ₹224.64 crore

This cost is IDENTICAL in all three scenarios — the whole point of the forward hedge.

(b) FUTURES at ₹5,300/MWh (Cash-Settled):

For a cash-settled future, Maruti Suzuki still BUYS ELECTRICITY at spot rate from the grid, but the futures P&L offsets the price variance.

Under any scenario:

Physical purchase cost = 4,32,000 × Spot End (varies)

Futures P&L (Long) = 4,32,000 × (Spot End − Future Price)

= 4,32,000 × (Spot End − 5,300)

Net Effective Cost = Physical Cost − Futures Gain (or + Futures Loss)

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= 4,32,000 × Spot End − 4,32,000 × (Spot End − 5,300)

= 4,32,000 × 5,300

= ₹228.96 crore (INDEPENDENT of Spot End)

(c) SWAP at ₹5,150/MWh Fixed:

Maruti Suzuki BUYS physical from grid at spot; separately pays swap counterparty a NET SETTLEMENT.

Physical cost = 4,32,000 × Spot End

Swap Payment (Maruti pays) = 4,32,000 × (5,150 − Spot End)

: Maruti PAYS Fixed ₹5,150, RECEIVES Floating Spot End.

Swap Net for Maruti = 4,32,000 × (Spot End − 5,150) [positive if spot > fixed]

Net Effective Cost = Physical Cost − Swap Receive

= 4,32,000 × Spot End − 4,32,000 × (Spot End − 5,150)

= 4,32,000 × 5,150

= ₹222.48 crore (INDEPENDENT of Spot End)

(iii) Unhedged Cost Under Each Scenario

Scenario	Avg Spot (₹/MWh)	Total Cost	vs Baseline (₹216 cr)
A: Spot Rises	6,000	4,32,000 × ₹6,000 = ₹259.20 crore	₹ + 43.20 crore (worse)
B: Spot Stable	5,000	4,32,000 × ₹5,000 = ₹216.00 crore	₹ 0.00 (as expected)
C: Spot Falls	4,500	4,32,000 × ₹4,500 = ₹194.40 crore	₹ − 21.60 crore (savings)

(iv) Consolidated Comparison

Scenario	Unhedged (₹ cr)	Forward at ₹5,200 (₹ cr)	Future at ₹5,300 (₹ cr)	Swap at ₹5,150 (₹ cr)
A: Spot Rises (₹6,000)	259.20	224.64	228.96	222.48
B: Spot Stable (₹5,000)	216.00	224.64	228.96	222.48
C: Spot Falls (₹4,500)	194.40	224.64	228.96	222.48

Key Observations:

(i) All THREE hedged strategies produce a KNOWN, FIXED cost — the whole purpose of hedging.

(ii) The SWAP at ₹5,150/MWh is the CHEAPEST hedge (₹222.48 crore) — lowest fixed price of the three.

(iii) The FORWARD at ₹5,200/MWh is second (₹224.64 crore).

(iv) The FUTURE at ₹5,300/MWh is the MOST EXPENSIVE hedge (₹228.96 crore) — likely reflects exchange margin/clearing costs embedded in pricing.

(v) In the DOWNSIDE scenario (Spot falls to ₹4,500), the UNHEDGED position (₹194.40 crore) actually BEATS all hedges — but Maruti forgoes this upside for CERTAINTY.

(v) MCX Futures Position Sizing

Contract Specification:

- Contract Size: 1 MWh per lot
- Direction: LONG (to lock in purchase price)

Number of Lots Required:

Number of Lots = Total MWh to Hedge / Lot Size

= 4,32,000 MWh / 1 MWh per lot

= 4,32,000 LONG lots (spread across 6 monthly contracts)

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Per-Month Contract Size:

Per Month = 72,000 lots each (per delivery month)

Spread across Jul 2026, Aug 2026, Sep 2026, Oct 2026, Nov 2026, Dec 2026 contracts.

Margin Requirement (Illustrative):

Contract Notional Value per Lot = 1 MWh × ₹5,300 = ₹5,300

Total Notional = 4,32,000 × ₹5,300 = ₹228.96 crore

MCX Initial Margin (typical): 10-15% of notional for electricity

Estimated Initial Margin: 12% × ₹228.96 crore = ₹27.48 crore

Additionally: Daily MTM cash flows can be substantial. If spot rises to ₹6,000 immediately after position entry, unrealized gains of 4,32,000 × ₹700 = ₹30.24 crore would be credited (positive for the long). Conversely, a fall would create margin calls.

(vi) Recommendation to Rakesh Ganguly

Assessment Matrix:

Criteria	Forward	Future	Swap
Cost	₹224.64 cr	₹228.96 cr	₹222.48 cr (LOWEST)
Counterparty Risk	Tata Power (moderate)	MCX clearing (LOW)	Adani Power (moderate)
Cash Flow Volatility	None (delivery-based)	Daily MTM (HIGH)	Monthly settlement (moderate)
Operational Complexity	Simple (physical delivery)	Complex (margin management)	Moderate
Basis Risk	None (direct supply)	Minor (IEX vs Haryana)	None (IEX matches)
Flexibility (early termination)	Limited (contract lock-in)	High (close position anytime)	Moderate (unwind cost)

Recommendation: SWAP Contract with Adani Power Trading

Rationale:

(i) COST EFFICIENCY: Swap at ₹5,150/MWh delivers the LOWEST guaranteed cost — ₹222.48 crore versus ₹224.64 crore (Forward) or ₹228.96 crore (Future). Savings of ₹2.16 crore over the Forward alone.

(ii) NO MARGIN CALLS: Unlike futures, swaps do not require daily margin — attractive for Maruti's treasury (avoids ₹27 crore margin lock-up).

(iii) OPERATIONAL SIMPLICITY: Continues existing physical procurement from Haryana State Electricity Board — swap is purely financial overlay.

(iv) MITIGATED COUNTERPARTY RISK: Adani Power Trading is a large, regulated entity (Adani Enterprises subsidiary). Additional protection via ISDA Master Agreement and Credit Support Annex if needed.

(v) MONTHLY CASH FLOWS: Predictable monthly settlement based on IEX DAM average — easy for cash flow planning.

Backup Consideration:

For risk-averse treasuries, splitting the hedge might be optimal: 50% via Swap (financial protection) + 50% via Forward (physical procurement certainty). This diversifies counterparty exposure while retaining the swap's cost advantage on the financial portion.

Not Recommended:

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The MCX FUTURE is least attractive due to (a) highest fixed price, (b) daily MTM cash flow burden, (c) large margin requirement. Futures make sense only if Maruti wants FLEXIBILITY to close positions early — not relevant here given the fixed 6-month hedge horizon.

Question 16 — Weather Derivatives Hedging at HUL

Case Study — Hindustan Unilever Ltd (Kwality Walls Ice Cream Division)

Sanjeev Mehta, CFO of Hindustan Unilever Limited (HUL), is analyzing weather risk for the Kwality Walls ice cream business. Ice cream sales in India are HIGHLY CORRELATED WITH SUMMER TEMPERATURES — HUL's data shows that Q2 (June-September) ice cream revenue varies by ₹1 crore for every unit change in CDD (Cooling Degree Days) at Mumbai's Santa Cruz observatory. A COOL SUMMER significantly reduces revenues, while a HOT SUMMER boosts them. To reduce revenue volatility for the Kwality Walls division, Sanjeev is evaluating a WEATHER DERIVATIVE — specifically, a CDD Swap with an international reinsurer (Swiss Re) as counterparty.

HUL's Business Data:

Parameter	Value
Expected Q2 (Jun-Sep) Ice Cream Revenue	₹500 crore (at expected CDD 900)
Revenue Sensitivity	₹1 crore per CDD change
Reference Location	Mumbai (Santa Cruz Observatory)
Reference Period	1-Jun-2026 to 30-Sep-2026 (~122 days)
Base Temperature (WMO standard)	18°C
Historical Average CDD (2021-2025)	900

Proposed CDD Swap Contract with Swiss Re:

Parameter	Value
Contract Type	Cooling Degree Day (CDD) Swap
Reference Index	CDD at Mumbai Santa Cruz (based on IMD data)
Notional per CDD point	₹1 crore per CDD
HUL's Position	PAY Floating (actual) CDDs, RECEIVE Fixed (expected 900) CDDs
Settlement	Cash-settled at end of period, per IMD final data
Counterparty	Swiss Reinsurance Company Ltd (via ISDA Master Agreement)

Formula for Swap Settlement:

HUL's Net Swap Cash Flow = Notional × (Fixed CDD − Actual CDD)

If Actual < 900 (cool summer): HUL RECEIVES from Swiss Re

If Actual > 900 (hot summer): HUL PAYS Swiss Re

If Actual = 900 (normal): No settlement

Three Weather Scenarios:

Scenario	Description	Actual CDD
A: COOL SUMMER	Below-normal temperatures throughout summer	800
B: NORMAL SUMMER	As per 5-year historical average	900
C: HOT SUMMER	Heat wave, above-normal temperatures	1,000

Required:

(i) Compute the Q2 ICE CREAM REVENUE UNHEDGED for each of the three weather scenarios.

(ii) Compute HUL's NET SWAP CASH FLOW for each scenario (identify direction — receive or pay).

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(iii) Compute the TOTAL EFFECTIVE Q2 REVENUE (Ice Cream Revenue + Swap Settlement) for each scenario. Demonstrate the hedge effectiveness.

(iv) Explain the ECONOMIC RATIONALE for HUL entering this swap. Why would Swiss Re be the natural counterparty?

(v) Discuss the operational challenges of weather derivatives — specifically, BASIS RISK, DATA QUALITY, MEASUREMENT UNCERTAINTY.

(vi) Provide a recommendation to Sanjeev Mehta on whether HUL should proceed with the swap, including any alternatives to consider.

Solution

(i) Q2 Ice Cream Revenue Under Three Scenarios (Unhedged)

Revenue Formula (from HUL's sensitivity analysis):

Actual Revenue = Baseline Revenue + Sensitivity × (Actual CDD − Baseline CDD)

= ₹500 crore + ₹1 crore × (Actual CDD − 900)

Scenario A — Cool Summer (CDD = 800):

Revenue = 500 + 1 × (800 − 900)

= 500 + 1 × (− 100)

= ₹400 crore (₹100 crore SHORTFALL)

Scenario B — Normal Summer (CDD = 900):

Revenue = 500 + 1 × (900 − 900)

= ₹500 crore (BASELINE — no change)

Scenario C — Hot Summer (CDD = 1,000):

Revenue = 500 + 1 × (1,000 − 900)

= 500 + 100

= ₹600 crore (₹100 crore WINDFALL)

(ii) HUL's Net Swap Cash Flow

Swap Formula:

Net Swap Cash Flow = Notional × (Fixed CDD − Actual CDD)

= ₹1 crore × (900 − Actual CDD)

Scenario A — Cool Summer (CDD = 800):

Net Swap = 1 × (900 − 800)

= + ₹100 crore (HUL RECEIVES from Swiss Re)

Scenario B — Normal Summer (CDD = 900):

Net Swap = 1 × (900 − 900)

= ₹0 (No settlement)

Scenario C — Hot Summer (CDD = 1,000):

Net Swap = 1 × (900 − 1,000)

= – ₹100 crore (HUL PAYS Swiss Re)

(iii) Total Effective Q2 Revenue (Hedged)

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Scenario	Actual CDD	Ice Cream Revenue (₹ cr)	Swap Cash Flow (₹ cr)	Total Effective Revenue (₹ cr)
A: Cool Summer	800	400	+ 100 (Receive)	500
B: Normal Summer	900	500	0	500
C: Hot Summer	1,000	600	− 100 (Pay)	500

Hedge Effectiveness — Perfect Hedge Achieved:

(i) In ALL THREE weather scenarios, HUL's TOTAL EFFECTIVE REVENUE is ₹500 crore.

(ii) The swap PERFECTLY OFFSETS the weather-driven variation in ice cream sales.

(iii) HUL has TRANSFERRED its weather risk to Swiss Re — the swap counterparty absorbs the CDD variation.

(iv) This is because the swap NOTIONAL (₹1 crore per CDD) exactly matches HUL's revenue SENSITIVITY (₹1 crore per CDD) — the KEY CONDITION for a perfect weather hedge.

(iv) Economic Rationale & Choice of Swiss Re as Counterparty

Why HUL Enters the Swap:

(i) REVENUE PREDICTABILITY: Stakeholders (Board, investors, credit rating agencies) prefer stable earnings — the swap eliminates weather-induced volatility.

(ii) OPERATIONAL PLANNING: Certainty allows HUL to plan production capacity, inventory, and distribution more efficiently. No need for excess capacity as buffer against cool summers.

(iii) BUDGETING: Fixed revenue enables clearer capital allocation for expansion, marketing, R&D.

(iv) COMPETITIVE ADVANTAGE: Rival ice cream players (Amul, Vadilal) that don't hedge face more volatile earnings — HUL's derisked position enables more aggressive strategic moves.

(v) TAX PLANNING: Predictable earnings simplify quarterly tax provisioning.

Why Swiss Re is a Natural Counterparty:

(i) DIVERSIFICATION: Swiss Re insures thousands of weather-sensitive risks globally. Adding HUL's Mumbai CDD exposure is DIVERSIFYING (largely uncorrelated with Swiss Re's other risks).

(ii) GLOBAL WEATHER PORTFOLIO: Swiss Re can offset HUL's exposure with counter-positions in similar hedges elsewhere (e.g., European utilities that BENEFIT from cool summers).

(iii) SPECIALIZED EXPERTISE: Swiss Re has meteorologists, actuaries, and quants specifically dedicated to weather risk pricing.

(iv) REGULATORY CAPITAL: Under Solvency II framework, Swiss Re can hold weather risk more efficiently than industrial companies.

(v) Operational Challenges of Weather Derivatives

Challenge 1: BASIS RISK

The CDD is measured at ONE SPECIFIC LOCATION (Santa Cruz observatory in our case), but HUL's ice cream sales occur across MULTIPLE CITIES in India. If Mumbai has a normal summer while Delhi and Chennai have cool summers, HUL's actual revenue would decline but the swap would not pay off. This LOCATION BASIS RISK is unavoidable in weather derivatives.

Mitigation:

- Use MULTIPLE weather stations weighted by sales exposure (composite index)
- Layer regional swaps for specific high-revenue geographies
- Accept residual basis risk as cost of hedging

Challenge 2: DATA QUALITY AND RELIABILITY

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Weather derivatives depend on OFFICIAL METEOROLOGICAL DATA. Issues include:

- Data lags: IMD often takes 1-2 weeks post-period to publish final numbers
- Data revisions: Preliminary readings can be revised after the fact
- Instrument failures: Station equipment can malfunction, requiring manual estimates
- Data manipulation risk: Rare but possible in less-regulated markets

Mitigation:

- Use only IMD data (highest reliability in India)
- Contract specifies which version is binding (preliminary vs revised)
- Backup station provisions in case primary station data is unavailable

Challenge 3: MODEL RISK AND PRICING

Historical CDD patterns are only guides to the future — climate change is altering weather patterns globally. The 5-year historical average (900) may not reflect the new mean. Pricing weather derivatives is challenging when:

- Historical distributions are non-stationary (climate change)
- Extreme events (heat waves, cyclones) are hard to model
- Correlations with other risks are hard to quantify

Challenge 4: MARKET LIQUIDITY

Weather derivatives markets in India are NEARLY NON-EXISTENT. Global markets exist (CME, ICE) but focus on US and European locations. Indian companies must access these via international reinsurers (Swiss Re, Munich Re), OTC brokers, or specialized reinsurance houses. This limits: (a) transparency of pricing, (b) ease of unwinding positions, (c) counterparty diversity.

(vi) Recommendation to Sanjeev Mehta

Recommendation: PROCEED with the CDD Swap

Rationale:

(i) PERFECT HEDGE STRUCTURE: The swap notional (₹1 cr/CDD) matches HUL's revenue sensitivity — a rare opportunity to fully hedge weather risk.

(ii) ELIMINATES ₹200 CRORE OF VOLATILITY: Without hedge, revenue ranges from ₹400 to ₹600 crore (₹200 cr swing). With hedge, revenue is locked at ₹500 crore.

(iii) COUNTERPARTY IS TIER-1: Swiss Re has AA- credit rating; ISDA Master Agreement with Credit Support Annex provides adequate protection.

(iv) COST EFFICIENT: A swap has NO UPFRONT PREMIUM (unlike an option). Cash flows only at expiry based on actual CDD.

(v) STRATEGIC BENEFIT: Predictable Q2 revenue enhances HUL's earnings quality, potentially supporting higher P/E multiple.

Key Considerations Before Signing:

(i) Confirm ISDA Master Agreement and CSA are in place with Swiss Re

(ii) Ensure Legal team reviews contract for enforceability under Indian law

(iii) Understand that HUL GIVES UP the potential upside of a hot summer (would have earned extra ₹100 crore in Scenario C)

(iv) Board approval required — new derivative instrument requires disclosure to auditors

(v) Assess if this can be treated as CASH FLOW HEDGE under Ind AS 109 for accounting purposes

Alternatives to Consider:

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(i) PARTIAL HEDGE: Rather than fully hedging at ₹1 cr/CDD notional, HUL could hedge only 50% (notional ₹0.50 cr/CDD). This retains half the upside while eliminating half the downside — appealing to shareholders who value the possibility of positive earnings surprises.

(ii) PUT OPTION ON CDDs: Buy a put option that pays off only if CDDs fall below 850. HUL pays a small premium (₹5-10 crore) but retains full upside from hot summers. Suitable if HUL is more concerned about downside than upside.

(iii) CDD COLLAR: Buy put at 850 CDDs and sell call at 950 CDDs (zero-cost collar). Provides asymmetric protection with a cap on upside beyond 950.

(iv) GEOGRAPHIC DIVERSIFICATION: Combine Mumbai swap with Delhi, Chennai, Kolkata swaps to reduce basis risk. Higher cost but more comprehensive protection.

(v) DO NOTHING: Accept weather volatility as inherent business risk. This is what most Indian companies actually do — but HUL is sophisticated enough to consider innovative risk management.

Question 17 — Locational Basis Swap on Electricity Derivatives

Case Study — Continuation of Maruti Suzuki Manesar Plant Hedging

Rakesh Ganguly, CFO of Maruti Suzuki India Ltd, has reviewed the Q15 analysis and expressed a concern to his treasury team: while the IEX-linked swap at ₹5,150/MWh appeared to lock in electricity costs, the company's ACTUAL delivery point is Manesar node, not the IEX reference hub. Historical data from Maruti's electricity bills (2022-25) shows that Manesar node prices have DIVERGED from IEX DAM prices by amounts ranging from −₹50/MWh (excess supply) to +₹400/MWh (peak congestion). PTC India Energy Trading (India's largest power trader, government-owned, listed on NSE) has approached Maruti with a Locational Basis Swap product designed to hedge this residual exposure.

Recap of Q15 Data (Unchanged):

Parameter	Value
Facility	Maruti Suzuki Manesar Plant, Haryana
Total Consumption to Hedge	4,32,000 MWh (6 months, Jul-Dec 2026)
Q15 IEX-Linked Swap Fixed Rate	₹5,150/MWh (Adani Power Trading)
Q15 Swap Cost (Assuming No Basis)	4,32,000 × ₹5,150 = ₹222.48 crore

Historical Basis Analysis (2022-25) — Manesar Node vs IEX DAM:

Scenario	Basis (₹/MWh)	Historical Probability	Driver
Low (Excess Supply)	− 50	20%	Strong monsoon → Northern hydro surplus
Normal	+ 150	50%	Typical congestion + open access charges
High (Peak Congestion)	+ 400	30%	Summer peak + coal shortage → grid congestion

Proposed LBS Contract with PTC India Energy Trading:

Parameter	Value
Contract Type	Locational Basis Swap (OTC, cash-settled)
Notional Quantity	4,32,000 MWh (6-month period)
Reference Location	Manesar Node (Haryana State Load Dispatch data)
Reference Hub	IEX Day-Ahead Market (weighted average)
Maruti's Position	PAY Fixed Basis ₹200/MWh, RECEIVE Actual Basis
Settlement	Monthly, based on POSOCO published data
Counterparty	PTC India Energy Trading Ltd (via ISDA Master Agreement)

Required:

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(i) Explain the four primary drivers of locational basis in Indian electricity markets.

(ii) Recompute Maruti's EFFECTIVE COST per MWh and TOTAL COST under each of the three basis scenarios WITHOUT the LBS (using only the Q15 IEX-linked swap).

(iii) Compute the EXPECTED TOTAL COST and the STANDARD DEVIATION of cost WITHOUT the LBS. Identify Maruti's basis risk exposure.

(iv) Verify that adding the LBS produces a PERFECT HEDGE. Compute the effective cost per MWh and total cost under the combined structure (Q15 IEX-linked swap + LBS).

(v) Compute the COST OF CERTAINTY — the incremental cost Maruti pays for the LBS relative to the expected cost without LBS. Assess the hedge effectiveness ratio.

(vi) Provide a RECOMMENDATION to Rakesh Ganguly on whether Maruti should proceed with the LBS.

Solution

(i) Four Primary Drivers of Locational Basis in Indian Electricity Markets

Driver 1 — Transmission Losses:

Physical electricity flow across the grid encounters technical losses in transmission lines (I^2R heating losses) and step-up/step-down transformers. Central Electricity Authority (CEA) reports Indian transmission and distribution losses at 18-22% overall, with technical losses alone at 4-6%. Consumers geographically distant from generation sources absorb higher effective prices to compensate for these losses — creating a positive basis at distant delivery points.

Driver 2 — Transmission Congestion:

India's National Grid has capacity constraints, particularly on the North-East-West corridor and the North-South intra-connections. When power flows exceed corridor capacity (typical in summer peak or after unit outages), the grid operator (POSOCO) invokes CONGESTION management, and prices at the constrained-out region rise sharply. Congestion basis can spike from ₹100/MWh (normal) to ₹500+/MWh (severe). Manesar, being in the Northern Region (structural deficit), consistently faces positive congestion basis.

Driver 3 — Open Access Charges (CERC + State Regulations):

Consumers procuring power through Open Access (bypassing distribution utilities via bilateral contracts or exchange purchases) pay regulated charges including: (a) Transmission charges (₹80-120/MWh), (b) Wheeling charges (state-specific, ₹30-80/MWh), (c) Cross-Subsidy Surcharge (CSS, imposed by state discoms, ₹80-200/MWh), (d) Additional Surcharge (₹20-50/MWh). These add ₹150-350/MWh to delivery-point cost even when IEX reference price stays flat.

Driver 4 — Regional Supply-Demand Imbalance:

Structural regional differences create persistent basis patterns. Northern Region (Haryana, Delhi, UP, Punjab) is a chronic power importer with growing demand from IT, real estate, and manufacturing (including Manesar auto belt). Southern Region has renewable surplus (Karnataka wind, Tamil Nadu solar). Northern regions therefore trade at persistent positive basis to IEX reference; Southern regions often trade at slight negative basis.

(ii) Effective Cost per MWh and Total Cost WITHOUT LBS

Formula:

Effective Cost per MWh = ₹5,150 (Q15 Swap Fixed) + Actual Basis

Total Cost = Effective Cost per MWh × 4,32,000 MWh

Scenario A — Low Basis (Excess Supply, Prob 20%):

Effective Cost = 5,150 + (− 50) = ₹5,100/MWh

Total Cost = 5,100 × 4,32,000

= ₹220.32 crore

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Scenario B — Normal Basis (Prob 50%):

Effective Cost = 5,150 + 150 = ₹5,300/MWh

Total Cost = 5,300 × 4,32,000

= ₹228.96 crore

Scenario C — High Basis (Peak Congestion, Prob 30%):

Effective Cost = 5,150 + 400 = ₹5,550/MWh

Total Cost = 5,550 × 4,32,000

= ₹239.76 crore

Summary Table:

Scenario	Basis (₹/MWh)	Effective Cost (₹/MWh)	Total Cost (₹ crore)	Deviation from Q15 Assumption (₹ cr)
Low (Excess Supply)	− 50	5,100	220.32	− 2.16 (savings)
Normal	+ 150	5,300	228.96	+ 6.48 (over-run)
High (Peak Congestion)	+ 400	5,550	239.76	+ 17.28 (over-run)
Q15's ASSUMED Cost (basis = 0)	**0**	**5,150**	**222.48**	**0 (base case)**

Key Insight — The Hidden Basis Risk in Q15:

Q15's analysis implicitly assumed Manesar node price = IEX reference price (i.e., basis = 0). In reality, actual costs deviate materially — from ₹2.16 crore savings in the best case to ₹17.28 crore over-run in the worst case. The most likely outcome (Normal scenario, 50% probability) already incurs ₹6.48 crore of unhedged cost beyond Q15's expected ₹222.48 crore.

(iii) Expected Cost and Standard Deviation WITHOUT LBS

Expected Total Cost:

E[Cost] = Σ (Probability × Total Cost)

Scenario	Probability	Total Cost (₹ cr)	Probability × Cost (₹ cr)
Low Basis	0.20	220.32	44.064
Normal Basis	0.50	228.96	114.480
High Basis	0.30	239.76	71.928
Expected Total Cost			**₹230.472 crore**

Standard Deviation of Cost:

Scenario	Probability	Deviation (₹ cr)	Deviation² (₹ cr²)	Prob × Dev² (₹ cr²)
Low Basis	0.20	220.32 − 230.472 = −10.152	103.062	20.612
Normal Basis	0.50	228.96 − 230.472 = −1.512	2.286	1.143
High Basis	0.30	239.76 − 230.472 = +9.288	86.263	25.879
Variance				**₹47.634 cr²**
Standard Deviation = √47.634				**₹6.902 crore**

Basis Risk Exposure Summary:

- Expected Total Cost: ₹230.47 crore (₹7.99 crore ABOVE Q15's assumed ₹222.48 cr)
- Standard Deviation: ₹6.90 crore
- Worst-case exposure: ₹239.76 crore (₹17.28 cr above Q15 baseline)
- Range of possible outcomes: ₹19.44 crore spread (from ₹220.32 to ₹239.76)

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(iv) Verification of Perfect Hedge with LBS Added

Combined Cash Flow Analysis per MWh:

With BOTH the Q15 IEX-linked swap AND the LBS in place:

Cash Flow Component	Direction	Amount per MWh (₹)
Physical purchase at Manesar	OUTFLOW	Manesar Spot
Q15 Swap: Pay Fixed	OUTFLOW	5,150
Q15 Swap: Receive Floating (IEX)	INFLOW	IEX Spot
LBS: Pay Fixed Basis	OUTFLOW	200
LBS: Receive Floating Basis (Manesar − IEX)	INFLOW	Manesar Spot − IEX Spot

Net Cash Outflow per MWh:

= Manesar Spot + 5,150 − IEX Spot + 200 − (Manesar Spot − IEX Spot)

= Manesar Spot + 5,150 − IEX Spot + 200 − Manesar Spot + IEX Spot

= ₹5,350/MWh (all variable terms cancel)

Verification Under Each Basis Scenario:

Scenario	Physical Cost per MWh	Q15 Swap Net	LBS Net	Total per MWh
Low (−50)	IEX − 50	5,150 − IEX	−50 − 200 = −250	5,350
Normal (+150)	IEX + 150	5,150 − IEX	150 − 200 = −50	5,350
High (+400)	IEX + 400	5,150 − IEX	400 − 200 = +200	5,350

Total Cost With Combined Hedge:

Total Cost = ₹5,350/MWh × 4,32,000 MWh

= ₹231.12 crore (LOCKED IN, all scenarios)

The combined structure achieves a PERFECT HEDGE — total cost is invariant to both IEX price movements AND Manesar-IEX basis fluctuations. This is the derivatives equivalent of buying "insurance" against all electricity price risk components.

(v) Cost of Certainty and Hedge Effectiveness

Cost of Certainty:

Cost of Certainty = Total Cost WITH LBS − Expected Total Cost WITHOUT LBS

= ₹231.12 crore − ₹230.472 crore

= ₹0.648 crore = ₹64.8 lakh

Interpretation:

PTC India Energy Trading charges a ₹15/MWh margin over the expected basis of ₹185/MWh (they offer fixed at ₹200/MWh). Over 4,32,000 MWh, this translates to ₹64.8 lakh — the "insurance premium" Maruti pays for perfect cost certainty.

Hedge Effectiveness Ratio:

Hedge Effectiveness = Std Dev Eliminated / Cost of Certainty

= ₹6.90 crore / ₹0.648 crore

= 10.7x

Each rupee spent on the LBS eliminates 10.7 rupees of standard deviation exposure — an EXCEPTIONAL insurance ratio. Industrial buyers typically consider ratios above 3-4x as attractive; 10.7x is highly favourable.

Consolidated Comparison — Without LBS vs With LBS:

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Metric	Without LBS (Q15 only)	With LBS (Q15 + LBS)
Expected Total Cost	₹230.47 crore	₹231.12 crore
Standard Deviation	₹6.90 crore	₹0.00 (perfect hedge)
Worst Case Outcome	₹239.76 crore	₹231.12 crore
Best Case Outcome	₹220.32 crore	₹231.12 crore
Cost of Certainty	—	₹0.648 crore (₹64.8 lakh)
Downside Protection	None (up to ₹17.28 cr exposure)	Full (₹0 exposure)

(vi) Recommendation to Rakesh Ganguly

Recommendation: PROCEED with the Locational Basis Swap with PTC India Energy Trading

Rationale:

(i) SUPERIOR RISK-REWARD: ₹64.8 lakh premium eliminates ₹6.90 crore of standard deviation exposure — 10.7x insurance ratio. Extraordinary value in institutional risk management terms.

(ii) WORST-CASE PROTECTION: Without LBS, high basis scenario (30% probability) would cost Maruti ₹239.76 crore — ₹8.64 crore MORE than the LBS-hedged outcome. LBS caps this downside completely.

(iii) PREDICTABLE BUDGETING: Cost is locked at ₹231.12 crore regardless of grid conditions — allows Maruti's finance team to plan Q3 FY27 operating expenses with certainty.

(iv) COUNTERPARTY QUALITY: PTC India is government-owned, NSE-listed, India's largest power trader — strong counterparty. Layer with ISDA Master Agreement and Credit Support Annex.

(v) INSTITUTIONAL SIGNALING: A large corporate hedging locational basis is a POSITIVE SIGNAL to auditors, credit rating agencies, and investors — demonstrates sophisticated treasury discipline.

(vi) IMMATERIAL PREMIUM: The ₹64.8 lakh cost is 0.28% of the total ₹231 crore energy budget — a negligible expense for the certainty gained.

Alternative Structures to Consider:

(i) PARTIAL HEDGE (50% notional): Cover only 2,16,000 MWh via LBS at fixed basis ₹200/MWh. Cost ₹32.4 lakh but retains 50% of upside if basis stays favourable. Suitable if Maruti's risk tolerance permits.

(ii) BASIS COLLAR: Buy call on basis (strike ₹350) + Sell put on basis (strike ₹0). Zero-cost structure protecting against high-basis scenarios while retaining some upside. Requires more complex structuring but net-zero premium.

(iii) MULTIPLE COUNTERPARTIES: Split notional across PTC India (60%) + Tata Power Trading (40%). Diversifies counterparty risk at slight pricing premium.

(iv) SHORTER-TENOR ROLLING HEDGES: Use monthly LBS strips instead of 6-month bullet. Allows adjustment as basis dynamics evolve. Higher operational complexity but more flexible.

(v) DO NOTHING: Accept basis risk as an operational cost. Not recommended for Maruti given the scale of exposure (₹17 cr worst-case).

Implementation Checklist:

(i) ISDA Master Agreement + CSA execution with PTC India (2-3 week process)

(ii) Board approval — new derivative instrument requires disclosure to Audit Committee

(iii) Ind AS 109 treatment — assess for cash flow hedge accounting qualification

(iv) Establish operational protocol for monthly settlement (POSOCO data access, treasury reconciliation)

(v) Report combined hedge structure (Q15 swap + LBS) in quarterly financial statements per Ind AS 107 disclosure requirements

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Question 18 — Timing Option (Option to Delay Investment)

Case Study — Godrej Properties Ltd (Whitefield Bengaluru Project)

Rakesh Sridhar, CFO of Godrej Properties Limited, is evaluating a residential real estate development project on a 15-acre plot in Whitefield, Bengaluru. The company holds the land title but has flexibility on when to commence construction. Given the current cycle in the Bengaluru residential market, Rakesh is contemplating whether to launch the project immediately or wait one year for more clarity on IT sector hiring, interest rate direction, and RERA compliance costs.

Project Financials (15-Jul-2026):

Parameter	Value
Total Construction Cost (payable at launch)	₹200 crore
Present Value of Expected Cash Flows if launched NOW	₹220 crore
NPV if launched NOW (traditional DCF)	₹20 crore (₹220 − ₹200)
Risk-Free Rate	8% p.a.

Uncertainty Scenario (if Godrej DEFERS by 1 year):

Scenario	Description	PV of Cash Flows at Year 1
Optimistic	Bengaluru IT hiring recovers; property demand strong	₹280 crore
Pessimistic	IT sector stagnates; residential demand weak	₹160 crore

Additional Note:

Construction cost is expected to remain ₹200 crore in Year 1 (locked-in via long-term contractor agreement). Godrej can start construction at Year 1 by paying the ₹200 crore cost only if favorable market conditions emerge.

Required:

(i) Compute the up factor (u) and down factor (d) for the binomial model based on the two scenarios.

(ii) Compute the RISK-NEUTRAL PROBABILITY (p) of the up-scenario using the formula ((1 + r) − d) / (u − d).

(iii) Compute the PAYOFF at Year 1 in both the Up and Down scenarios if Godrej chooses to WAIT.

(iv) Compute the VALUE OF WAITING (present value of the deferral strategy) using risk-neutral valuation.

(v) Compute the VALUE OF THE TIMING OPTION (difference between Value of Waiting and NPV Now).

(vi) State your decision recommendation to Rakesh Sridhar. Explain the intuition behind the recommendation.

Solution

(i) Rate of Return in Each State

ICAI Method — Investment (₹200 crore) as Base:

Favourable Scenario:

Rate up = (PV_up / Investment) − 1

= (₹280 / ₹200) − 1

= 40%

Unfavourable Scenario:

Rate down = (PV_down / Investment) − 1

= (₹160 / ₹200) − 1

= – 20%

(ii) Risk-Neutral Probability

Setting Up Risk-Neutral Equation:

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Under risk-neutral valuation, the expected return equals the risk-free rate:

$r_f = p \times r_{up} + (1 - p) \times r_{down}$

$8\% = p \times 40\% + (1 - p) \times (-20\%)$

Solving for p:

$0.08 = 0.40p + (1 - p)(-0.20)$

$0.08 = 0.40p - 0.20 + 0.20p$

$0.08 + 0.20 = 0.60p$

$0.28 = 0.60p$

$p = 0.28 / 0.60 = 0.4667$ (or 7/15)

Therefore:

- Risk-neutral probability (favourable) = 0.4667
- Risk-neutral probability (unfavourable) = 1 − 0.4667 = 0.5333

(iii) NPV in Each Future State

Favourable State:

NPV up = PV_up − Investment

= ₹280 − ₹200

= + ₹80 crore

Unfavourable State:

NPV down = PV_down − Investment

= ₹160 − ₹200

= – ₹40 crore (NEGATIVE)

CRITICAL METHODOLOGY POINT:

Under ICAI's timing option methodology (Illustration 6), the NEGATIVE NPV of −₹40 crore in the unfavourable state IS INCLUDED in the expected payoff computation. This differs from the standard financial option approach (Hull, Damodaran) which would apply max(NPV, 0) and set the unfavourable payoff to zero. Students MUST follow ICAI's method in the exam.

(iv) Expected Payoff at Year 1

Formula (ICAI Illustration 6):

Expected Payoff = p × NPV_up + (1 − p) × NPV_down

Substituting Values:

Expected Payoff = 0.4667 × (+ ₹80) + 0.5333 × (− ₹40)

= ₹37.333 + (− ₹21.333)

= ₹16.00 crore

Verification Using Fractions (for accuracy):

Expected Payoff = (7/15) × 80 + (8/15) × (−40)

= 560/15 + (−320/15)

= 240/15

= ₹16 crore (exact)

(v) PV of Waiting Strategy

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Formula:

PV of Waiting = Expected Payoff / (1 + r_f)

Substituting Values:

PV of Waiting = ₹16.00 / 1.08

= ₹14.81 crore

(vi) Value of Timing Option and Decision

Formula:

Value of Timing Option = PV of Waiting − NPV Now

Substituting Values:

Value of Timing Option = ₹14.81 − ₹20.00

= – ₹5.19 crore (NEGATIVE)

Consolidated Decision Table:

Strategy	Value (₹ crore)	Decision
Invest NOW	20.00 (NPV Now)	Preferred
WAIT 1 year (Timing Option)	14.81 (PV of Waiting)	Inferior
Value of Timing Option	**(5.19)**	**INVEST NOW**

Rakesh's Recommendation to Godrej Properties Board:

(i) INVEST NOW — proceed with the Whitefield project immediately.

(ii) Under ICAI methodology, the timing option DESTROYS ₹5.19 crore of value in this specific case. Waiting is not attractive.

(iii) The mathematical intuition: while the favourable state offers a strong +₹80 crore NPV, the unfavourable state's −₹40 crore NPV is heavily weighted (probability 53.33%). The expected outcome of waiting (₹16 crore at Year 1, or ₹14.81 crore today) falls short of the certain ₹20 crore available by investing today.

(iv) The current NPV of ₹20 crore is positive and achievable with certainty. Waiting introduces downside risk that outweighs the upside potential under this methodology.

Interpretation of the Negative Option Value:

A NEGATIVE Value of Timing Option is a valid and pedagogically important outcome. It means:

(i) The current market conditions offer sufficient profitability that immediate action is superior to speculation on future outcomes.

(ii) The downside risk (₹40 crore loss in unfavourable state, weighted by 53.33% risk-neutral probability) outweighs the upside potential (₹80 crore gain, weighted by 46.67%).

(iii) Delaying commits Godrej to future outcomes without the certainty of today's positive NPV.

Important Practical Caveats:

(i) This analysis follows ICAI's assumption that Godrej WOULD invest in Year 1 regardless of NPV sign. In real-world practice, Godrej would ABANDON if unfavourable — converting the −₹40 crore to zero, which would make waiting more attractive under Hull/Damodaran methodology.

(ii) This analysis assumes the LAND HOLDING can be maintained without cost. In practice, small holding costs (property tax, security) further reduce the value of waiting.

(iii) If COMPETITORS may launch similar projects in the interim (Prestige Estates, Sobha, Brigade), market saturation reduces the value of waiting.

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(iv) ICAI's methodology gives a CONSERVATIVE estimate of timing option value — the international method (Hull/Damodaran) would give a higher value (₹27.90 crore in this case) by capping the downside at zero.

Question 19 — Growth Option (Option to Expand)

Case Study — Café Coffee Day Ltd (Tier-2 City Expansion Plan)

Vinita Krishnan, Chief Strategy Officer of Café Coffee Day Ltd (CCD), is evaluating a proposal to expand into TIER-2 cities where CCD has minimal presence. The strategy team has designed a two-phase approach: Phase 1 involves piloting 20 stores in select Tier-2 cities to test market response, and Phase 2 (contingent on Phase 1 success) involves scaling up to 100 additional stores across the country. The Board is skeptical because Phase 1 by itself has negative NPV under traditional DCF analysis.

Phase 1 Financials (Pilot 20 Stores):

Parameter	Value
Investment Cost (immediate, mandatory)	₹40 crore
Present Value of Phase 1 Cash Flows	₹35 crore
Phase 1 NPV (Traditional DCF)	₹35 − ₹40 = − ₹5 crore (NEGATIVE)

Phase 2 GROWTH OPTION (100 Additional Stores, Exercisable at Year 2):

Parameter	Value
Additional Investment if Exercised	₹100 crore (payable at Year 2)
Current PV of Phase 2 Cash Flows (as of today)	₹90 crore
Phase 2 Traditional NPV if launched today	₹90 − ₹100 = − ₹10 crore (also negative)
Risk-Free Rate	8% p.a.

Uncertainty Modelling (2-Year Single-Step Binomial):

Scenario	Description	Multiplier
Up scenario (Success)	Phase 1 succeeds; Tier-2 market proves viable	u = 1.50
Down scenario (Failure)	Phase 1 underperforms; market response weak	d = 0.67

Key Point:

At Year 2, based on Phase 1 outcomes, CCD will decide whether to exercise the Phase 2 Growth Option. Traditional DCF would REJECT Phase 1 (negative NPV of ₹5 crore), but Vinita wants to demonstrate that the GROWTH OPTION EMBEDDED in Phase 1 makes the overall proposition value-accretive.

Required:

(i) Compute the PV of Phase 2 cash flows at Year 2 in both Up and Down scenarios.

(ii) Compute the PAYOFF of the Growth Option at Year 2 in each scenario. Explain when CCD would exercise vs. abandon the growth option.

(iii) Compute the RISK-NEUTRAL PROBABILITY (p) for the 2-year period.

(iv) Compute the VALUE OF THE GROWTH OPTION at Year 0 (present value).

(v) Compute the TOTAL PROJECT VALUE combining Phase 1 NPV and the Growth Option Value.

(vi) Provide a decision recommendation to Vinita and the CCD Board. Explain how the growth option changes the accept/reject decision.

Solution

(i) PV of Phase 2 Cash Flows at Year 2

Up Scenario (Phase 1 succeeds):

PV_up = Current PV × u

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= ₹90 × 1.50

PV_up = ₹135 crore

Down Scenario (Phase 1 underperforms):

PV_down = Current PV × d

= ₹90 × 0.67

PV_down = ₹60.30 crore

(ii) Growth Option Payoff at Year 2

Up Scenario Payoff:

Payoff_up = Max (PV_up − Expansion Cost, 0)

= Max (₹135 − ₹100, 0)

= ₹35 crore (EXERCISE the growth option)

Down Scenario Payoff:

Payoff_down = Max (PV_down − Expansion Cost, 0)

= Max (₹60.30 − ₹100, 0)

= ₹0 (DO NOT EXERCISE — abandon expansion)

Key Insight:

The growth option creates ASYMMETRIC OUTCOMES — CCD captures the upside (₹35 crore profit) if Phase 1 succeeds, but avoids the downside (would lose ₹40 crore if forced to invest in unfavorable conditions). This asymmetry is what gives the growth option its value.

(iii) Risk-Neutral Probability

Formula for Multi-Year Period:

p = ((1 + r)^T − d) / (u − d)

Substituting Values (T = 2 years):

(1 + r)^T = $(1.08)^2$ = 1.1664

p = (1.1664 − 0.67) / (1.50 − 0.67)

= 0.4964 / 0.83

p = 0.5981

1 − p = 0.4019

(iv) Value of the Growth Option at Year 0

Formula:

Growth Option Value = [p × Payoff_up + (1 − p) × Payoff_down] / (1 + r)^T

Substituting Values:

Growth Option Value = [0.5981 × ₹35 + 0.4019 × ₹0] / $(1.08)^2$

= [₹20.93 + ₹0] / 1.1664

= ₹20.93 / 1.1664

Growth Option Value = ₹17.95 crore

(v) Total Project Value (Phase 1 NPV + Growth Option Value)

Formula:

Total Value = Phase 1 NPV + Growth Option Value

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Substituting Values:

Component	Value (₹ crore)
Phase 1 Traditional NPV	− 5.00
Value of Phase 2 Growth Option	+ 17.95
Total Project Value (with Real Option)	**+ 12.95**

(vi) Decision Recommendation

Comparison — Traditional DCF vs Real Options Analysis:

Decision Framework	NPV (₹ crore)	Decision
Traditional DCF (Phase 1 only)	− 5.00	REJECT Phase 1
Real Options (Phase 1 + Growth Option)	+ 12.95	ACCEPT Phase 1

Recommendation to Vinita and CCD Board:

(i) ACCEPT Phase 1 despite its individual negative NPV of ₹5 crore.

(ii) Phase 1's TRUE ECONOMIC VALUE is not ₹−5 crore but ₹+12.95 crore because it CREATES the option to exercise the Phase 2 expansion.

(iii) The ₹17.95 crore growth option value FAR EXCEEDS the ₹5 crore Phase 1 loss — this is a value-creating investment.

(iv) Traditional DCF is a SUBOPTIMAL FRAMEWORK for staged investment decisions because it treats each stage as an independent, take-it-or-leave-it decision. Real Options analysis captures the SEQUENTIAL, CONDITIONAL nature of business expansion.

(v) The Board should view Phase 1 as a "STRATEGIC LEARNING INVESTMENT" — CCD pays ₹5 crore net to gain the OPTION to make a much larger, more valuable investment based on early results.

Practical Considerations for Implementation:

(i) CCD's operational teams must have CLEAR MILESTONES for evaluating Phase 1 success (specific KPIs: same-store sales, gross margin, customer acquisition cost).

(ii) The Board must PROTECT THE OPTION VALUE by not prematurely committing to Phase 2 (this destroys the flexibility).

(iii) MONITORING SYSTEMS should be in place to track market signals throughout Phase 1 execution.

(iv) If Phase 1 results are AMBIGUOUS (neither clearly positive nor negative), CCD retains the option to defer Phase 2 for further learning — a valuable second-order flexibility.

(v) COMPETITIVE DYNAMICS matter: if Starbucks or Third Wave Coffee also enter Tier-2 markets during Phase 1, the growth option may erode. This should be monitored.

Question 20 — Abandonment Option with Salvage Enhancement at Waaree Energies

Case Study — Waaree Energies Ltd (Solar Cell Manufacturing Plant)

Hitesh Doshi, Managing Director of Waaree Energies Ltd (India's largest solar photovoltaic module manufacturer, listed on NSE in October 2024), is evaluating a proposal to set up a new integrated solar CELL manufacturing plant at Chikhli, Gujarat. The project would upgrade Waaree from a solar MODULE assembler to a fully integrated cell + module manufacturer — reducing dependence on imported cells from China and Southeast Asia. However, the CFO Sonal Shah has flagged significant uncertainty regarding the project's future value, driven by three factors: (a) continuity of the PLI (Production-Linked Incentive) scheme for solar manufacturing, (b) potential re-imposition or reduction of Basic Customs Duty (BCD) on imported solar cells, (c) ongoing Chinese solar cell dumping pressure on global prices.

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As part of the risk mitigation strategy, Siemens Energy (the equipment supplier for cell manufacturing lines) has offered Waaree a BUY-BACK GUARANTEE that would enhance the plant's Year 1 salvage value in exchange for an upfront fee.

Project Financials (15-Jul-2026):

Parameter	Value
Present Value of Project Today (standard DCF)	₹1,000 crore
Risk-Free Rate	8% p.a.
Abandonment Decision Date	End of Year 1
Base Salvage Value at Year 1 (sale of equipment + land)	₹800 crore

Year 1 Uncertainty Scenarios:

Scenario	Trigger Event	Project Value Change	PV at Year 1 (₹ cr)
Favourable	PLI extended; BCD hiked on imported cells	+ 20%	1,200
Unfavourable	BCD reduced; Chinese dumping intensifies	− 30%	700

Siemens Buy-Back Guarantee Offer:

Parameter	Value
Upfront Fee (payable today)	₹15 crore
Enhanced Salvage Value at Year 1	₹900 crore (up from ₹800 crore)
Guarantor	Siemens Energy (AA rated)

Required:

(i) Compute the RISK-NEUTRAL PROBABILITY of the favourable outcome.

(ii) Determine the VALUE of the abandonment option using risk-neutral valuation, at the BASE salvage value of ₹800 crore.

(iii) Determine whether Waaree should PURCHASE the Siemens Buy-Back Guarantee. Show the incremental value analysis.

(iv) Comment on the STRATEGIC SIGNIFICANCE of abandonment options in capital budgeting decisions, particularly for capital-intensive industries like solar manufacturing.

Solution

(i) Risk-Neutral Probability of Favourable Outcome

Setting Up the Risk-Neutral Equation:

Under risk-neutral valuation, expected return equals the risk-free rate:

8% = p × (+ 20%) + (1 − p) × (− 30%)

Solving for p:

0.08 = 0.20p − 0.30 (1 − p)

0.08 = 0.20p − 0.30 + 0.30p

0.08 + 0.30 = 0.20p + 0.30p

0.38 = 0.50p

p = 0.38 / 0.50 = 0.76

Therefore:

- Risk-neutral probability (favourable) = 0.76 or 76%
- Risk-neutral probability (unfavourable) = 1 − 0.76 = 0.24 or 24%

Important Clarification:

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These are RISK-NEUTRAL probabilities — synthetic probabilities that ensure no-arbitrage pricing. They are NOT the real-world probabilities (which might be, say, 60% favourable and 40% unfavourable based on management's actual assessment). The risk-neutral framework EMBEDS the risk premium in the probabilities rather than in the discount rate — allowing valuation at the risk-free rate.

(ii) Value of Abandonment Option (Base Salvage = ₹800 crore)

Payoff Analysis at Year 1:

State	Project Value (₹ cr)	Salvage (₹ cr)	Continue or Abandon?	Option Payoff (₹ cr)
Favourable	1,200	800	Continue (project worth more)	0
Unfavourable	700	800	Abandon (salvage worth more)	800 − 700 = 100

Key Insight — Asymmetric Payoff:

The abandonment option pays off ONLY in the unfavourable state — this is what makes it a valuable INSURANCE POLICY. In the favourable state, management RATIONALLY CONTINUES the project (₹1,200 > ₹800), so no abandonment benefit. In the unfavourable state, management RATIONALLY ABANDONS (salvage ₹800 > continuation ₹700), converting a ₹300 crore loss into a ₹100 crore recovery.

Computing the Option Value:

Expected Payoff at Year 1 = p × Payoff_up + (1 − p) × Payoff_down

= 0.76 × ₹0 + 0.24 × ₹100

= ₹0 + ₹24 crore

= ₹24 crore

PV of Abandonment Option:

PV = Expected Payoff / (1 + r_f)

= ₹24 / 1.08

= ₹22.22 crore

Interpretation:

- The flexibility to abandon the project is worth ₹22.22 crore TODAY
- Traditional DCF (which assumes the project continues regardless of outcome) UNDERSTATES the true project NPV by ₹22.22 crore
- The TRUE project value = ₹1,000 (base PV) + ₹22.22 (abandonment option) = ₹1,022.22 crore

(iii) Siemens Buy-Back Guarantee Decision

Step 1 — Value Abandonment Option at Enhanced Salvage (₹900 crore):

State	Project Value (₹ cr)	Enhanced Salvage (₹ cr)	Decision	Option Payoff (₹ cr)
Favourable	1,200	900	Continue	0
Unfavourable	700	900	Abandon	900 − 700 = 200

Expected Payoff at Year 1 = 0.76 × ₹0 + 0.24 × ₹200

= ₹0 + ₹48

= ₹48 crore

PV of Enhanced Option = ₹48 / 1.08

= ₹44.44 crore

Step 2 — Compute Incremental Value of Guarantee:

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Item	Value (₹ crore)
Enhanced Option Value (Salvage ₹900 cr)	44.44
Less: Base Option Value (Salvage ₹800 cr)	**(22.22)**
Incremental Value of Guarantee	**22.22**
Less: Cost of Guarantee	**(15.00)**
Net Benefit	**+ 7.22**

Decision:

PURCHASE the Siemens Buy-Back Guarantee — Net Benefit of ₹7.22 crore.

Rationale:

(i) The ₹15 crore fee BUYS ₹22.22 crore of additional option value — a 48.15% return on the enhancement expenditure.

(ii) The guarantee CONVERTS a good project (with ₹22.22 crore of option value) into a BETTER project (with ₹44.44 crore of option value) — doubling the downside protection.

(iii) Even if the favourable scenario materialises (76% likely), Waaree loses only ₹15 crore — a small price for the peace of mind and the ₹100 crore of additional salvage protection in the unfavourable scenario.

(iv) The guarantee is essentially a PUT OPTION on the plant sold by Siemens to Waaree at a favourable price (below fair value).

Practical Implementation Considerations:

(i) Legal Structure: Draft as an ISDA-style Master Agreement or Equipment Supply Agreement with an embedded Buy-Back clause.

(ii) Counterparty Risk: Siemens Energy is AA-rated, but include a CSA (Credit Support Annex) for further protection if the exposure exceeds ₹500 crore.

(iii) Trigger Definition: Specify precisely what triggers the buy-back — a specific date (End of Year 1), or event-based (BCD reduction, PLI cancellation, etc.).

(iv) Valuation Method: Clarify how the salvage price is determined at the abandonment date — fixed at ₹900 crore, or market-linked with a floor.

(v) Regulatory: Report the guarantee under Ind AS 109 as a Financial Guarantee Contract. Assess whether it qualifies as a derivative under Ind AS 109 (likely yes).

(iv) Strategic Significance of Abandonment Options

Why Abandonment Options Matter — Especially for Capital-Intensive Industries:

(i) CONVENTIONAL DCF UNDERSTATES VALUE: Traditional NPV analysis assumes the project runs to completion regardless of outcome. Reality: rational management ABANDONS if salvage exceeds continuation value. Ignoring this flexibility undervalues projects by 5-25% typically.

(ii) FLEXIBILITY HAS MEASURABLE VALUE: The ₹22.22 crore base option value in this case is REAL money. It represents the ex-ante value of NOT COMMITTING irreversibly to a project.

(iii) PROJECT STRUCTURING MATTERS: The same project can be made materially more valuable by NEGOTIATING salvage enhancements at the outset. Waaree gains ₹7.22 crore of value by simply paying ₹15 crore for the Siemens guarantee — a 48% ROI on flexibility purchase.

(iv) SOLAR & SEMICONDUCTOR MANUFACTURING: These industries feature rapid technology obsolescence (TopCon → HJT → Tandem cells), volatile input prices (polysilicon), and policy dependence (PLI, BCD). Abandonment options are ESSENTIAL for value protection.

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(v) REAL-WORLD APPLICATIONS: Indian corporate examples where abandonment options have been material: (a) Vedanta closed its Sterlite Copper plant in Tamil Nadu; (b) Tata Steel abandoned its European operations; (c) Multiple Indian solar module manufacturers (Vikram Solar, Adani Solar) have modified capacity based on policy changes.

(vi) M&A APPLICATION: Acquirers value target companies with abandonment options higher — the ability to divest non-core assets or shut down loss-making units adds materially to value. This is why PRIVATE EQUITY funds (KKR, Blackstone, Bain Capital) explicitly value abandonment options in LBO models.

(vii) GENERAL PRINCIPLE: In an uncertain environment, MANAGEMENT FLEXIBILITY = OPTION VALUE. The more uncertainty, the more valuable the flexibility. This is fundamentally different from the traditional "more risk = higher discount rate" view.

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CHAPTER 10 — FOREIGN EXCHANGE EXPOSURE AND RISK MANAGEMENT

Question 1 — Cross Rate + Bid-Ask + Forward Hedge — Tata Motors JPY Receivable

Case Study — Tata Motors Limited (JPY Receivable from Toyota Motor Corporation)

Rakesh Ganguly, CFO of Tata Motors Limited, has received an order from Toyota Motor Corporation, Japan, for export of auto parts and components manufactured at Tata Motors' Pune facility. The invoice value is JPY 200 crore, receivable in 3 months. Rakesh needs to convert JPY to INR and is evaluating hedging alternatives using a forward contract with Mizuho Bank India (the Indian branch of Japan's Mizuho Financial Group).

Since INR/JPY is not directly quoted in Indian markets, the conversion must be routed via USD as the vehicle currency.

Exchange Rate Quotes (15-Jul-2026):

Quote	Bid	Ask
Spot INR/USD (Mumbai interbank)	₹83.20	₹83.24
Spot USD/JPY (Tokyo interbank)	JPY 148.50	JPY 148.60
3-month Forward INR/USD	₹84.10	₹84.20
3-month Forward USD/JPY	JPY 147.80	JPY 147.90

Required:

(i) Compute the INR/JPY SPOT CROSS RATE applicable to Tata Motors (per 100 JPY).

(ii) Compute the INR/JPY 3-MONTH FORWARD CROSS RATE applicable to Tata Motors (per 100 JPY).

(iii) Compute the TOTAL INR RECEIPT if Tata Motors takes SPOT conversion of the entire JPY 200 crore today.

(iv) Compute the TOTAL INR RECEIPT if Tata Motors HEDGES via a 3-month forward contract.

(v) Compute the ANNUALIZED FORWARD PREMIUM on JPY (from Tata Motors' perspective).

(vi) Provide a RECOMMENDATION to Rakesh on whether to hedge via the forward or leave the exposure unhedged.

Solution

(i) INR/JPY Spot Cross Rate

Tata Motors' Position: Receiver of JPY, wants INR

Step 1: Sell JPY → Buy USD

Bank sells USD to Tata Motors — use USD/JPY ASK = JPY 148.60

Step 2: Sell USD → Buy INR

Bank buys USD from Tata Motors — use INR/USD BID = ₹83.20

Cross Rate:

INR per JPY = ₹83.20 / 148.60 = ₹0.55989 per JPY

INR per 100 JPY = ₹55.99

(ii) INR/JPY 3-Month Forward Cross Rate

Same two-step logic applied to Forward rates:

Step 1: Sell JPY fwd → Buy USD fwd — use USD/JPY 3-m Fwd ASK = JPY 147.90

Step 2: Sell USD fwd → Buy INR fwd — use INR/USD 3-m Fwd BID = ₹84.10

Forward Cross Rate:

INR per JPY = ₹84.10 / 147.90 = ₹0.56863 per JPY

INR per 100 JPY = ₹56.86

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(iii) Spot Conversion — Total INR Receipt

Step 1: Convert JPY to USD at Spot USD/JPY ASK (148.60):

USD received = JPY 200 crore / 148.60 = JPY 2,00,00,00,000 / 148.60

= USD 1,34,58,950 (approximately)

Step 2: Convert USD to INR at Spot INR/USD BID (83.20):

INR received = USD 1,34,58,950 × ₹83.20 = ₹1,11,97,84,657

= ₹111.98 crore (approximately)

(iv) Forward Hedge — Total INR Receipt

Step 1: Convert JPY to USD at Forward USD/JPY ASK (147.90):

USD received = JPY 200 crore / 147.90 = USD 1,35,22,650

Step 2: Convert USD to INR at Forward INR/USD BID (84.10):

INR received = USD 1,35,22,650 × ₹84.10 = ₹1,13,72,54,902

= ₹113.73 crore (approximately)

(v) Annualized Forward Premium on JPY

Formula:

Annualized Forward Premium = ((Forward − Spot) / Spot) × (12/n) × 100

where n = tenor in months

Substituting Values:

Annualized Premium = ((56.86 − 55.99) / 55.99) × (12/3) × 100

= (0.87 / 55.99) × 4 × 100 = 0.01554 × 400

= 6.22% p.a.

Interpretation:

The JPY is trading at a 6.22% ANNUALIZED FORWARD PREMIUM against INR — meaning JPY is expected to STRENGTHEN over the next 3 months. For a JPY receiver like Tata Motors, this forward premium is FAVOURABLE — they lock in a higher INR realisation.

(vi) Recommendation to Rakesh Ganguly

Comparison Summary:

Strategy	Total INR Receipt (₹ crore)	Certainty
Spot conversion (today)	111.98	Certain (immediate)
3-month Forward hedge	113.73	Certain (locked at 3-m fwd)
Unhedged (wait 3 months, spot)	Uncertain — depends on JPY/USD and INR/USD moves	Fully at risk

Recommendation: HEDGE via 3-month forward contract

Rationale:

(i) FORWARD LOCKS IN ADDITIONAL ₹1.75 CRORE over spot conversion — the forward premium on JPY is favourable for Tata Motors as a JPY receiver.

(ii) ELIMINATES CURRENCY RISK: JPY/INR could depreciate over 3 months due to Bank of Japan monetary policy shifts, USD strengthening, or Indian macro pressures. Hedge removes this uncertainty.

(iii) BOARD-LEVEL COMFORT: For a listed company, hedging is expected by investors and analysts. Any FX loss on a large receivable would be questioned in earnings calls.

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(iv) ACCOUNTING TREATMENT: Under Ind AS 109, the forward contract can be designated as a Cash Flow Hedge with hedge accounting treatment — reducing P&L volatility.

(v) COST OF CARRY IS FAVOURABLE: The 6.22% annualized forward premium on JPY implies the market expects JPY to strengthen — locking in today captures this expectation.

Question 2 — Nostro Account & Overbought/Oversold Position — Kotak Bank Forex Desk

Case Study — Kotak Mahindra Bank Forex Trading Desk (BKC, Mumbai)

Amit Chandak, Chief Dealer at Kotak Mahindra Bank's forex trading desk in BKC Mumbai, manages the USD Nostro account maintained with JPMorgan Chase Bank, New York. On 15-July-2026, Amit must review the day's transactions and take cover action to square both the cash and exchange positions before end of trading.

Opening Balances (Start of 15-Jul-2026):

Position	Balance	Nature
Nostro USD Cash (with JPM NY)	USD 4 million	CREDIT
Exchange Position (from prior forward book)	USD 3 million	OVERBOUGHT

Transactions on 15-Jul-2026 (all in USD million):

Sr.	Transaction	Amount	Bank's Action
1	TT Sale to customer (importer paying overseas supplier)	10	Sells USD
2	TT Purchase from customer (exporter receiving payment)	12	Buys USD
3	Interbank Sale to Deutsche Bank	20	Sells USD
4	Interbank Purchase from HSBC	15	Buys USD
5	Export Bill purchased (immediate Nostro credit)	5	Buys USD
6	DD (Demand Draft) issued to overseas beneficiary	2	Sells USD
7	FCNR Deposit received from NRI customer	3	Deposit (not FX trade)
8	Forward Purchase (3-m) from exporter customer	20	Buys USD (forward)
9	Forward Sale (3-m) to importer customer	12	Sells USD (forward)

Market Rates at End of Day (15-Jul-2026):

Quote	Bid	Ask
Spot USD/INR	₹83.20	₹83.30
3-month Forward USD/INR	₹83.85	₹83.95

Required:

(i) Compute the CASH POSITION (Nostro balance) at end of day. Identify if surplus or overdraft.

(ii) Compute the EXCHANGE POSITION at end of day. Identify if overbought or oversold.

(iii) Design the OPTIMAL COVER STRATEGY to make BOTH cash position and exchange position SQUARE.

(iv) Compute the P&L IMPACT (bid-ask cost) of the cover transactions.

(v) Explain conceptually why the FCNR deposit AFFECTS cash position but NOT exchange position.

(vi) Recommend a TREASURY POLICY to prevent excessive open positions from accumulating during the trading day.

Solution

(i) Cash Position at End of Day

Only transactions physically affecting Nostro are counted:

Description	USD million
Opening Nostro Balance	**+ 4.00**

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Description	USD million
IN (Credits to Nostro):	
TT Purchase from customer (exporter)	+ 12
Interbank Purchase from HSBC	+ 15
Export Bill purchased	+ 5
FCNR Deposit received	**+ 3**
Total IN	**+ 35**
OUT (Debits from Nostro):	
TT Sale to customer (importer)	− 10
Interbank Sale to Deutsche Bank	− 20
DD Issued to beneficiary	**− 2**
Total OUT	**− 32**
Net Movement	**+ 3**
Closing Nostro Cash Balance	**USD 7 million (SURPLUS)**

Note: Forward transactions (Sr. 8 and 9) are EXCLUDED as they don't affect cash today — they will affect Nostro on the 3-month maturity date.

(ii) Exchange Position at End of Day

All FX trades (spot + forward) that create currency risk are included. FCNR is EXCLUDED.

Description	USD million
Opening Exchange Position	**+ 3.00 (Overbought)**
PURCHASES (Bank buys USD, adds to LONG):	
TT Purchase from customer	+ 12
Interbank Purchase from HSBC	+ 15
Export Bill purchased	+ 5
Forward Purchase (3-m)	**+ 20**
Total Purchases	**+ 52**
SALES (Bank sells USD, adds to SHORT):	
TT Sale to customer	− 10
Interbank Sale to Deutsche Bank	− 20
DD Issued	− 2
Forward Sale (3-m)	**− 12**
Total Sales	**− 44**
Net Position Change	**+ 8**
Closing Exchange Position	**USD 11 million (OVERBOUGHT)**

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Interpretation:

Kotak Bank is holding USD 11 million MORE in future USD receivables than it has committed to deliver. This creates a LONG USD exposure — the bank will profit if USD appreciates and lose if USD depreciates. This open position must be COVERED to eliminate speculative FX risk from the trading book.

(iii) Optimal Cover Strategy

Objective: Make BOTH Cash Position and Exchange Position SQUARE (zero).

Position Summary:

Position	Current Level	Target	Action Needed
Cash (Nostro USD)	+ 7M surplus	0M	Sell USD 7M (spot)
Exchange	+ 11M overbought	0M	Sell USD 11M (any tenor)

Optimal Split — Sell USD 7M Spot + Sell USD 4M Forward:

Step	Action	Cash Impact	Exchange Impact
Step 1	Sell USD 7M SPOT at bid ₹83.20	− 7M (Nostro debited)	− 7M
Step 2	Sell USD 4M FORWARD at bid ₹83.85	0 (fwd - no Nostro impact today)	− 4M
Total Cover Impact		**− 7M**	**− 11M**
Closing After Cover		**0 (SQUARE) ✓**	**0 (SQUARE) ✓**

INR Cash Flows from Cover:

- Spot sale: USD 7M × ₹83.20 = ₹58.24 crore received TODAY
- Forward sale: USD 4M × ₹83.85 = ₹33.54 crore receivable in 3 months

Why NOT Option A (Sell USD 11M spot)?

Would take cash from +7M to −4M (create Nostro overdraft) — attracts penal interest from JPMorgan and reflects poor treasury discipline.

Why NOT Option B (Sell USD 11M forward)?

Would leave cash at +7M surplus — Nostro earns near-zero interest; ₹58.24 crore of INR could be earning 6-7% in domestic money market. Opportunity cost approximately ₹35-40 lakh per year on this idle balance.

(iv) P&L Impact (Bid-Ask Cost of Cover)

Comparison vs Fair Mid Rates:

Leg	Mid Rate	Executed Rate	Loss per USD	Loss (₹)
Spot Sale (USD 7M)	83.25	83.20 (bid)	0.05	0.05 × 7M = ₹3.50 lakh
Forward Sale (USD 4M)	83.90	83.85 (bid)	0.05	0.05 × 4M = ₹2.00 lakh
Total Bid-Ask Cost				**₹5.50 lakh**

Note on P&L Attribution:

This ₹5.50 lakh is only the BID-ASK cost of the cover — the pure market-making friction. Actual P&L on the day depends on:

- Rates at which Kotak originally acquired/committed each of the 9 transactions
- Bank's target margins on customer flows (typically 3-8 paise per USD spread)
- Overall dealing-room limits (single-day open position, VaR)

(v) Why FCNR Affects Cash but NOT Exchange Position

Conceptual Explanation:

An FCNR deposit is a BORROWING by the bank in foreign currency — not an FX trade. When an NRI deposits USD 3M:

(i) USD 3M CREDITED to Nostro → Cash position increases by USD 3M

(ii) USD 3M LIABILITY created (bank owes 3M USD to depositor on maturity + interest)

(iii) The USD asset (Nostro credit) and USD liability (deposit) are IN THE SAME CURRENCY

(iv) Net FX Exposure = USD Asset − USD Liability = 3M − 3M = 0

(v) Therefore Exchange Position is UNAFFECTED — no directional FX risk

The bank has taken on INTEREST RATE RISK and LIQUIDITY RISK from the FCNR (must pay interest, must have USD liquidity at maturity), but not FX RISK. This is why treasury reporting separates "Foreign Currency Deposits" from "Open FX Positions".

Analogy:

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If Kotak Bank BORROWED USD 3M from JPMorgan overnight, it would similarly increase Nostro but not create exchange position — same principle. FCNR is functionally an NRI-facing borrowing.

(vi) Recommended Treasury Policy

(i) INTRA-DAY POSITION LIMITS: Set maximum permitted open exchange position at USD 5M per currency during trading hours; automatic alerts at USD 3M threshold.

(ii) END-OF-DAY SQUARING MANDATE: Chief Dealer must square all open positions before 5:00 PM IST (before New York opens); documented exceptions require Treasurer's approval.

(iii) NOSTRO CASH TARGETS: Maintain Nostro balances within ±USD 2M of target (typically minimal working balance to avoid idle funds AND overdraft risk).

(iv) REAL-TIME DASHBOARD: Deploy treasury MIS system (Reuters Dealing, Bloomberg TOMS, Kondor+) that shows live cash and exchange positions to all dealers.

(v) SEGREGATION: Separate dealers for customer flow (proprietary vs client trading) and interbank cover — reduces conflicts of interest.

(vi) STRESS TESTING: Weekly VaR analysis on open positions; monthly scenario analysis (2008 crisis, 2013 taper tantrum, 2020 COVID moves) to stress-test capital adequacy.

(vii) REGULATORY COMPLIANCE: Comply with RBI's Net Overnight Open Position (NOOP) limit (currently 25% of Tier-1 capital for AD Category-I banks) and Aggregate Gap Limit (AGL).

Question 3 — Cancellation and Extension of Forward Contract — Infosys with HDFC Bank

Case Study — Infosys Limited (USD Forward Sale Contract with HDFC Bank)

Priya Nair, Treasurer of Infosys Limited, had booked a 3-month FORWARD SALE contract with HDFC Bank on 15-April-2026 to sell USD 10 million at ₹83.50 per USD. The contract was intended to hedge an anticipated USD receivable from a US-based BFSI client for IT services delivered.

On 15-July-2026 (due date), the underlying receivable has been DELAYED by 3 months due to the client's project timeline extension. Priya must decide between:

- Alternative A: CANCEL the forward contract (unwind, no delivery)
- Alternative B: EXTEND the forward by 3 months to align with the delayed receivable

Market Rates on 15-July-2026 (Cancellation/Extension Date):

Quote	Bid (Bank Buys USD)	Ask (Bank Sells USD)
Spot INR/USD (Ready)	₹83.80	₹83.90
3-month Forward INR/USD (new)	₹84.20	₹84.30

Original Contract Terms:

- Booking Date: 15-April-2026
- Original Maturity: 15-July-2026
- Amount: USD 10 million
- Type: SALE (Infosys sells USD, bank buys)
- Contract Rate: ₹83.50 per USD

Required:

(i) Compute the CANCELLATION CHARGE payable by (or refundable to) Infosys under Alternative A. Identify the direction of the cash flow.

(ii) Compute the CASH FLOW to Infosys under Alternative B (Extension by 3 months). Show cancellation of original and rebooking of new contract.

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(iii) Compute the EFFECTIVE NEW SALE RATE under the Extension alternative.

(iv) COMPARE the effective outcome under Extension vs the original contract rate (₹83.50), and provide RECOMMENDATION to Priya.

Solution

(i) Cancellation Charge — Alternative A

Applicable Rate: Bank's TT Selling Rate (Ask) on cancellation date = ₹83.90

(Because to "cancel" a customer's SALE contract, the bank effectively SELLS USD back to the customer — thus applying its Ask rate)

Cancellation Charge Computation:

Charge = (Bank's TT Ask on cancellation date − Contract Rate) × Amount

= (₹83.90 − ₹83.50) × USD 10,000,000

= ₹0.40 × 10,000,000

= ₹40,00,000 = ₹40 lakh

Direction: Infosys PAYS ₹40 lakh to HDFC Bank

Reason:

The USD has APPRECIATED from ₹83.50 (contract rate) to ₹83.90 (current spot ask). Infosys had committed to SELL USD at ₹83.50 — a rate now unfavourable to Infosys (since market gives ₹83.80 bid). By cancelling, HDFC Bank has to unwind its own back-to-back position in the market at the higher rate, incurring a loss of ₹0.40 per USD. This loss is passed on to Infosys as the cancellation charge.

(ii) Extension by 3 Months — Alternative B (Cash Flow Analysis)

Step 1: Cancel Original Forward at Ready Rate

Same as Part (i): Infosys pays cancellation charge of ₹40 lakh

Cash flow today: OUT ₹40,00,000 (to HDFC Bank)

Step 2: Rebook New 3-month Forward SALE at Bank's New Forward BID

(Because Infosys is SELLING USD forward, bank BUYS USD forward at Bid)

New Forward Rate = ₹84.20 per USD

New Contract: Infosys sells USD 10M at ₹84.20 for delivery on 15-Oct-2026

Cash flow at new maturity: IN ₹84.20 × 10,000,000 = ₹84,20,00,000 = ₹84.20 crore

(iii) Effective New Sale Rate under Extension

Formula:

Effective Rate = New Forward Rate − (Cancellation Charge per unit)

Computation:

Cancellation charge per USD = ₹40 lakh / USD 10M = ₹0.40 per USD

Effective Rate = ₹84.20 − ₹0.40

= ₹83.80 per USD

Alternative Presentation (Net Cash Flow Basis):

Item	Timing	Cash Flow (₹)
Cancellation charge paid	Today (15-Jul-26)	(40,00,000)
New forward sale receipt	New maturity (15-Oct-26)	84,20,00,000
Net Effective Receipt		**83,80,00,000**

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Item	Timing	Cash Flow (₹)
Effective Sale Rate per USD		**₹83.80**

(iv) Comparison and Recommendation to Priya Nair

Comparative Analysis:

Alternative	Description	Effective Sale Rate	vs Original (₹83.50)
Original delivery (impossible)	Deliver USD today — but underlying delayed	₹83.50	Baseline
A. Cancellation	Unwind, cost ₹40 lakh, no future contract	N/A	Lose ₹40 lakh
B. Extension by 3 months	Cancel + Rebook at ₹84.20 for Oct maturity	₹83.80	+ ₹0.30 per USD

Recommendation: EXTENSION (Alternative B)

Rationale:

(i) ALIGNS WITH UNDERLYING: The underlying USD receivable has been delayed by 3 months. Extension synchronises the hedge with the actual exposure.

(ii) EFFECTIVE RATE IMPROVES: The extended contract locks in ₹83.80 per USD — actually BETTER than the original ₹83.50 by ₹0.30 per USD (or ₹30 lakh on USD 10M).

(iii) AVOIDS UNHEDGED PERIOD: Cancellation leaves the underlying receivable UNHEDGED for the next 3 months, exposing Infosys to USD/INR volatility.

(iv) MARKET DYNAMICS FAVOURABLE: The new forward rate (₹84.20) reflects continued INR weakness expectations, which for a USD exporter like Infosys is beneficial.

(v) OPERATIONAL SIMPLICITY: Extension is a single transaction with HDFC Bank — no need to renegotiate a new relationship or execute mirror trades.

Cash Flow Summary if Extension is Chosen:

- 15-Jul-2026: Pay ₹40 lakh cancellation charge to HDFC Bank
- 15-Oct-2026: Receive ₹84.20 crore for delivering USD 10 million
- Net INR receipt at Oct maturity: ₹84.20 cr − ₹0.40 cr = ₹83.80 crore
- Effective sale rate: ₹83.80/USD (better than original ₹83.50)

Question 4 — Currency Options for Hedging -- Sun Pharma EUR Receivable

Case Study — Sun Pharma (EUR Receivable from European Generics Sales)

Neha Deshpande, Treasurer of Sun Pharmaceutical Industries Limited, has a EUR 20 million receivable in 6 months from Ranbaxy Europe B.V. (Sun Pharma's European generics subsidiary). The receivable is for a specialty generic drug shipment invoiced in EUR.

Neha is evaluating hedge alternatives with Standard Chartered Bank India, including a plain-vanilla forward and a currency option (PUT on EUR).

Market Data (15-Jul-2026):

Parameter	Value
Spot EUR/INR	₹90.50
6-month Forward EUR/INR	₹91.00
Put Option on EUR (Strike ₹91)	Premium ₹1.50 per EUR
EUR Amount Receivable	EUR 20,000,000
Time to Receipt	6 months

Required:

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(i) Compute the INR RECEIPT if Sun Pharma hedges via a FORWARD contract.

(ii) Compute the TOTAL PREMIUM COST for the PUT OPTION hedge.

(iii) Compute the INR RECEIPT under the PUT OPTION hedge at spot levels ₹85, ₹89, ₹91, ₹93, and ₹95 per EUR at maturity.

(iv) Compute the BREAK-EVEN SPOT at which the option hedge equals the forward hedge in INR receipt.

(v) Prepare a COMPARATIVE PAYOFF TABLE showing INR receipt under Forward vs Option at various spot levels.

(vi) Provide a RECOMMENDATION to Neha on which hedge to use, considering different market views.

Solution

(i) Forward Hedge — INR Receipt

Sun Pharma sells EUR 20M forward at ₹91.00 per EUR.

INR Receipt at maturity = EUR 20,000,000 × ₹91.00

= ₹1,82,00,00,000 = ₹182 crore (CERTAIN)

(ii) Put Option — Total Premium Cost

Premium = EUR 20,000,000 × ₹1.50 per EUR

= ₹3,00,00,000 = ₹3 crore (paid upfront)

Note: For CA Final AFM level, premium is compared at MATURITY without time value adjustment. In more rigorous analysis, premium would be compounded at deposit rate to compare at same maturity date.

(iii) INR Receipt Under Put Option at Various Spot Levels

Formula:

If Spot at maturity < Strike (₹91): EXERCISE PUT → INR = EUR × Strike − Premium

If Spot at maturity ≥ Strike (₹91): DON'T EXERCISE → INR = EUR × Spot − Premium

Scenario 1: Spot = ₹85 at maturity

Spot (85) < Strike (91) → EXERCISE PUT

INR Receipt = 20M × ₹91 − ₹3 cr = ₹182 cr − ₹3 cr = ₹179 crore

Scenario 2: Spot = ₹89 at maturity

Spot (89) < Strike (91) → EXERCISE PUT

INR Receipt = 20M × ₹91 − ₹3 cr = ₹182 cr − ₹3 cr = ₹179 crore

Scenario 3: Spot = ₹91 at maturity

Spot (91) = Strike (91) → Indifferent (usually don't exercise if equal)

INR Receipt = 20M × ₹91 − ₹3 cr = ₹179 crore

Scenario 4: Spot = ₹93 at maturity

Spot (93) > Strike (91) → DON'T EXERCISE, sell in spot

INR Receipt = 20M × ₹93 − ₹3 cr = ₹186 cr − ₹3 cr = ₹183 crore

Scenario 5: Spot = ₹95 at maturity

Spot (95) > Strike (91) → DON'T EXERCISE, sell in spot

INR Receipt = 20M × ₹95 − ₹3 cr = ₹190 cr − ₹3 cr = ₹187 crore

(iv) Break-Even Spot

Set Option Receipt = Forward Receipt:

For Spot > Strike (no exercise): 20M × Spot − ₹3 cr = ₹182 cr

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Solving: 20M × Spot = ₹185 cr

Spot = ₹185 cr / 20M = ₹185,00,00,000 / 2,00,00,000

Break-Even Spot = ₹92.50 per EUR

Interpretation:

- Below ₹92.50 (including all cases where Put is exercised): FORWARD outperforms OPTION
- At exactly ₹92.50: Both give ₹182 crore (indifferent)
- Above ₹92.50: OPTION outperforms FORWARD (participates in EUR strength)

(v) Comparative Payoff Table

Spot at Maturity (₹/EUR)	Forward Receipt (₹ cr)	Put Option Receipt (₹ cr)	Difference (Option – Fwd)
85 (Deep ITM)	182.00	179.00	(3.00)
89 (ITM)	182.00	179.00	(3.00)
91 (At Strike)	182.00	179.00	(3.00)
92.50 (Break-Even)	182.00	182.00	0.00
93 (OTM)	182.00	183.00	+ 1.00
95 (Deep OTM)	182.00	187.00	+ 5.00

(vi) Recommendation to Neha Deshpande

Analysis Depending on Market View:

(i) BEARISH on EUR (expect EUR to WEAKEN below ₹91): Forward is superior. Sun Pharma locks in ₹91 vs option's floor of ₹89.50 (₹91 strike − ₹1.50 premium equivalent).

(ii) NEUTRAL/UNCERTAIN: Forward is safer — provides certainty without premium cost. Option's break-even of ₹92.50 requires meaningful EUR strength to justify the premium.

(iii) BULLISH on EUR (expect EUR to STRENGTHEN above ₹92.50): Option is superior. Captures upside beyond break-even while providing downside floor.

(iv) STRONGLY BULLISH (expect EUR above ₹95): Option significantly outperforms — every ₹1 above break-even adds ₹20 lakh to Sun Pharma's INR receipt.

Suggested Approach: SPLIT HEDGE (Portfolio Approach)

Hedge 50% via Forward + 50% via Put Option:

- Forward portion: locks in EUR 10M × ₹91 = ₹91 crore (certain)
- Option portion: EUR 10M with Put at ₹91, premium ₹1.5 cr
- Total premium: ₹1.5 cr (half of full option hedge)
- Result: Downside floor at (₹91 + ₹89.50)/2 = ₹90.25 blended; upside participation on half the exposure

For Sun Pharma's specific context (large recurring EUR receivables from generics business):

A ROLLING FORWARD strategy (bookings staggered over multiple months) combined with SELECTIVE OPTION overlays for larger exposures is common practice at pharma majors' treasuries. Given Sun Pharma's meaningful natural EUR receipts, tactical use of options during periods of high volatility (e.g., ECB policy meetings, Indian election results, US Fed pivots) is recommended.

Question 5 — Multilateral Netting & Leading/Lagging — Wipro Group Treasury Optimization

Case Study — Wipro Group (Global IT MNC with 4 Regional Subsidiaries)

Aparna Iyer, Group CFO of Wipro Limited, is reviewing the Q3 FY27 intercompany settlement cycle. Wipro's global operations involve significant cross-entity flows arising from: (a) offshore development services rendered from India

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to US/UK/Germany client-facing subsidiaries, (b) royalty and IP license fees within the group, (c) shared services (HR, procurement, technology) cross-charged among entities, (d) client billing collected by regional subsidiaries and remitted to India.

Aparna is evaluating whether to move from the current BILATERAL settlement model (each pair settles separately) to a MULTILATERAL NETTING model routed through Wipro India's Bengaluru HQ treasury.

Intercompany Positions for Q3 FY27 Settlement (all due 30-Sep-2026):

Payer	Payee	Amount	Nature
Wipro India	Wipro USA	USD 250 million	US client billing collected by US, offshore delivery cost
Wipro USA	Wipro India	USD 300 million	Client billing collected by US, remitted to India
Wipro India	Wipro UK	GBP 80 million	UK technology license fee
Wipro UK	Wipro India	GBP 120 million	UK client billing remitted to India
Wipro India	Wipro Germany	EUR 60 million	German ERP platform license
Wipro Germany	Wipro India	EUR 100 million	German client billing remitted to India
Wipro USA	Wipro UK	GBP 40 million	Cross-border project handover
Wipro UK	Wipro Germany	EUR 30 million	Shared services charge

External Payment (Not Intercompany):

Payer	Payee	Amount	Nature
Wipro India	HSBC London	USD 50 million	Quarterly ECB interest payment

Market Data (15-Jul-2026):

Currency Pair	Spot Rate	3-Month Forward	3-M Interest Rate (annualized)
INR/USD	₹83.50	₹84.00	INR: 7.5% USD: 5.0%
INR/GBP	₹105.00	₹105.80	INR: 7.5% GBP: 4.5%
INR/EUR	₹91.00	₹91.50	INR: 7.5% EUR: 3.5%

Bank Forward Margin: 20 basis points on notional hedged

Required:

(i) Compute BILATERAL NET positions for each pair. Identify the direction and amount of each net flow.

(ii) Compute total HEDGING NOTIONAL under BILATERAL settlement (each entity hedges its own net flow); express in ₹ crore.

(iii) Compute the MULTILATERAL NETTING outcome through Wipro India's Bengaluru HQ. Identify which flows can be netted internally including the external HSBC payment.

(iv) Compute total HEDGING NOTIONAL under MULTILATERAL settlement.

(v) Quantify the SAVING from multilateral vs bilateral: (a) hedged notional reduction, (b) cost saving per quarter at 20 bps, (c) annualized saving.

(vi) Assess LEADING/LAGGING opportunities given interest rate differentials. Comment on practical constraints.

(vii) Recommend the final treasury strategy to Aparna Iyer.

Solution

(i) Bilateral Net Positions

Pair	Gross Payables (M)	Gross Receivables (M)	Net Position
India ↔ USA (USD)	India → USA: 250	USA → India: 300	USA owes India USD 50M
India ↔ UK (GBP)	India → UK: 80	UK → India: 120	UK owes India GBP 40M

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Pair	Gross Payables (M)	Gross Receivables (M)	Net Position
India ↔ Germany (EUR)	India → Germany: 60	Germany → India: 100	Germany owes India EUR 40M
USA ↔ UK (GBP)	USA → UK: 40	None	USA owes UK GBP 40M
UK ↔ Germany (EUR)	UK → Germany: 30	None	UK owes Germany EUR 30M
India → HSBC (external, USD)	India → HSBC: 50	None	India pays USD 50M

(ii) Hedging Notional Under BILATERAL Settlement

Each entity hedges its own net flow separately. INR-equivalent computed at SPOT rates.

Entity	Hedge Action	Amount	INR (₹ cr)
Wipro India	Sell USD forward (receive from USA)	USD 50M × ₹83.50	417.50
Wipro India	Sell GBP forward (receive from UK)	GBP 40M × ₹105.00	420.00
Wipro India	Sell EUR forward (receive from Germany)	EUR 40M × ₹91.00	364.00
Wipro India	**Buy USD forward (pay HSBC external)**	**USD 50M × ₹83.50**	**417.50**
Sub-total India			**1,619.00**
Wipro USA	Buy GBP forward (pay UK)	GBP 40M × ₹105.00	420.00
Wipro UK	**Buy EUR forward (pay Germany)**	**EUR 30M × ₹91.00**	**273.00**
TOTAL BILATERAL HEDGING NOTIONAL			**₹ 2,312.00 crore**

Bilateral Bank Cost @ 20 bps:

Cost = ₹2,312 crore × 0.20% = ₹4.624 crore per quarter

(iii) Multilateral Netting Through Wipro India Bengaluru HQ

Key Insight — India's USD Position Fully Nets Out:

India's USD Cash Flows	USD Million
Intercompany receipt from Wipro USA (net)	+ 50
External payment to HSBC (ECB interest)	− 50
Net USD Position	**0 (FULLY NETTED)**

Mechanism:

Under multilateral netting through the Bengaluru HQ treasury, Wipro USA remits its USD 50M net owed amount to Wipro India's USD Nostro account. That same USD 50M is used DIRECTLY to fund the quarterly HSBC ECB interest payment on the SAME settlement date. NO FX conversion required — the USD receipt covers the USD payment without touching INR.

Result: Wipro India eliminates BOTH USD hedges (Sell USD 50M + Buy USD 50M).

Other Currency Flows (Unchanged):

- GBP: India receives GBP 40M net from UK — still needs to convert to INR (sell GBP forward)
- EUR: India receives EUR 40M net from Germany — still needs to convert to INR (sell EUR forward)
- USA still needs to buy GBP 40M for UK payment (USA is USD-based)
- UK still needs to buy EUR 30M for Germany payment (UK is GBP-based)

(iv) Hedging Notional Under MULTILATERAL Settlement

Entity	Hedge Action	Amount	INR (₹ cr)
Wipro India	Sell GBP forward	GBP 40M × ₹105.00	420.00
Wipro India	Sell EUR forward	EUR 40M × ₹91.00	364.00
	USD flows FULLY NETTED (no hedge)	**—**	**0.00**
Sub-total India			**784.00**

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Entity	Hedge Action	Amount	INR (₹ cr)
Wipro USA	Buy GBP forward	GBP 40M × ₹105.00	420.00
Wipro UK	**Buy EUR forward**	**EUR 30M × ₹91.00**	**273.00**
TOTAL MULTILATERAL HEDGING NOTIONAL			**₹ 1,477.00 crore**

Multilateral Bank Cost @ 20 bps:

Cost = ₹1,477 crore × 0.20% = ₹2.954 crore per quarter

(v) Quantified Saving from Multilateral vs Bilateral

Metric	Bilateral	Multilateral	Saving
Total Hedging Notional (₹ crore)	2,312.00	1,477.00	835.00 (36.1% reduction)
Bank Cost @ 20 bps per Quarter (₹ crore)	4.624	2.954	1.670
Annualized Saving (4 quarters)	**18.496**	**11.816**	**6.680 crore**

Interpretation:

Multilateral netting through Wipro India HQ reduces hedged notional by ₹835 crore per quarter (36.1%) and delivers annual bank fee saving of ₹6.68 crore. Additional benefits (not quantified in the fee saving): reduced number of forward contracts (from 6 to 4), simpler audit trail, lower operational risk, better counterparty concentration management.

(vi) Leading/Lagging Assessment

Interest Rate Differentials:

Currency	3-M Rate (annualized)	Differential vs INR
INR	7.50%	—
USD	5.00%	INR earns 2.50% p.a. more
GBP	4.50%	INR earns 3.00% p.a. more
EUR	3.50%	INR earns 4.00% p.a. more

Directional Framework for Wipro India (INR-based treasury):

- LAG foreign payables — Delay paying USD/GBP/EUR; invest surplus INR at 7.5%
- LEAD foreign receivables — Accelerate receiving USD/GBP/EUR; convert to INR sooner to earn INR carry

Theoretical Neutrality Under IRP:

Under Interest Rate Parity, forward rates already price the differential. For instance, INR/USD 3-m forward of ₹84.00 vs spot ₹83.50 implies USD is priced to APPRECIATE 0.60% over 3 months (or 2.4% annualized) — approximately matching the interest differential. In efficient markets, leading/lagging generates ZERO expected value.

Where Leading/Lagging Adds Value in Practice:

(i) IRP DEVIATIONS: Actual forward may be mispriced relative to theoretical; capture the deviation

(ii) TRANSACTION COST SAVINGS: Reduces number of forward contracts and their bid-ask costs

(iii) WORKING CAPITAL OPTIMIZATION: Frees up cash at high-interest-rate entities (India), reduces cash at low-interest entities

(iv) CENTRALIZED FX VIEW: Group treasury can take directional views better than individual subsidiaries

(v) CASH POOLING BENEFITS: Aggregating cash at HQ enables notional pooling and better bank negotiations

Practical Constraints:

- RBI FEMA permits payment terms up to 12 months for exports (recently extended); imports typically 12 months for merchant / 3 years for capital goods
- Intercompany settlement terms must be arm's-length and documented for TP compliance
- US and EU regulators (IRS, HMRC, BaFin) also scrutinize intercompany terms

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- Excessive leading/lagging can trigger regulatory scrutiny and challenge to arm's-length pricing

(vii) Recommendation to Aparna Iyer

Recommendation: IMPLEMENT Multilateral Netting Immediately + Selective Leading/Lagging

Implementation Roadmap:

(i) PHASE 1 (Q3 FY27 — Immediate): Set up Multilateral Netting through Bengaluru HQ treasury. Standardize intercompany settlement date (30-Sep-2026 for Q3). Deliver ₹1.67 crore quarterly saving = ₹6.68 crore annualized.

(ii) PHASE 2 (Q4 FY27): Formalize In-House Bank structure at Bengaluru HQ. Route all intercompany USD/GBP/EUR flows through central treasury Nostro accounts (HDFC Bank India for USD, HSBC for GBP, Deutsche Bank for EUR).

(iii) PHASE 3 (FY28): Establish GIFT City IFSC entity for enhanced treasury operations (permitted under IFSCA regulations); potentially convert to a full-fledged Group Treasury Centre.

(iv) PHASE 4 (FY29): Extend netting to include client-facing subsidiaries (Wipro Digital, Rizing, Capco) and consolidate global cash pooling.

Governance:

(i) Board approval for netting policy and central treasury delegation of authority

(ii) Documented Netting Agreement with each subsidiary — arm's-length pricing, transfer pricing compliance

(iii) Ind AS 32/109 accounting treatment — offset presentation of assets and liabilities per netting agreement

(iv) Statutory audit sign-off on netting arrangements (Deloitte / KPMG typical for Wipro-scale)

(v) Monthly reporting to Audit Committee on net FX exposures and hedging effectiveness

Additional Value Levers Beyond Netting:

- Cash pooling — physical or notional — aggregating group INR/USD/EUR at HQ
- Group insurance policies (marine cargo, cyber, D&O) with combined premiums
- Consolidated debt facilities — negotiate group-level revolvers with larger commitments
- Shared treasury systems (Kyriba, SAP Treasury, FIS Quantum) — enables real-time visibility

Question 6 — Triangular Arbitrage with Bid-Ask — Nuvama Wealth Proprietary Trading

Case Study — Nuvama Wealth (Formerly Edelweiss) Proprietary Trading Desk

Vinit Bhoot, Chief Dealer at Nuvama Wealth's proprietary currency trading desk in Mumbai, is monitoring live rates across three markets on 15-July-2026. He notices a potential triangular arbitrage opportunity across INR-USD-EUR crosses and must evaluate whether the deviation is exploitable after transaction costs.

Live Rates (15-Jul-2026, 11:30 AM IST):

Currency Pair	Market Centre	Bid	Ask
USD/INR	Mumbai Interbank	₹83.20	₹83.30
EUR/USD	Frankfurt Interbank	1.0850	1.0870
EUR/INR	Mumbai Interbank	₹91.20	₹91.40

Available Capital for Arbitrage: ₹100 crore

Required:

(i) Compute the IMPLIED EUR/INR cross rate (bid and ask) using the USD as vehicle currency.

(ii) Compare implied cross rate with the DIRECT EUR/INR quote. Identify whether triangular arbitrage exists.

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(iii) If arbitrage exists, DESIGN the execution sequence (INR → ? → ? → INR) and compute the PROFIT on ₹100 crore capital.

(iv) Verify that the REVERSE PATH does NOT yield profit (i.e., the arbitrage is direction-specific).

(v) Scale the profit to ₹1,000 crore capital (institutional block trade size) and compute annualized return assuming this trade is executed once per week.

(vi) Explain WHY such arbitrage opportunities are transient in real markets and what execution challenges Vinit's desk faces.

Solution

(i) Implied EUR/INR Cross Rate via USD

Formula: EUR/INR (implied) = USD/INR × EUR/USD

Implied Bid (cheapest way to obtain EUR from INR via USD):

= USD/INR (bid) × EUR/USD (bid) = 83.20 × 1.0850 = ₹90.2720

Implied Ask (most expensive way to obtain EUR from INR via USD):

= USD/INR (ask) × EUR/USD (ask) = 83.30 × 1.0870 = ₹90.5471

Fair Cross Rate EUR/INR: ₹90.27 / ₹90.55

(ii) Comparison and Arbitrage Identification

Quote Type	Bid	Ask
Direct EUR/INR (Mumbai)	₹91.20	₹91.40
Implied EUR/INR (via USD)	₹90.27	₹90.55

Critical Observation:

Direct BID (₹91.20) > Implied ASK (₹90.55) — the direct quote for EUR/INR is HIGHER than what would be obtained by going through USD.

Arbitrage Direction: Buy EUR INDIRECTLY (via USD, cheap) and Sell EUR DIRECTLY (at higher price in Mumbai).

(iii) Arbitrage Execution — Starting Capital ₹100 Crore

Sequence: INR → USD → EUR → INR

Step	Transaction	Rate Used	Result
1	Buy USD with INR	USD/INR ASK ₹83.30	INR 100 cr / 83.30 = USD 1,20,04,802
2	Buy EUR with USD	EUR/USD ASK 1.0870	USD 1,20,04,802 / 1.0870 = EUR 1,10,43,976
3	Sell EUR for INR	EUR/INR BID ₹91.20	EUR 1,10,43,976 × 91.20 = INR 1,00,72,10,612

Arbitrage Profit:

Ending INR: ₹1,00,72,10,612

Less: Starting INR: ₹1,00,00,00,000

PROFIT: ₹72,10,612 ≈ ₹72.10 lakh

Return: 72.10 basis points (0.721%) on invested capital, RISK-FREE

(iv) Reverse Path Verification (Confirms Direction)

Sequence: INR → EUR (direct) → USD → INR

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Step	Transaction	Rate Used	Result
1	Buy EUR directly with INR	EUR/INR ASK ₹91.40	INR 100 cr / 91.40 = EUR 1,09,40,919
2	Sell EUR for USD	EUR/USD BID 1.0850	EUR 1,09,40,919 × 1.0850 = USD 1,18,70,897
3	Sell USD for INR	USD/INR BID ₹83.20	USD 1,18,70,897 × 83.20 = INR 98,76,58,643

Reverse Path Result: INR 98.77 crore (LOSS of ₹1.23 crore)

This confirms that arbitrage is ONE-DIRECTIONAL — only the INR → USD → EUR → INR path yields profit.

(v) Institutional Scaling

Scaling to ₹1,000 Crore Capital:

Profit at ₹1,000 crore = ₹72.10 lakh × 10 = ₹7.21 crore per trade

Annualized Return (52 weekly trades assuming persistence):

Annual Profit = ₹7.21 cr × 52 = ₹374.92 crore (theoretically)

Annualized Return = 0.721% × 52 = 37.5% (theoretically)

Caveat: This annualization is HYPOTHETICAL — such opportunities do not persist for repeated weekly execution.

(vi) Why Arbitrage is Transient in Real Markets

(i) HIGH-FREQUENCY TRADERS (HFTs) with co-located servers in Mumbai (BSE/NSE data centre) and Frankfurt (Deutsche Börse) detect arbitrage in MICROSECONDS and execute within milliseconds. By the time a discretionary trader like Vinit spots the opportunity, it's already gone.

(ii) MARKET IMPACT: Even a ₹100 crore trade will move the direct EUR/INR bid DOWN (as arbitrageurs sell EUR) and the implied cross UP (as they buy USD then EUR). The very act of arbitrage extinguishes the opportunity.

(iii) TRANSACTION COSTS: Real dealing includes brokerage (₹0.5-1 paisa per USD), settlement charges, and margin funding costs. On a 72 bps gross profit, ~30-40 bps may be eaten by all-in costs, leaving 30-40 bps net.

(iv) REGULATORY LATENCY: Cross-border settlement (SWIFT wires) takes T+1 to T+2 days for EUR and USD. During this settlement lag, FX moves can WIPE OUT the arbitrage profit.

(v) COUNTERPARTY LIMITS: Nuvama's counterparty lines with EACH bank are finite — cannot execute unlimited size without hitting limits.

(vi) REGULATORY REPORTING: Every large FX deal must be reported to RBI (FEMA compliance), which introduces operational friction.

(vii) OPPORTUNITY WINDOW: Real-world arbitrage windows in liquid FX pairs (USDINR, EURUSD) last 50-500 milliseconds. Only HFT firms (Optiver, Jane Street, Jump Trading — all active in India via NSE Colo) can capture these systematically.

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Question 7 — Currency Futures + Basis Risk + Rollover — HCL Technologies NSE Hedge

Case Study — HCL Technologies USD Receivable Hedge via NSE Futures

Ashish Adukia, Treasurer of HCL Technologies Limited, has a USD 30 million receivable from a US-based BFSI client (Fiserv Inc.) in 3 months, arising from an IT infrastructure managed services contract. He is evaluating whether to hedge via NSE-traded USDINR futures or via OTC forward with a bank.

Market Data (15-Jul-2026):

Parameter	Value
Spot USDINR	₹83.50

Parameter	Value
NSE USDINR Future (Sep-26 expiry, 3-m)	₹84.00
Contract Lot Size	USD 1,000
Initial Margin (SPAN + Exposure)	3% of contract value
OTC 3-m Forward from HDFC Bank	₹84.05
USD Amount to Hedge	USD 30,000,000

Required:

(i) Compute the HEDGE RATIO (number of futures contracts required) and total notional in ₹ crore.

(ii) Compute the INITIAL MARGIN required.

(iii) Compute the TOTAL INR REALIZATION under the futures hedge at expiry spot levels of ₹82.00, ₹83.50, ₹84.00, ₹85.00, and ₹86.00. Show that the futures hedge locks in the future price of ₹84.00 (assuming zero basis at expiry).

(iv) Analyze BASIS RISK — if at expiry the futures settle at Spot + 5 paise (residual basis), compute the shortfall from the locked-in target.

(v) Compare the futures hedge outcome with the OTC forward at ₹84.05.

(vi) Provide RECOMMENDATION on futures vs OTC forward, considering execution efficiency, credit risk, and operational costs.

Solution

(i) Hedge Ratio and Notional

Number of Contracts:

N = USD Receivable / Lot Size = USD 30,000,000 / 1,000 = 30,000 contracts

Total Notional in INR:

Notional = 30,000 contracts × 1,000 USD × ₹84.00 = ₹2,52,00,00,000 = ₹252 crore

Hedge Direction:

HCL is a USD RECEIVER — will receive USD 30M in 3 months and needs to sell to INR. To hedge, HCL SELLS 30,000 USDINR futures at ₹84.00. Sold future gains value if USDINR falls (offsetting the loss on the USD receivable at lower spot).

(ii) Initial Margin

Margin = 3% × Notional = 3% × ₹252 crore = ₹7.56 crore

Additional Considerations:

- Daily MTM: If USDINR rises, HCL faces MTM loss on short futures → margin calls
- Adverse move of ₹1 → MTM loss of ₹3 crore (30M × 1) → margin call for ₹3 crore
- HCL must maintain liquidity buffer for margin calls (typically 25-50% of initial margin)

(iii) Total INR Realization at Expiry (Zero Basis Assumption)

Spot @ Expiry (₹)	Fut Settlement (₹)	Futures P&L (₹ cr)	Spot Convert (₹ cr)	Total INR (₹ cr)
82.00	82.00	(84.00-82.00)×30M = +6.00	30M×82.00 = 246.00	252.00
83.50	83.50	(84.00-83.50)×30M = +1.50	30M×83.50 = 250.50	252.00
84.00	84.00	0.00	30M×84.00 = 252.00	252.00
85.00	85.00	(84.00-85.00)×30M = -3.00	30M×85.00 = 255.00	252.00
86.00	86.00	(84.00-86.00)×30M = -6.00	30M×86.00 = 258.00	252.00

Key Insight:

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Total INR realization is CONSTANT at ₹252 crore regardless of spot movement — the futures hedge PERFECTLY LOCKS IN the initial future price of ₹84.00 per USD (assuming zero basis at expiry).

(iv) Basis Risk Analysis

Scenario: Spot at Expiry ₹82.00, Futures settle at ₹82.05 (5 paise basis)

Component	Computation	Value (₹ cr)
Futures P&L	(84.00 - 82.05) × 30M	+ 5.85
Spot Conversion	82.00 × 30M	246.00
Total INR (With Basis)		**251.85**
Target INR (Locked-in)		**252.00**
Basis Loss		**₹0.15 cr = ₹15 lakh**

Interpretation:

Basis risk causes a small shortfall (₹15 lakh on ₹252 crore = 6 bps). In liquid contracts near expiry, basis typically converges to within 1-2 paise, making the residual basis risk very small. For long-tenor rollover hedges, cumulative basis risk from multiple rolls can add up more materially.

(v) Comparison with OTC Forward

Metric	NSE Currency Futures	OTC Forward (HDFC Bank)
Locked-in Rate	₹84.00 (zero basis)	₹84.05
Total INR at Maturity	₹252.00 cr	₹252.15 cr
Difference	-	+ ₹0.15 cr (Forward higher)
Margin/Collateral	₹7.56 cr initial + daily MTM	Nil (bank line)
Credit Risk	None (CCP cleared via NSE Clearing)	HDFC Bank counterparty risk
Basis Risk	Small (~5 paise = ₹15 lakh)	Zero (contract customized)
Transparency	Full — public prices	Bilateral, opaque pricing
Flexibility	Standard sizes/dates only	Any size, any date
Operational Complexity	Higher (margin calls, MTM)	Lower (no daily settlement)

(vi) Recommendation to Ashish Adukia

Recommendation: Use OTC Forward with HDFC Bank

Rationale:

(i) OTC FORWARD DELIVERS ₹0.15 CR MORE (₹252.15 cr vs futures ₹252.00 cr) — a direct pickup that offsets the 5-paise futures basis risk.

(ii) NO MARGIN LOCK-UP: The ₹7.56 crore initial margin for futures ties up liquidity for 3 months. HCL can use these funds for other operations.

(iii) NO MTM CASH FLOW VOLATILITY: If USDINR rises before expiry, futures create MTM losses requiring margin top-ups. Forward has no interim cash flows.

(iv) OPERATIONAL SIMPLICITY: One-time bilateral trade vs continuous MTM management for futures.

(v) HDFC BANK IS A STRONG COUNTERPARTY: A+ credit rating; existing banking relationship with HCL.

(vi) IND AS 109 HEDGE ACCOUNTING: Simpler documentation for forward as cash flow hedge; futures also qualify but need more testing.

When NSE Futures ARE Preferred:

(i) Small amounts (< USD 1M) where banks may not quote competitively

(ii) Retail traders / SMEs with no bank relationship for OTC dealings

(iii) Speculation and directional views (futures more transparent price discovery)

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(iv) Positions requiring frequent adjustment (easier to close/re-establish on exchange)

(v) When counterparty risk is a concern (small exporters lacking bank credit lines)

Question 8 — Zero-Cost Collar (Range Forward) — Cipla USD Receivable

Case Study — Cipla Limited (USD Receivable from US Generics Distributor)

Kedar Upadhye, Global CFO of Cipla Limited, has a USD 40 million receivable in 6 months from Cipla USA Inc., arising from generic drug sales to US pharmacy chains. He is evaluating a zero-cost collar structure offered by Deutsche Bank India that provides downside protection while retaining some upside participation, without paying any upfront premium.

Kedar is comparing three hedging approaches: (a) plain-vanilla forward, (b) pure put option, and (c) zero-cost collar.

Market Data (15-Jul-2026):

Parameter	Value
Spot USDINR	₹83.50
6-month Forward USDINR	₹84.00
Put Option on USD (Strike ₹82.50)	Premium ₹0.60 per USD
Call Option on USD (Strike ₹85.50)	Premium ₹0.60 per USD
USD Amount Receivable	USD 40,000,000
Time to Receipt	6 months (30-Jan-2027)

Note: The Put Premium (₹0.60/USD) EQUALS the Call Premium (₹0.60/USD), enabling a Zero-Cost Collar.

Required:

(i) Compute the TOTAL PREMIUM COST of the Zero-Cost Collar (should be ₹0).

(ii) Compute the INR RECEIPT under the Zero-Cost Collar at spot levels ₹78, ₹80, ₹82.50, ₹83.50, ₹84.50, ₹85.50, ₹87, and ₹90 per USD.

(iii) Identify the FLOOR and CAP (in ₹ crore terms) of the Zero-Cost Collar.

(iv) Compare the Zero-Cost Collar with (a) plain forward hedge at ₹84.00, and (b) pure put option at ₹82.50 with ₹0.60 premium.

(v) Under what MARKET VIEW would the Zero-Cost Collar be preferred over the alternatives?

(vi) Provide a nuanced RECOMMENDATION to Kedar considering Cipla's risk appetite and multi-year FX exposure.

Solution

(i) Total Premium Cost of Zero-Cost Collar

Structure:

- BUY Put on USD at ₹82.50 strike, premium ₹0.60 per USD → Cipla PAYS ₹0.60 × 40M = ₹2.40 crore
- SELL Call on USD at ₹85.50 strike, premium ₹0.60 per USD → Cipla RECEIVES ₹0.60 × 40M = ₹2.40 crore

Net Premium = ₹2.40 cr (paid) − ₹2.40 cr (received) = ZERO

The Zero-Cost Collar is truly self-financing — no upfront cash flow required.

(ii) INR Receipt at Various Spot Levels

Logic:

- Below Floor (₹82.50): Cipla EXERCISES Put — sells at ₹82.50
- Between Floor and Cap (₹82.50 - ₹85.50): Neither option exercised — sells at Spot
- Above Cap (₹85.50): Buyer of Call (Deutsche Bank) EXERCISES against Cipla — Cipla MUST sell at ₹85.50

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Spot @ Maturity (₹)	Put Exercised?	Call Exercised?	Effective Rate (₹)	INR Receipt (₹ cr)
78.00	YES (deep ITM)	NO	82.50 (Floor)	330.00
80.00	YES (ITM)	NO	82.50 (Floor)	330.00
82.50	At Strike (no effect)	NO	82.50	330.00
83.50	NO	NO	83.50 (Spot)	334.00
84.50	NO	NO	84.50 (Spot)	338.00
85.50	NO	At Strike (no effect)	85.50 (Cap)	342.00
87.00	NO	YES (Cipla obligated)	85.50 (Cap)	342.00
90.00	NO	YES (deep ITM for buyer)	85.50 (Cap)	342.00

Payoff Pattern:

- FLOOR: ₹82.50 → INR ₹330.00 crore (guaranteed minimum)
- PARTICIPATION RANGE: ₹82.50 to ₹85.50 → INR ₹330 to ₹342 crore (moves with spot)
- CAP: ₹85.50 → INR ₹342.00 crore (maximum realizable, even if spot spikes to ₹90+)

(iii) Floor and Cap Analysis

Boundary	Effective Rate	INR Value (₹ crore)
FLOOR (Put Strike)	₹82.50	₹330.00
CAP (Call Strike)	₹85.50	₹342.00
Range Width	**₹3.00 per USD**	**₹12 crore**

Cipla's Effective Realization Range: ₹330 crore to ₹342 crore

(iv) Comparison with Alternatives

Spot @ Maturity (₹)	Forward @ ₹84 (₹ cr)	Pure Put @ ₹82.50 (₹ cr)	Zero-Cost Collar (₹ cr)
78.00	336.00	82.50×40M − 2.40 = 327.60	330.00
82.00	336.00	82.50×40M − 2.40 = 327.60	330.00
83.50	336.00	83.50×40M − 2.40 = 331.60	334.00
84.00 (Forward)	336.00	84.00×40M − 2.40 = 333.60	336.00
85.50 (Collar Cap)	336.00	85.50×40M − 2.40 = 339.60	342.00
87.00	336.00	87.00×40M − 2.40 = 345.60	342.00
90.00	336.00	90.00×40M − 2.40 = 357.60	342.00

Key Observations:

- BELOW ₹82.50: Forward wins (₹336 cr > Collar ₹330 cr > Put ₹327.60 cr)
- ₹82.50 to ₹84.00: Collar > Put, both < Forward
- ₹84.00 to ₹85.50: Collar > Forward > Put (in this range)
- ₹85.50 to ~₹87.00: Collar ≥ Forward but Put now overtakes
- ABOVE ₹87: Put wins (unlimited upside vs Collar cap at ₹342 cr and Forward at ₹336 cr)

(v) Market View for Zero-Cost Collar Preference

Zero-Cost Collar is optimal when:

(i) USD is expected to trade WITHIN the range ₹82.50 to ₹85.50 (participate in spot moves within range)

(ii) Downside protection is essential (₹82.50 floor) but upside beyond ₹85.50 is considered UNLIKELY

(iii) No upfront premium can be paid (budget constraint or accounting preference)

(iv) Cipla is INDIFFERENT about missing extreme upside (₹87+) — willing to give up in exchange for zero cost

Zero-Cost Collar is SUB-OPTIMAL when:

(i) Strong view that USD will BREAK OUT above ₹85.50 (pure put or unhedged better)

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(ii) Strong view that USD will crash below ₹82.50 (forward locks in ₹84 — better than collar's ₹82.50 floor)

(iii) Cipla's cash flow certainty is critical (forward provides absolute certainty)

(iv) USD/INR volatility is expected to be VERY HIGH (option premiums may be mispriced)

(vi) Recommendation to Kedar Upadhye

Recommendation: PROCEED with Zero-Cost Collar for 50% + Forward for 50%

Rationale:

(i) MODERATE VIEW: Cipla's own USDINR forecast for Jan-27 is around ₹84.50-85.00 (RBI intervention band, no major shocks expected). Collar's participation range (₹82.50-85.50) fits well.

(ii) SPLIT HEDGE REDUCES REGRET RISK: If USDINR breaks above ₹85.50 (say Fed pauses aggressively), Cipla still captures upside on the 50% forward-hedged portion beyond ₹84 up to some extent.

(iii) PROTECTION AT REASONABLE FLOOR: ₹82.50 floor is only ₹1.00 below spot ₹83.50 (12 paise below the 6-m forward). Acceptable downside for zero cost.

(iv) NO CASH FLOW IMPACT: No upfront premium preserves working capital.

(v) ACCOUNTING TREATMENT: Under Ind AS 109, the collar can be designated as a cash flow hedge with hedge accounting; documentation is well-established for standard collars.

(vi) COUNTERPARTY QUALITY: Deutsche Bank India (subsidiary of Deutsche Bank AG, A- rated) with ISDA framework — strong counterparty.

Specific Structure Recommendation:

- USD 20M via Zero-Cost Collar (Floor ₹82.50, Cap ₹85.50) → INR ₹165 crore to ₹171 crore
- USD 20M via Forward at ₹84 → INR ₹168 crore (certain)
- Combined outcome: INR ₹333 to ₹339 crore (narrow range)

Governance:

- Treasury Committee approval for both structures (single-transaction threshold at Cipla is typically ₹250 crore)
- Board notification of collar structure (option-based hedges require Board-level awareness)
- Ind AS 109 hedge accounting designation and effectiveness testing quarterly
- Reuters/Bloomberg competitive quoting from at least 3 banks (Deutsche, HDFC, HSBC) before execution

Question 9 — Translation Exposure Hedging — Sun Pharma / Taro Pharmaceuticals (Ind AS 21)

Case Study — Sun Pharmaceutical Industries Ltd (Taro Pharmaceuticals Translation Exposure)

Sudhir Valia, Executive Director and Whole-time Director of Sun Pharma, is reviewing the FY27 consolidated financial statements planning cycle. Sun Pharma's US subsidiary, Taro Pharmaceuticals Industries Ltd. (acquired in stages between 2010-2019, current ownership 78.5%), reports in USD. Its net investment (equity value) as attributable to Sun Pharma is USD 500 million. With USDINR having depreciated from ₹45 at Taro's original acquisition (2010) to ₹83.50 currently, and analyst forecasts pointing to further depreciation to ₹85 over the next year, Sudhir must decide how to hedge the translation exposure.

Balance Sheet Position (30-Jun-2026):

Parameter	Value
Net Investment in Taro (attributable to Sun Pharma)	USD 500 million
Historical Rate at Original Acquisition (2010)	₹45.00 / USD
Current Rate (30-Jun-2026)	₹83.50 / USD
Expected Rate at 30-Jun-2027 (analyst consensus)	₹85.00 / USD
Cumulative FCTR since acquisition (in OCI)	To be computed

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Parameter	Value
This period expected translation change	To be computed

Hedging Alternatives Being Evaluated:

- Alternative A: BALANCE SHEET HEDGE — Borrow USD 500M against Sun Pharma's INR assets, use proceeds for other purposes
- Alternative B: NET INVESTMENT HEDGE via FORWARD — Sell USD 500M forward at IRP-implied rate
- Alternative C: NO HEDGE — Accept translation risk

Market Data:

Parameter	Value
INR interest rate (1-year)	7.50%
USD interest rate (1-year)	5.00%
Spot USDINR	₹83.50
1-year Forward USDINR (IRP-implied)	₹85.49

Required:

(i) Compute the NET INVESTMENT VALUE in INR under (a) Historical rate ₹45, (b) Current rate ₹83.50, (c) Expected future rate ₹85. Identify the CUMULATIVE FCTR and THIS PERIOD translation change.

(ii) Under ALTERNATIVE A (Balance Sheet Hedge): Compute the offset if Sun Pharma borrows USD 500M. Show that translation gain on investment is EXACTLY offset by translation loss on USD loan.

(iii) Under ALTERNATIVE B (Forward Hedge): Compute the hedge P&L and combined effect. Explain why it does NOT provide a perfect hedge.

(iv) Under ALTERNATIVE C (No Hedge): Compute the projected FCTR impact and comment on P&L, ratios, and covenant implications.

(v) Provide a RECOMMENDATION to Sudhir Valia considering Ind AS 21 treatment, hedge accounting, and corporate risk appetite.

Solution

(i) Net Investment Value in INR at Different Rates

FX Rate Basis	Rate (₹/USD)	USD 500M × Rate	INR Value (₹ crore)
Historical (Acquisition 2010)	₹45.00	500 × 45 = 22,500 M	2,250
Current (30-Jun-2026)	₹83.50	500 × 83.50 = 41,750 M	4,175
Expected (30-Jun-2027)	₹85.00	500 × 85 = 42,500 M	4,250

Cumulative Translation Reserve (FCTR):

Cumulative FCTR = ₹4,175 crore (current) − ₹2,250 crore (historical) = ₹1,925 crore CREDIT in OCI

This Period Expected Translation Change (FY27):

Translation Gain = ₹4,250 crore (expected) − ₹4,175 crore (current) = ₹75 crore GAIN (to OCI)

Interpretation:

Since 2010, USDINR depreciation from ₹45 to ₹83.50 has ADDED ₹1,925 crore to Sun Pharma's consolidated equity through the Foreign Currency Translation Reserve. This is UNREALIZED gain (in OCI, not P&L). The projected further depreciation to ₹85 will add ANOTHER ₹75 crore in FY27.

(ii) Alternative A — Balance Sheet Hedge

Structure:

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- Sun Pharma borrows USD 500M against INR balance sheet strength (e.g., External Commercial Borrowing from HSBC London)
- USD 500M loan translated to INR at closing rate
- Loan proceeds can be used to: (a) fund Taro's working capital, (b) redeem existing INR debt, (c) fund India capex — economic use is separate from hedging purpose

Translation Effect at Different Rates:

Date	Rate	Investment Value (₹ cr)	USD Loan Value (₹ cr)	Net
Current (30-Jun-26)	₹83.50	4,175	4,175 (liability)	0
Expected (30-Jun-27)	₹85.00	4,250	4,250 (liability)	0
Translation Change		**+ ₹75 cr GAIN**	**+ ₹75 cr LOSS**	**₹0 (PERFECT HEDGE)**

Result: PERFECT TRANSLATION HEDGE — the ₹75 crore translation GAIN on investment is exactly offset by ₹75 crore translation LOSS on the USD loan. Net impact on consolidated equity: ZERO.

Cost Considerations:

- USD borrowing rate (5%) vs INR investment rate (7.5%) → Interest differential CARRY of 2.5%
- If USD 500M borrowed and INR 4,175 crore deposited: Interest carry = 4,175 × 2.5% = ₹104 crore per year
- But: This carry is COMPENSATION for taking on FX risk on the loan principal. Under IRP, this carry is roughly = expected INR depreciation vs USD
- Under Ind AS 21, this interest cost/income flows to P&L (not OCI) — creates a P&L vs OCI mismatch

(iii) Alternative B — Forward Hedge on Net Investment

Structure: Sell USD 500M forward at 1-year IRP rate of ₹85.49

Cash Flow Analysis at Maturity (30-Jun-2027, Realized Spot ₹85):

Component	Computation	₹ crore
Translation Gain on Investment	(₹85 – ₹83.50) × 500M / 10	+ 75
Forward Sale P&L (sold at 85.49, covered at 85.00)	(₹85.49 – ₹85.00) × 500M / 10	+ 24.50
Combined Effect		**+ ₹99.50 crore**
Alternative — if Realized Spot at ₹87		
Translation Gain on Investment	(₹87 – ₹83.50) × 500M / 10	+ 175
Forward Sale P&L	**(₹85.49 – ₹87.00) × 500M / 10**	**– 75.50**
Combined Effect		**+ ₹99.50 crore**

Key Insight:

The forward hedge locks in a NET benefit of ₹99.50 crore regardless of realized spot — BUT this benefit is NOT zero (unlike the perfect balance sheet hedge). The forward at ₹85.49 (higher than current ₹83.50) already prices in expected INR depreciation. Sun Pharma essentially locks in the INR value at the forward rate.

Why It Doesn't Perfectly Hedge Translation:

- Forward rate (₹85.49) ≠ Current translation rate (₹83.50) — forward premium creates a residual
- If Sun Pharma wanted to lock in EXACTLY the current translation value (₹4,175 cr), they'd need a spot conversion — but that would liquidate the investment
- Under Ind AS 109, the effective portion of the forward hedge gain/loss goes to OCI (matching translation reserve), but any INEFFECTIVENESS goes to P&L

(iv) Alternative C — No Hedge

Projected Impact (Spot ₹85 at 30-Jun-2027):

- Investment value rises to ₹4,250 crore → ₹75 crore ADDED to FCTR (OCI)

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- Consolidated equity INCREASES by ₹75 crore
- P&L UNAFFECTED (translation doesn't hit P&L until subsidiary is disposed)
- Debt-to-equity ratio slightly IMPROVES due to higher equity
- Return on equity slightly DECLINES (larger equity denominator with same PAT)

Downside Scenario (Spot ₹80 at 30-Jun-2027):

- Investment value falls to ₹4,000 crore → ₹175 crore REDUCED from FCTR (OCI)
- Consolidated equity DECREASES by ₹175 crore
- May breach debt covenants if net worth-based (e.g., loan agreements require minimum ₹15,000 crore net worth)
- Rating agency scrutiny (CRISIL, ICRA) on volatile OCI
- Analyst commentary on "non-recurring FX impact"

(v) Recommendation to Sudhir Valia

Recommendation: CONDITIONAL — Use Balance Sheet Hedge PARTIALLY (USD 200-300M) + Accept Residual Translation

Rationale:

(i) SIZE CONSIDERATION: A full USD 500M balance sheet hedge requires taking on ₹4,175 crore of USD debt. This is 20-25% of Sun Pharma's existing debt book — a material balance sheet expansion.

(ii) PARTIAL HEDGE ACHIEVES 50% OFFSET: USD 250M loan offsets 50% of translation swings, keeping the FCTR volatility manageable while preserving flexibility.

(iii) USE PROCEEDS PRODUCTIVELY: The USD 250M loan can be deployed into US business expansion (Taro capex, US clinical trials for Sun's own molecules) — creating operational value beyond hedging.

(iv) INTEREST DIFFERENTIAL WORKING FOR YOU: USD 5% borrowing vs INR 7.5% carry earns ~2.5% p.a. positive spread if funds are held in INR deposits (₹250 × 5% USD interest = ₹12.5 cr USD cost; but INR deposit earns 7.5% × 250 = ~₹19 cr — net positive INR carry).

(v) NET INVESTMENT HEDGE ACCOUNTING: Under Ind AS 109, designate the USD 250M borrowing as a Net Investment Hedge — the FX translation of the loan will flow to OCI (matching translation of the investment), rather than P&L.

(vi) AVOID DERIVATIVE-BASED HEDGE: Forward hedges create P&L noise and require quarterly effectiveness testing — operationally expensive for a corporate finance team.

(vii) MAINTAIN OPTIONALITY: If USDINR view becomes stronger (e.g., BoP crisis), can incrementally increase the hedge to USD 400M-500M. Full hedge locked in today removes this optionality.

Governance and Process:

(i) Board approval for the ECB structure (US $250M requires RBI's Automatic Route approval)

(ii) ISDA Master Agreement and CSA (though this is a loan, related derivatives may follow)

(iii) Ind AS 109 hedge designation: file effectiveness testing documentation with statutory auditor (Deloitte for Sun Pharma)

(iv) Quarterly review by Audit Committee on hedge effectiveness

(v) Disclose the hedging strategy in Annual Report notes to Financial Statements (per SEBI LODR)

(vi) Coordinate with Investor Relations to communicate the strategy — analysts value clarity on FX management

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Question 10 — PPP + Fisher Effect + IRP Combined Parity — ICICI Prudential AMC Cross-Border Analysis

Case Study — ICICI Prudential AMC (Cross-Border Investment Analysis for Fund of Funds)

Sankaran Naren, CIO of ICICI Prudential Mutual Fund, is evaluating a proposed FUND OF FUNDS (FoF) structure that would invest INR corpus into US Treasury-backed money market funds. The fund would raise INR from Indian retail investors and route the money to US instruments. Naren needs to analyze all four international parity conditions to determine whether the strategy is expected to add value AFTER accounting for FX risk.

Market Data (15-Jul-2026):

Parameter	Value
Spot INR/USD	₹83.00
1-year Forward INR/USD (actual quoted)	₹85.00
INR Nominal 1-year Rate (G-Sec)	7.50%
USD Nominal 1-year Rate (US T-Bill)	5.00%
Expected Inflation India (RBI forecast)	5.50%
Expected Inflation USA (Fed dot plot)	2.50%
Investment Notional	USD 20 million (INR 166 crore)

Required:

(i) Compute the IRP-THEORETICAL forward rate. Compare with the ACTUAL forward and determine if IRP holds.

(ii) Compute the PPP-PREDICTED 1-year spot rate based on inflation differentials.

(iii) Compute the FISHER REAL RATES for both INR and USD. Comment on the International Fisher Effect.

(iv) Assess the CONSISTENCY between IRP, PPP, and IFE. Identify which parities hold and which are violated.

(v) For the proposed INR-to-USD money market FoF: Analyze both COVERED and UNCOVERED strategies. Compute expected returns net of FX.

(vi) Provide RECOMMENDATION to Sankaran Naren, considering risk-adjusted return, regulatory constraints, and investor suitability.

Solution

(i) IRP Theoretical Forward

Formula: F = S × (1 + r_INR) / (1 + r_USD)

F_IRP = ₹83.00 × (1 + 0.075) / (1 + 0.050)

= ₹83.00 × (1.075 / 1.050)

= ₹83.00 × 1.023810

= ₹84.98

Comparison:

Rate	Value (₹/USD)
IRP Theoretical Forward	84.98
Actual Forward	85.00
Deviation	**+ ₹0.02 (2 paise)**

Conclusion: IRP HOLDS (within transaction costs). No covered arbitrage available.

(ii) PPP-Predicted 1-Year Spot

Formula: E[S_1yr] = S_0 × (1 + π_INR) / (1 + π_USD)

E[S_1yr] = ₹83.00 × (1 + 0.055) / (1 + 0.025)

= ₹83.00 × (1.055 / 1.025)

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= ₹83.00 × 1.029268

= ₹85.43

Interpretation:

PPP predicts INR will depreciate to ₹85.43 per USD over 1 year, driven by 3% inflation differential (India 5.5% vs USA 2.5%). This is the LONG-TERM equilibrium rate implied by relative inflation.

(iii) Fisher Real Rates and IFE

Formula: (1 + Real Rate) = (1 + Nominal) / (1 + Inflation)

Real INR Rate:

Real INR = (1.075 / 1.055) − 1 = 1.01896 − 1 = 0.01896

= 1.90% p.a.

Real USD Rate:

Real USD = (1.050 / 1.025) − 1 = 1.02439 − 1 = 0.02439

= 2.44% p.a.

Comparison:

Currency	Nominal Rate	Expected Inflation	Real Rate (Fisher)
INR	7.50%	5.50%	1.90%
USD	5.00%	2.50%	2.44%
Differential (USD – INR)	**– 2.50%**	**– 3.00%**	**+ 0.54%**

International Fisher Effect (IFE) Assessment:

Under strict IFE, real rates should be EQUAL across currencies (capital flows would equalize them). Here, US real rate (2.44%) EXCEEDS Indian real rate (1.90%) by 54 bps. This suggests:

(i) IFE is VIOLATED — real rates differ by 54 bps

(ii) US offers higher REAL return than India (holding all else constant)

(iii) Capital should theoretically flow to USD (raising USD real rate, lowering INR real rate) — but capital controls, currency risk, and country premia prevent full equalization

(iv) This deviation MAY create arbitrage or return premium for US-invested capital (subject to FX risk)

(iv) Consistency Analysis Among Parities

Relationship	Prediction	Actual	Holds?
IRP: Forward vs Interest Diff	₹84.98	₹85.00	YES (2 paise deviation)
PPP: Expected Spot vs Inflation	₹85.43	TBD (realizes over 1 year)	TBD
PPP vs Forward Consistency	PPP ₹85.43 > Forward ₹85.00	Gap ₹0.43	MISALIGNED (43 paise)
IFE: Real Rate Equalization	Real rates equal	US 2.44%, INR 1.90%	VIOLATED (54 bps)

Interpretation:

(i) IRP HOLDS: This means the FORWARD MARKET is efficient — no covered arbitrage.

(ii) PPP-Forward MISMATCH: PPP predicts INR will depreciate MORE (to ₹85.43) than the forward implies (₹85.00). If PPP realizes, an uncovered USD-long position would GAIN 43 paise per USD.

(iii) IFE VIOLATED: US offers 54 bps HIGHER real rate. Under mobile capital, this would attract INR investors to USD assets — subject to FX risk.

(iv) COMBINED PICTURE: A DIRECTIONAL BET on INR depreciation (buying USD) has POSITIVE expected value under PPP realization, but ZERO expected value under IRP-based forward pricing.

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(v) Covered vs Uncovered Investment Strategies

Strategy A — COVERED Investment (Hedge FX via Forward):

- Buy USD 20M at spot ₹83 → Pay INR 20M × 83 = INR 166 crore
- Invest USD 20M at US T-Bill 5% for 1 year → USD 21M at maturity
- Sell USD 21M forward at ₹85 (locked today) → Receive INR 21M × 85 = INR 178.50 crore
- Return: (178.50 − 166) / 166 = 7.53% ≈ INR G-Sec rate (7.50%)

Result: Covered return ≈ Domestic rate → NO FREE LUNCH (as IRP holds)

Strategy B — UNCOVERED Investment (Accept FX Risk):

- Buy USD 20M at spot ₹83 → Pay INR 166 crore
- Invest at US T-Bill 5% → USD 21M at maturity
- Convert USD 21M at REALIZED spot in 1 year (unknown)

Scenario Analysis:

Realized Spot	INR Received	Return	Comment
₹80 (INR appreciates)	21M × 80 = 168 cr	1.20%	Loss vs domestic 7.5%
₹83 (no change)	21M × 83 = 174.3 cr	5.00%	Below domestic rate
₹85 (Forward realized)	21M × 85 = 178.5 cr	7.53%	Same as covered
₹85.43 (PPP realized)	21M × 85.43 = 179.4 cr	8.07%	+0.54% carry (matches real rate diff)
₹88 (INR depreciates fast)	21M × 88 = 184.8 cr	11.33%	+3.8% carry (best case)

(vi) Recommendation to Sankaran Naren

Recommendation: DECLINE the FoF Proposal as Structured — Consider Alternative

Rationale:

(i) COVERED STRATEGY = ZERO EXCESS RETURN: Since IRP holds, hedging FX eliminates any excess return over INR G-Sec (7.50%). Retail investors gain no benefit vs a domestic money market fund.

(ii) UNCOVERED STRATEGY = FX GAMBLE: Return depends entirely on realized USDINR. Expected value marginally positive (under PPP + real rate diff), but downside risk is significant if INR appreciates.

(iii) NOT SUITABLE FOR RETAIL: SEBI mandates suitability assessment for foreign investment funds. Retail investors typically lack ability to bear FX risk.

(iv) REGULATORY COST: SEBI's LRS (Liberalized Remittance Scheme) framework applies — daily NAV must reflect FX moves; additional compliance burden.

(v) OPPORTUNITY COST: Better alternatives exist — India equity funds (long-term higher returns), G-Sec funds (safe, 7.5% return matched), corporate bond funds (higher yield).

(vi) COUNTRY RISK: Also expose fund to US-specific risks (US recession, US rate cycle, US political risk) with no INR-diversification benefit for INR-based investors.

Alternative Strategies for Naren to Consider:

(i) DIVERSIFIED GLOBAL EQUITY FoF: Invest in developed market equities (S&P 500, MSCI World) — genuine diversification with equity risk premium, not just FX arbitrage

(ii) EMERGING MARKET DEBT FoF: Invest in higher-yielding EM sovereigns (Brazil, Indonesia) — better carry with FX diversification

(iii) HEDGED HIGH-YIELD USD CORPORATE FoF: Hedge FX to eliminate risk, but capture credit spread over T-Bills (500-800 bps typical) — this provides real excess return

(iv) ROUTE VIA GIFT CITY IFSC: Structure the fund in GIFT City IFSC to access tax and regulatory advantages for cross-border investments

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(v) CURRENCY-HEDGED USD BOND ETF: Direct exposure to US corporate bonds with FX hedge — more transparent than FoF, lower fees

Governance:

(i) Present analysis to Investment Committee with clear articulation of parity-based framework

(ii) SEBI product approval requires suitability assessment and disclosure of FX risks

(iii) IRDA/PFRDA approval if targeting insurance/pension flows

(iv) Fund documentation must explicitly cover parity conditions and expected FX behavior

(v) Investor education campaign — this is a sophisticated product requiring informed consent

Question 11 — REVERSE Working — Early Delivery of Forward Contract (FEDAI Rule)

Case Study — HDFC Bank Corporate Banking (Early Delivery Request from Reliance Industries)

Srikanth Venkatachari, Joint Chief Financial Officer of Reliance Industries Limited, had booked a 90-day forward SALE contract on 15-February-2026 with HDFC Bank Corporate Banking, Mumbai, to sell USD 5 million against an expected receivable from Chevron Corp. USA (crude oil refinery services). The contract due date was 15-May-2026.

On 15-April-2026 (30 days BEFORE the due date), Chevron unexpectedly wired the USD 5M ahead of schedule. Srikanth approached HDFC to make an EARLY DELIVERY under the forward contract.

HDFC Bank processed the early delivery and sent Reliance a debit advice showing SWAP CHARGES and INTEREST ON OUTLAY — but DID NOT DISCLOSE the underlying spot rate on the early delivery date or the original contract rate. Srikanth's treasury team wants to REVERSE-ENGINEER these rates from the given charges for verification and audit purposes.

Transaction Details (Original Booking):

Parameter	Value
Contract Type	Forward SALE (Reliance sells USD to HDFC)
Amount	USD 5,000,000
Booking Date	15-February-2026
Original Due Date	15-May-2026 (90-day forward)
Early Delivery Date	15-April-2026
Days Early (Residual Period)	30 days
Interest Rate Applied by HDFC	12% p.a.

Additional Market Data DISCLOSED by HDFC (Anchor):

Parameter	Value
Forward ASK Rate for Residual 30 Days (15-May-2026 delivery)	₹83.50

Debit Advice from HDFC Bank (Charges — CONTRACT RATE and SPOT RATE not disclosed):

Charge Component	Amount (₹)
Swap Charges	15,00,000
Interest on Outlay (30 days at 12% p.a.)	19,726
TOTAL CHARGES DEBITED TO RELIANCE	**₹ 15,19,726**

Required:

(i) Working BACKWARDS from the SWAP CHARGE and the given Forward ASK rate, derive the SPOT BID rate on the early delivery date (15-April-2026).

(ii) Working BACKWARDS from the INTEREST ON OUTLAY and the derived Spot Bid, derive the ORIGINAL CONTRACT RATE at which Reliance had booked the forward sale.

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(iii) PROVE that both charges are consistent with the derived rates.

(iv) Compute the NET AMOUNT credited to Reliance's account after all charges.

(v) Explain the ECONOMIC RATIONALE for each of the two charges — why does the bank recover them from the customer even though customer honoured the contract?

(vi) Comment on whether early delivery was ADVANTAGEOUS or DISADVANTAGEOUS for Reliance vs waiting till the due date.

Solution

(i) Reverse Working — Spot BID Rate on Early Delivery Date

Formula:

Swap Charge = (Forward ASK for Residual − Spot BID on Early Delivery Date) × Amount

Rearranging:

Spot BID = Forward ASK − (Swap Charge / Amount)

= ₹83.50 − (₹15,00,000 / 5,000,000)

= ₹83.50 − ₹0.30

= ₹83.20 per USD

Interpretation:

The spot bid on 15-April-2026 was ₹83.20 per USD. The bank did a swap: sold USD spot at ₹83.20 (bid) and bought back USD forward at ₹83.50 (ask) for delivery to interbank on 15-May-2026. Swap loss per USD = ₹0.30, passed to customer.

(ii) Reverse Working — Original Contract Rate

Key Concept — Interest on Outlay Basis:

The interest is computed on the bank's ACTUAL FUNDING DIFFERENTIAL during the early delivery period, NOT on the contract value. The differential is the amount by which the bank had to fund the customer's payment above what it could recover from spot sale.

Formula:

Interest on Outlay = Amount × Outlay per USD × Interest Rate × Days/365

Where Outlay per USD = Contract Rate − Spot BID on Early Delivery Date

Rearranging:

Outlay per USD = Interest on Outlay / (Amount × Rate × Days/365)

= ₹19,726 / (5,000,000 × 0.12 × 30/365)

= ₹19,726 / ₹49,315.07

= ₹0.40 per USD

Derived Contract Rate:

Contract Rate = Spot BID + Outlay per USD

= ₹83.20 + ₹0.40

= ₹83.60 per USD

Verification of Contract Rate:

On booking date (15-Feb-2026), 3-month forward BID rate that HDFC quoted to Reliance = ₹83.60. This includes market forward premium (USD trading at forward premium vs INR) plus HDFC's spread.

(iii) Proof of Consistency

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Charge	Formula	Computation	Amount (₹)
Swap Charge	(Fwd Ask − Spot Bid) × Amount	(83.50 − 83.20) × 5M = 0.30 × 5M	15,00,000 ✓
Interest on Outlay	Amount × Outlay × Rate × Days/365	5M × 0.40 × 12% × 30/365	19,726 ✓
TOTAL			**15,19,726 ✓**

Both charges reconcile precisely with the derived rates (Spot Bid ₹83.20, Contract Rate ₹83.60).

(iv) Net Amount Credited to Reliance

Item	Amount (₹)
Gross INR at Contract Rate (USD 5M × ₹83.60)	41,80,00,000
Less: Swap Charge	(15,00,000)
Less: Interest on Outlay	**(19,726)**
NET AMOUNT CREDITED TO RELIANCE	**41,64,80,274**
In ₹ crore	**₹ 41.6480 crore**

Effective Rate to Reliance:

₹41,64,80,274 / USD 5,000,000 = ₹83.2960 per USD

Difference vs Contract Rate: ₹83.60 − ₹83.2960 = ₹0.3040 per USD (cost of early delivery)

(v) Economic Rationale for Each Charge

Why Swap Charge (₹15 lakh):

HDFC had committed to DELIVER USD 5M to its interbank counterparty on 15-May-2026 at the interbank forward rate. With Reliance delivering early on 15-April, HDFC has USD 5M in hand a MONTH before it's needed. Rather than hold USD (foreign currency exposure risk), HDFC does a swap:

- Sells USD 5M spot on 15-April at Spot Bid ₹83.20 (receives INR ₹41.60 crore)
- Buys USD 5M forward for 15-May at Forward Ask ₹83.50 (agrees to pay INR ₹41.75 crore in 30 days)
- Swap cost per USD = 83.50 − 83.20 = ₹0.30 = ₹15 lakh, RECOVERED from Reliance

Without this recovery, HDFC would absorb the swap cost — hence the charge.

Why Interest on Outlay (₹19,726):

HDFC pays Reliance at Contract Rate ₹83.60 on 15-April (early). To recover this outflow, HDFC sells USD 5M spot at ₹83.20 (bid) — but this recovers only ₹83.20 per USD. HDFC funds the ₹0.40 per USD differential (₹20 lakh in aggregate) for 30 days until the interbank forward matures. Interest at 12% p.a. for 30 days on ₹20 lakh = ₹19,726, RECOVERED from Reliance.

Without this recovery, HDFC would absorb the funding cost — hence the charge.

(vi) Was Early Delivery Advantageous for Reliance?

Analysis:

Scenario	Effective Rate	INR Amount	Timing
Early Delivery (Actual)	₹83.2960	₹41.65 cr	15-Apr-26
Wait till Due Date @ Contract Rate	₹83.60	₹41.80 cr	15-May-26 (30 days later)

Loss in nominal terms: ₹41.80 cr − ₹41.65 cr = ₹15.20 lakh

However, consider TIME VALUE OF INR RECEIVED EARLIER:

- Reliance receives ₹41.65 crore on 15-April instead of ₹41.80 crore on 15-May
- Reliance can invest ₹41.65 crore at say 7% p.a. (T-Bill or overnight MF) for 30 days
- Interest earned = 41.65 cr × 7% × 30/365 = ₹23.96 lakh

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- Net benefit of early delivery = ₹23.96 lakh (interest earned) − ₹15.20 lakh (rate loss) = ₹8.76 lakh POSITIVE

Additional Considerations:

(i) OPERATIONAL: Early receipt simplifies accounting close (April vs May month-end); reduces open FX exposure

(ii) CREDIT RISK: Eliminates any counterparty risk on Chevron USD wire (already received)

(iii) USE OF FUNDS: If Reliance had a pressing INR need (working capital, tax payment, capex), early receipt is strictly better than delayed receipt at slightly higher rate

(iv) STRATEGIC: Sends signal to bank that Reliance uses forward market efficiently — supports relationship management

Verdict: Given the positive time-value arithmetic and operational benefits, EARLY DELIVERY WAS ADVANTAGEOUS for Reliance.

Question 12 — Merchant Bill Buying — Export Bill Discounting (Rate + Interest + Margin)

Case Study — ICICI Bank Corporate (Export Bill Discounting for Bharat Forge)

Kishore Saletore, CFO of Bharat Forge Limited, has received a 30-day usance export bill of USD 2 million from Ford Motor Co., USA, for a shipment of crankshafts to Ford's US assembly plant. Kishore wants to negotiate the bill with ICICI Bank Corporate Banking to receive INR immediately rather than waiting 30 days for USD collection.

Market Data (15-Jul-2026):

Parameter	Value
Spot USDINR (Interbank, Mumbai)	₹83.00 / ₹83.10 (Bid/Ask)
1-Month Forward Premium (annualized)	20 / 25 paise (Bid/Ask)
Bill Usance Period	30 days
ICICI Bank Exchange Margin (Bill Buying)	0.15%
Interest Rate on Bill (30 days)	10% p.a.
USD Amount of Bill	USD 2,000,000
FEDAI Rounding Convention	Nearest 0.0025 (rounded DOWN for buying rate)

Required:

(i) Compute the BASE RATE (before margin) — the interbank rate at which ICICI would purchase 30-day forward USD.

(ii) Apply the EXCHANGE MARGIN of 0.15% and compute the RATE BEFORE ROUNDING.

(iii) Apply FEDAI ROUNDING (nearest 0.0025, rounded down) to arrive at the final BILL BUYING RATE.

(iv) Compute the GROSS INR EQUIVALENT of the bill (before interest deduction).

(v) Compute the INTEREST DEDUCTION for the 30-day usance period.

(vi) Compute the NET AMOUNT CREDITED to Bharat Forge's account.

(vii) Comment on the effective ALL-IN COST to Bharat Forge of using this facility vs waiting 30 days for direct USD collection.

Solution

(i) Base Rate (Interbank Bill Buying Rate)

Logic:

ICICI Bank BUYS USD from Bharat Forge (customer sells USD via bill). For a 30-day forward-equivalent transaction, ICICI uses the SPOT BID plus the 1-month FORWARD PREMIUM BID.

Computation:

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Base Rate = Spot Bid + 1-month Forward Premium Bid

= ₹83.00 + ₹0.20

= ₹83.20

(ii) Rate After Exchange Margin

Logic:

ICICI applies a 0.15% margin — deducted from the base rate (since bank is buying, margin lowers the rate paid to customer).

Computation:

Margin Amount = Base Rate × 0.15% = ₹83.20 × 0.0015 = ₹0.1248

Rate After Margin = ₹83.20 − ₹0.1248 = ₹83.0752

(iii) Final Bill Buying Rate (After FEDAI Rounding)

Logic:

Round DOWN to nearest 0.0025 (FEDAI convention favours the bank when buying).

Computation:

₹83.0752 → nearest lower multiple of 0.0025 = ₹83.0750

Final Bill Buying Rate: ₹83.0750 per USD

(iv) Gross INR Equivalent of the Bill

Gross INR = USD 2,000,000 × ₹83.0750

= ₹16,61,50,000 = ₹1,661.50 lakh = ₹16.615 crore

(v) Interest Deduction

Logic:

ICICI advances INR today; USD collection happens in 30 days. Bank charges interest for this credit period at 10% p.a.

Computation:

Interest = Gross INR × Rate × (Days/365)

= ₹16,61,50,000 × 10% × (30/365)

= ₹16,61,50,000 × 0.00821918

= ₹13,65,616 = ₹13.66 lakh

(vi) Net Amount Credited to Bharat Forge

Computation:

Item	Amount (₹)
Gross INR at Bill Buying Rate (₹83.0750 × USD 2M)	16,61,50,000
Less: Interest Deduction (30 days @ 10%)	**(13,65,616)**
NET AMOUNT CREDITED TO BHARAT FORGE	**16,47,84,384**
Net Amount (₹ crore)	**₹ 16.4784 crore**

(vii) Effective All-In Cost Analysis

Comparison — Bill Discounting vs Wait for Collection:

Strategy	Immediate INR	INR at Day 30	Effective Rate
Discount Bill Today (Actual)	₹16.4784 crore	N/A (paid today)	₹82.39 per USD
Wait 30 days + Spot Convert at say ₹83.30 (Spot Ask)	0	₹16.66 crore	₹83.30 per USD

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Strategy	Immediate INR	INR at Day 30	Effective Rate
Wait 30 days + Forward Sale at ₹83.20 (Base Rate)	0	₹16.64 crore	₹83.20 per USD

Effective Rate on Bill Discount:

₹16,47,84,384 / USD 2,000,000 = ₹82.3922 per USD

Effective Cost of Facility:

Bharat Forge foregoes ₹0.81 per USD vs waiting and doing forward (₹83.20 − ₹82.39)

Total foregone = ₹0.81 × 2M = ₹16.20 lakh

This is the price of LIQUIDITY (getting INR today vs 30 days later).

When Bill Discounting Makes Sense:

(i) Bharat Forge has an IMMEDIATE INR need (working capital, tax payment, salary)

(ii) Bharat Forge's own cost of INR funding (bank overdraft) exceeds the effective bill discount cost

(iii) Uncertainty about Ford's payment timing (bill provides bank-backed guarantee of INR)

(iv) Bharat Forge wants to eliminate USD/INR risk immediately (though this is captured in forward too)

When Waiting is Better:

- Ample INR liquidity available at rates below 10%
- Ford's payment discipline is strong (low credit risk)
- Bank's overall discounting cost is prohibitive

Question 13 — Seagull Option — 3-Leg Structured Hedge (Wipro USD Receivable)

Case Study — Wipro Limited (USD 25M Receivable, 6 months)

Aparna Iyer, Group CFO of Wipro Limited, has a USD 25 million receivable from a US-based BFSI client in 6 months. She has been offered a Seagull structure by JPMorgan India as an alternative to plain vanilla forward or pure put option.

Market Data (15-Jul-2026):

Parameter	Value
Spot USDINR	₹83.50
6-month Forward USDINR	₹84.00
Buy Put — Strike K1	₹83.00; Premium ₹0.80/USD
Sell Put — Strike K2 (K2 < K1)	₹81.00; Premium ₹0.20/USD
Sell Call — Strike K3 (K3 > K1)	₹86.00; Premium ₹0.50/USD
USD Amount	USD 25,000,000

Required:

(i) Compute NET PREMIUM per USD and total net premium in INR.

(ii) Compute EFFECTIVE RATE and INR RECEIPT at spot levels ₹78, ₹80, ₹81, ₹82, ₹83, ₹84, ₹85, ₹86, ₹88, ₹90.

(iii) Identify the PROTECTION RANGE and points where protection breaks.

(iv) Compare with Plain Forward at ₹84.00 and Plain Put at ₹83.00 (premium ₹0.80).

(v) Recommend whether Aparna should accept the Seagull structure.

Solution

(i) Net Premium

Net Premium per USD = 0.80 (Buy Put) − 0.20 (Sell Put) − 0.50 (Sell Call) = ₹0.10 per USD

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Total Net Premium (paid by Wipro) = USD 25M × ₹0.10 = ₹25 lakh

(ii) Payoff Table (INR receipt net of premium)

Spot (₹)	Region	Effective Rate	INR Receipt (₹ cr)
78.00	Below K2 (protection lost)	Spot + 2 = 80.00	199.75
80.00	Below K2 (protection lost)	Spot + 2 = 82.00	204.75
81.00	At K2 (floor of protection)	83.00 (K1)	207.25
82.00	Between K2 and K1 (protected)	83.00 (K1)	207.25
83.00	At K1 (protection floor)	83.00	207.25
84.00	Between K1 and K3 (participation)	84.00 (Spot)	209.75
85.00	Between K1 and K3 (participation)	85.00 (Spot)	212.25
86.00	At K3 (cap begins)	86.00 (Cap)	214.75
88.00	Above K3 (capped)	86.00 (Cap)	214.75
90.00	Above K3 (capped)	86.00 (Cap)	214.75

Formula for Below K2 Region:

Long Put exercised at K1 = ₹83; Sold Put exercised against Wipro at K2 = ₹81 (Wipro must buy USD at ₹81)

Net: Sell at 83, Buy at 81, plus lose (K2 − Spot) on the sold put obligation → Effective = Spot + (K1 − K2) = Spot + 2

(iii) Protection Range

- FULL PROTECTION: ₹81.00 to ₹83.00 (effective rate locked at ₹83.00)
- PARTICIPATION RANGE: ₹83.00 to ₹86.00 (benefits from spot appreciation)
- CAP: ₹86.00 (all upside beyond capped)
- BREAK IN PROTECTION: Below ₹81.00 (Wipro exposed to further downside)

(iv) Comparison with Alternatives

Spot (₹)	Forward @ 84 (₹ cr)	Plain Put @ 83, prem 0.80 (₹ cr)	Seagull (₹ cr)
78.00	210.00	83×25 − 20 = 207.50 − 2.00 = 205.50	199.75
81.00	210.00	205.50	207.25
83.00	210.00	205.50	207.25
84.00	210.00	84×25 − 2 = 208.00	209.75
86.00	210.00	86×25 − 2 = 213.00 (215−2)	214.75
88.00	210.00	88×25 − 2 = 218.00	214.75
90.00	210.00	90×25 − 2 = 223.00	214.75

(v) Recommendation to Aparna

Recommendation: ACCEPT Seagull ONLY if strong view that spot will trade in ₹81-86 range

(i) Seagull provides ₹207.25 crore floor (with participation up to ₹214.75 crore) at just ₹25 lakh net premium — much cheaper than plain put (₹2 crore premium).

(ii) The MAJOR RISK is below ₹81 — Wipro exposed to further depreciation (short put obligation). If USDINR crashes to ₹78, Wipro receives only ₹199.75 crore (much worse than forward's ₹210 crore).

(iii) The CAP at ₹86 means Wipro gives up gains above ₹86 — acceptable if not bullish USD.

(iv) For Wipro's SIZE and BOARD OVERSIGHT, a plain forward at ₹84 (₹210 crore certain) may be preferred over Seagull's asymmetric risk-return.

(v) COMPROMISE STRUCTURE: Hedge 60% via Seagull + 40% via Forward — captures both upside and floor protection.

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Question 14 — Early Delivery + Early Cancellation + Early Extension with Broken Period Forward

SCENARIO 1 — Early Delivery of SALE Contract (Bank buys FCY early):

- Customer receives INR at ORIGINAL CONTRACT RATE
- Bank does SWAP: SELLS USD spot at Spot BID + BUYS USD forward for residual period at Forward ASK

Swap Loss = (Forward ASK for Residual − Spot BID on Early Delivery Date) × Amount

Outlay per USD = Contract Rate − Spot BID on Early Delivery Date

Interest on Outlay = Amount × Outlay per USD × Rate × Days/365

Rationale: Bank pays customer at contract rate but recovers only spot bid from immediate spot sale. Bank funds the differential during the early delivery period.

SCENARIO 2 — Early Cancellation of PURCHASE Contract (Bank sold FCY forward earlier):

- Contract is UNWOUND — no delivery
- Applicable rate = Bank's BID for residual period (bank buys back USD from customer)
- Apply margin (DEDUCT for buying rate), Round DOWN to 0.0025

Cancellation Charge = (Contract Rate − Applicable Rate) × Amount

- If POSITIVE (Contract > Applicable): Customer PAYS bank (USD depreciated; customer was locked at high price)
- If NEGATIVE (Contract < Applicable): Bank PAYS customer (USD appreciated; customer gains)

SCENARIO 3 — Early Extension = Cancel + Rebook:

- STEP 1: Cancel original contract at residual period rate (like Scenario 2)
- STEP 2: Rebook new forward at new extended period rate
- For SALE contract cancellation: Applicable = Bank's ASK for residual (+ margin, round UP)
- For SALE contract new booking: Rate = Bank's BID for new period (− margin, round DOWN)

Broken Period Forward Rate (Linear Interpolation):

When residual period (e.g., 45 days) falls between quoted tenors (1M and 2M):

Broken Period Rate = 1M Rate + [(2M Rate − 1M Rate) × (Extra Days / 30)]

FEDAI Rounding Convention:

- Buying rates (bank buys FCY): ROUND DOWN to nearest 0.0025 — bank pays less INR
- Selling rates (bank sells FCY): ROUND UP to nearest 0.0025 — bank receives more INR

Case Study — HDFC Bank Corporate Banking (Three Simultaneous Scenarios)

Ashish Kohli, Senior Vice President — Corporate Banking at HDFC Bank Ltd., Mumbai, is handling three separate corporate treasury requests on 15-June-2026. Each involves pre-due-date execution of a previously booked forward contract with different customers.

Common Market Data (15-June-2026, Interbank Quotes):

Tenor	USDINR Bid/Ask
Spot	₹83.20 / ₹83.25
1-Month Forward (15-Jul-26)	₹83.40 / ₹83.50
2-Month Forward (15-Aug-26)	₹83.60 / ₹83.70
3-Month Forward (15-Sep-26)	₹83.80 / ₹83.90

Common Assumptions:

- HDFC Bank Exchange Margin: 0.10% on all rates
- Interest Rate on Outlay: 12% p.a.
- FEDAI Rounding: Nearest 0.0025 (DOWN for buying, UP for selling)

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- Days count: Actual/365

SCENARIO A — Grasim Industries (Exporter / SALE Contract) — EARLY DELIVERY

- Grasim is an EXPORTER receiving USD 3M from Vodafone Group PLC UK for VSF (viscose staple fibre) exports
- Original booking (1-May-2026): Customer SALE — Grasim to SELL USD 3M to HDFC at ₹83.65 on 15-Aug-2026 (105-day forward)
- HDFC's Cover: HDFC SOLD USD 3M forward in interbank at ₹83.70 (interbank forward bid + spread) for 15-Aug delivery
- On 15-June-2026, Vodafone wired the USD early. Grasim requests EARLY DELIVERY (45 days before due date)

SCENARIO B — Ambuja Cements (Importer / PURCHASE Contract) — EARLY CANCELLATION

- Ambuja is an IMPORTER paying USD 4M to Ferrostaal AG Germany for cement mill equipment
- Original booking (15-Apr-2026): Customer PURCHASE — Ambuja to BUY USD 4M from HDFC at ₹83.75 on 15-Aug-2026 (4-month forward)
- HDFC's Cover: HDFC BOUGHT USD 4M forward in interbank at ₹83.72 (interbank forward ask − spread) for 15-Aug delivery
- Ambuja's shipment was cancelled by Ferrostaal. Ambuja requests EARLY CANCELLATION on 15-June-2026 (60 days before due date; 2-month residual)

SCENARIO C — Reliance Digital (Exporter / SALE Contract) — EARLY EXTENSION

- Reliance Digital is an EXPORTER receiving USD 2M from Best Buy Co. USA for consumer electronics exports
- Original booking (15-Apr-2026): Customer SALE — Reliance Digital to SELL USD 2M to HDFC at ₹83.55 on 15-Jul-2026 (3-month forward)
- HDFC's Cover: HDFC SOLD USD 2M forward in interbank for 15-Jul delivery
- Best Buy has delayed USD payment by 2 months. Reliance Digital requests EXTENSION to 15-Sep-2026 (extend original due date by 2 months; approaching 30 days early)

Required:

(i) Compute the BROKEN PERIOD 45-DAY forward rate by interpolation between 1-month and 2-month quotes.

(ii) SCENARIO A: Compute Swap Charge, Interest on Outlay, and NET AMOUNT credited to Grasim.

(iii) SCENARIO B: Compute the applicable cancellation rate (with margin and rounding) and the CANCELLATION CHARGE — indicate whether customer pays bank or vice versa.

(iv) SCENARIO C: For the early extension, compute (a) cancellation rate for the original contract, (b) cancellation charge, (c) new forward rate for the extended contract, (d) AMOUNT receivable on new due date, (e) EFFECTIVE new SALE rate after netting cancellation charge.

(v) Comment on the direction of USD/INR movement implied by the market data and its impact on each customer.

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Solution

(i) Broken Period 45-Day Forward Rate

Formula:

Broken Period Rate = 1M Rate + [(2M Rate − 1M Rate) × 15/30]

Bid Side:

= 83.40 + [(83.60 − 83.40) × 15/30] = 83.40 + [0.20 × 0.5] = ₹83.50

Ask Side:

= 83.50 + [(83.70 − 83.50) × 15/30] = 83.50 + [0.20 × 0.5] = ₹83.60

Broken Period 45-Day Forward: ₹83.50 / ₹83.60

(ii) SCENARIO A — Grasim Industries Early Delivery

Setup Recap:

- Grasim = EXPORTER; Customer SALE contract; HDFC BUYS USD 3M at ₹83.65
- HDFC's cover: HDFC SOLD USD 3M in interbank at ₹83.70 for 15-Aug delivery
- Early delivery on 15-Jun-2026; residual = 45 days to original due date

Bank's Mechanics on Early Delivery Date:

(i) HDFC pays Grasim at Contract Rate: 3M × ₹83.65 = ₹25.095 crore (OUTFLOW)

(ii) HDFC receives USD 3M from Grasim

(iii) HDFC has USD 3M in hand but interbank delivery is 15-Aug (45 days later)

(iv) HDFC does SWAP:

(v) → SELLS USD 3M spot on 15-Jun at Spot BID ₹83.20 (receives INR ₹24.96 crore)

(vi) → BUYS USD 3M forward for 15-Aug at 45-day Forward ASK ₹83.60 (will pay INR ₹25.08 crore on 15-Aug)

(vii) On 15-Aug: HDFC delivers USD 3M to interbank at cover rate ₹83.70 (receives INR ₹25.11 crore)

SWAP CHARGE Computation:

Swap Loss = (Forward ASK for residual 45d − Spot BID on early delivery date) × Amount

= (₹83.60 − ₹83.20) × USD 3,000,000

= ₹0.40 × 3,000,000

= ₹12,00,000 = ₹12.00 lakh

INTEREST ON OUTLAY Computation:

Key Concept: Interest is on the BANK'S FUNDING DIFFERENTIAL — the amount by which contract rate exceeds spot bid, funded during the early delivery period. NOT on contract value.

Outlay per USD = Contract Rate − Spot BID on early delivery date

= ₹83.65 − ₹83.20

= ₹0.45 per USD

Interest = Amount × Outlay per USD × Rate × Days/365

= 3,000,000 × ₹0.45 × 12% × 45/365

= 3,000,000 × ₹0.45 × 0.014795

= ₹19,973

NET AMOUNT TO GRASIM:

Item	Amount (₹)
Amount at Contract Rate (USD 3M × ₹83.65)	25,09,50,000
Less: Swap Charge	(12,00,000)
Less: Interest on Outlay	**(19,973)**
NET AMOUNT CREDITED TO GRASIM	**24,97,30,027**
Net Amount (₹ crore)	**₹ 24.9730 crore**

(iii) SCENARIO B — Ambuja Cements Early Cancellation

Setup Recap:

- Ambuja = IMPORTER; Customer PURCHASE contract; HDFC SELLS USD 4M to Ambuja at ₹83.75
- HDFC's cover: HDFC BOUGHT USD 4M in interbank at ₹83.72 for 15-Aug delivery
- Early cancellation on 15-Jun-2026; residual = 60 days (2 months) to original due date

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Applicable Cancellation Rate:

For PURCHASE contract cancellation: bank BUYS back USD from customer at bank's BID for residual period (2-M bid).

2-Month Forward Bid: ₹83.60

Less: Exchange Margin 0.10% = ₹83.60 × 0.001 = ₹0.0836

Rate Before Rounding: ₹83.60 − ₹0.0836 = ₹83.5164

Rounded DOWN to nearest 0.0025: ₹83.5150 per USD

Cancellation Charge Formula (PURCHASE contract):

Charge = (Contract Rate − Applicable Rate) × Amount

= (₹83.75 − ₹83.5150) × USD 4,000,000

= ₹0.2350 × 4,000,000

= ₹9,40,000 = ₹9.40 lakh

→ POSITIVE: Customer (Ambuja) PAYS Bank ₹9.40 lakh

Rationale: USD has depreciated (spot ₹83.20-25, forward ₹83.60 vs contract ₹83.75). Ambuja was locked into buying USD at higher rate (₹83.75) but market is now lower. On cancellation, Ambuja pays the differential.

(iv) SCENARIO C — Reliance Digital Early Extension

Setup Recap:

- Reliance Digital = EXPORTER; Customer SALE contract; HDFC BUYS USD 2M at ₹83.55
- Original due date: 15-Jul-2026; New (extended) due date: 15-Sep-2026
- Extension request on 15-Jun-2026 (approaching 30 days before original due date; residual 1 month to original, new tenor 3 months from today)

Step 1 — Cancel Original SALE Contract at 1-Month Rate (Residual):

For SALE cancellation: bank SELLS USD back to customer at bank's ASK for residual (1-M ask).

1-Month Forward Ask: ₹83.50

Add: Exchange Margin 0.10% = ₹83.50 × 0.001 = ₹0.0835

Rate Before Rounding: ₹83.50 + ₹0.0835 = ₹83.5835

Rounded UP to nearest 0.0025: ₹83.5850 per USD

Cancellation Charge (SALE contract):

Charge = (Applicable Rate − Contract Rate) × Amount

= (₹83.5850 − ₹83.55) × USD 2,000,000

= ₹0.0350 × 2,000,000

= ₹70,000 = ₹0.70 lakh (customer PAYS bank)

Step 2 — New Forward for 15-Sep (3-Month Tenor from 15-Jun):

For new SALE contract: bank BUYS USD at bank's BID for 3-month period.

3-Month Forward Bid: ₹83.80

Less: Exchange Margin 0.10% = ₹83.80 × 0.001 = ₹0.0838

Rate Before Rounding: ₹83.80 − ₹0.0838 = ₹83.7162

Rounded DOWN to nearest 0.0025: ₹83.7150 per USD

Amount Receivable on New Due Date (15-Sep-2026):

= USD 2,000,000 × ₹83.7150

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= ₹16,74,30,000 = ₹16.7430 crore

Effective New SALE Rate (Net of Cancellation Charge):

Cancellation Charge per USD = ₹70,000 / 2,000,000 = ₹0.0350 per USD

Effective New Rate = ₹83.7150 − ₹0.0350 = ₹83.6800

Compare with Original ₹83.55: Effective rate ₹83.68 is ₹0.13/USD BETTER for extended tenor

(Reflects the 2-month additional forward premium net of the small cancellation charge on residual period)

(v) Direction Commentary — USD/INR Movement

Aspect	Observation
Spot vs Old Contract Rates	USD spot ₹83.20-25 is LOWER than most old contract rates (83.55-83.75)
Implied Direction	USD DEPRECIATED between original booking dates (Apr-May) and 15-Jun

Customer Impact Summary:

Customer	Contract Type	USD Movement Impact	Net Outcome
Grasim	SALE (exporter)	Bank pays 83.65, spot 83.20 → bank funds outlay	Grasim pays ₹12.20 lakh charges
Ambuja	PURCHASE (importer)	Contract 83.75 > applicable 83.5150 → customer locked at high	Ambuja pays ₹9.40 lakh cancellation
Reliance Digital	SALE (exporter, extension)	Extension captures forward premium for later date	Effective ₹83.68 (better than orig 83.55)

Question 15 — Multi-Tenor USD Interest Obligations — Fixed Forward vs Option (Partial Cover)

Case Study — Torrent Pharma (USD Interest Payment Hedge)

Sanjay Gupta, CFO of Torrent Pharmaceuticals Ltd., is planning the hedge for Torrent's upcoming USD interest obligations on its USD 200 million ECB (raised from JPMorgan in 2024). The firm has a Board-mandated policy to fully hedge FCY obligations and is risk-averse.

USD Interest Payment Obligations:

Date	USD Amount	Days from 30-Jun-26
31-Oct-2026	USD 8,00,000	4 months
30-Nov-2026	USD 5,00,000	5 months

Market Data (30-June-2026):

Parameter	Value
Spot USDINR	₹83.50 / ₹83.60
4-month Forward USDINR (mid, for October)	₹84.20
5-month Forward USDINR (mid, for November)	₹84.35
Currency Option Lot Size	USD 25,000 per contract

Currency Option Quotes (INR per USD):

Strike Rate	October Call	October Put	November Call	November Put
₹84.00	₹0.60	₹0.35	₹0.80	₹0.55
₹85.00	₹0.30	₹1.05	₹0.50	₹1.30

Suggestion from Treasury Team (Twist):

The Treasury Team proposes buying call options at STRIKE ₹84 for PARTIAL coverage only — 20 contracts (USD 5,00,000) for October and 12 contracts (USD 3,00,000) for November. For the remainder USD amounts (USD 3,00,000 October and USD 2,00,000 November), the FORWARD RATE will be used as the best estimate of future spot rate (uncovered exposure).

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Required:

(i) Compute the TOTAL INR OUTFLOW under Strategy 1 (Fixed Forward for full amounts).

(ii) Compute the TOTAL INR OUTFLOW under Strategy 2 (Option at Strike ₹84 for partial cover + Forward as best-estimate spot for uncovered).

(iii) COMPARE the two strategies and identify the cheaper alternative.

(iv) Since Torrent is risk-averse, recommend the OPTIMAL HEDGING STRATEGY.

(v) Comment on why the option strategy underperforms despite offering downside protection.

Solution

(i) Strategy 1 — Fixed Forward (Full Cover)

Payment Date	USD Amount	Forward Rate	INR Outflow
31-Oct-26	8,00,000	₹84.20	₹6,73,60,000
30-Nov-26	5,00,000	₹84.35	₹4,21,75,000
TOTAL			**₹10,95,35,000**

Total Fixed Forward Cost: ₹10,95,35,000 = ₹1,095.35 lakh

(ii) Strategy 2 — Option Contract at Strike ₹84 (Partial Cover)

For OCTOBER Payment (USD 8,00,000):

- Option cover: 20 contracts × USD 25,000 = USD 5,00,000 (Buy Call @ ₹84, Premium ₹0.60)
- Uncovered: USD 3,00,000 (use forward rate ₹84.20 as best-estimate spot)
- Since forward-as-spot ₹84.20 > Strike ₹84 → EXERCISE Call

Component	Computation	INR Amount
Exercise Call (cover 5L)	USD 5,00,000 × ₹84.00	₹4,20,00,000
Premium Paid	USD 5,00,000 × ₹0.60	₹3,00,000
Uncovered 3L at Forward	**USD 3,00,000 × ₹84.20**	**₹2,52,60,000**
OCTOBER TOTAL		**₹6,75,60,000**

For NOVEMBER Payment (USD 5,00,000):

- Option cover: 12 contracts × USD 25,000 = USD 3,00,000 (Buy Call @ ₹84, Premium ₹0.80)
- Uncovered: USD 2,00,000 (use forward rate ₹84.35 as best-estimate spot)
- Since forward-as-spot ₹84.35 > Strike ₹84 → EXERCISE Call

Component	Computation	INR Amount
Exercise Call (cover 3L)	USD 3,00,000 × ₹84.00	₹2,52,00,000
Premium Paid	USD 3,00,000 × ₹0.80	₹2,40,000
Uncovered 2L at Forward	**USD 2,00,000 × ₹84.35**	**₹1,68,70,000**
NOVEMBER TOTAL		**₹4,23,10,000**

Total Option Strategy Cost = ₹6,75,60,000 + ₹4,23,10,000 = ₹10,98,70,000 = ₹1,098.70 lakh

(iii) Comparison of Strategies

Strategy	Total INR Outflow	Certainty
Strategy 1 — Fixed Forward	₹10,95,35,000 (₹1,095.35 lakh)	FULL certainty at booking
Strategy 2 — Option @ ₹84 (partial cover)	₹10,98,70,000 (₹1,098.70 lakh)	Partial (uncovered at spot)
Difference (Forward CHEAPER)	**₹3,35,000 (₹3.35 lakh)**	

(iv) Recommendation to Torrent Pharma

Recommendation: FIXED FORWARD (Strategy 1)

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(i) COST ADVANTAGE: Fixed Forward is cheaper by ₹3.35 lakh over the option-based partial cover strategy.

(ii) CERTAINTY: Torrent is risk-averse with Board-mandated full hedging policy. Fixed forward provides ABSOLUTE certainty of INR outflow at booking.

(iii) NO PREMIUM DRAG: Fixed forward has no upfront premium cost; option premium of ₹5.40 lakh (3.00 + 2.40) drags on P&L.

(iv) SIMPLICITY: Single forward booking per obligation date vs option premium payment + monitoring + exercise decision.

(v) PARTIAL COVER RISK: Option strategy leaves USD 5,00,000 uncovered (₹3L + ₹2L). Even at best-estimate forward rate, this creates true FX exposure Torrent cannot afford as risk-averse firm.

(vi) ACCOUNTING SIMPLICITY: Fixed forward qualifies for cash flow hedge accounting under Ind AS 109 with straightforward effectiveness testing; option accounting is more complex.

(v) Why Option Strategy Underperforms

(i) TIME VALUE OF PREMIUM: The call premium of ₹0.60 (Oct) and ₹0.80 (Nov) reflects both intrinsic value AND time value. When forward is only marginally above strike, most of the premium is TIME VALUE (paid but not extracted in expected value).

(ii) FORWARD-AS-SPOT PROXY: The uncovered portion is calculated at ₹84.20 (Oct) and ₹84.35 (Nov) — the same rates available in Strategy 1 fixed forward. So the uncovered portion has ZERO cost advantage vs forward.

(iii) OPTION EXERCISED AT STRIKE + PREMIUM: When exercised, effective rate = Strike + Premium = ₹84 + ₹0.60 = ₹84.60 (Oct) or ₹84 + ₹0.80 = ₹84.80 (Nov) — WORSE than forward ₹84.20 or ₹84.35.

(iv) PARTIAL COVER TRAP: The 'partial cover + forward-as-spot' twist creates a mixed strategy that inherits the WORST of both — option cost on covered portion, and no benefit on uncovered portion vs simply doing forward.

Question 16 — Cross-Currency Deal via Two Banks + Implied Cross-Pair Swap Points

Case Study — Bharti Airtel (CHF Payment to Swiss Vendor)

Sudhir Sharma, Head of Treasury at Bharti Airtel Ltd., needs to remit CHF 5 million to Novartis Switzerland for a spot delivery towards purchase of network equipment. Bharti has GBP funds available (from its African operations converted via UK entities). Sudhir is comparing quotes from two banks to minimize GBP outflow.

Bank A Quotes (Standard Chartered India):

Currency Pair	Spot	3-Month Swap Points	6-Month Swap Points
USD/CHF	1.4650 / 1.4655	5 / 10 (premium)	10 / 15 (premium)
GBP/USD	1.7645 / 1.7660	25 / 20 (discount)	35 / 25 (discount)

Bank B Quotes (HSBC India, Spot Only):

Currency Pair	Spot
USD/CHF	1.4653 / 1.4660
GBP/USD	1.7640 / 1.7650

Required:

(i) Compute the MINIMUM GBP amount Bharti Airtel must pay to obtain CHF 5,000,000 SPOT, considering the OPTIMAL split of legs between Bank A and Bank B.

(ii) Considering QUOTES from Bank A ONLY, compute the IMPLIED 3-MONTH SWAP POINTS for GBP/CHF (both bid and ask sides).

(iii) State whether the implied GBP/CHF swap is at PREMIUM or DISCOUNT.

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(iv) Briefly explain what BID/ASK swap point convention implies (which direction to apply).

Solution

(i) Minimum GBP for CHF 5M — Best-Path Split Between Banks

Path: GBP → USD → CHF (via vehicle currency USD)

Step 1 — Sell GBP for USD (customer sells GBP, receives USD):

Customer receives at bank's BID for GBP/USD. Higher bid = more USD per GBP = better for customer.

Bank	GBP/USD Bid	Winner?
Bank A	1.7645	✓ (Higher bid)
Bank B	1.7640	-

Winner: Bank A → 1 GBP = 1.7645 USD

Step 2 — Sell USD for CHF (customer sells USD, receives CHF):

Customer receives at bank's BID for USD/CHF. Higher bid = more CHF per USD = better for customer.

Bank	USD/CHF Bid	Winner?
Bank A	1.4650	-
Bank B	1.4653	✓ (Higher bid)

Winner: Bank B → 1 USD = 1.4653 CHF

Combined Cross Rate:

1 GBP = 1.7645 × 1.4653 CHF = 2.5855 CHF (rounded to 4 decimals)

GBP Required for CHF 5,000,000:

= CHF 5,000,000 / 2.5855

= GBP 19,33,845.58

MINIMUM GBP AMOUNT PAYABLE: GBP 1,933,846 (rounded)

Verification — Compare with Single-Bank Paths:

Path	1 GBP = ? CHF	GBP Needed for 5M CHF
Bank A only (1.7645 × 1.4650)	2.5850	19,34,204
Bank B only (1.7640 × 1.4653)	2.5848	19,34,354
OPTIMAL SPLIT (Bank A + Bank B)	**2.5855**	**19,33,846**

Savings from optimal split vs single-bank paths: GBP 358-508 (small but positive).

(ii) Implied 3-Month Swap Points for GBP/CHF (Bank A Only)

Step 1 — Compute Bank A SPOT GBP/CHF Cross:

Cross Bid = GBP/USD Bid × USD/CHF Bid = 1.7645 × 1.4650 = 2.5850

Cross Ask = GBP/USD Ask × USD/CHF Ask = 1.7660 × 1.4655 = 2.5881

Spot GBP/CHF (Bank A): 2.5850 / 2.5881

Step 2 — Compute Bank A 3-Month OUTRIGHT Rates:

USD/CHF 3M (Premium — points ADDED to spot):

Outright Bid = 1.4650 + 0.0005 = 1.4655

Outright Ask = 1.4655 + 0.0010 = 1.4665

USD/CHF 3M Outright: 1.4655 / 1.4665

GBP/USD 3M (Discount — points SUBTRACTED from spot):

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Outright Bid = 1.7645 − 0.0025 = 1.7620

Outright Ask = 1.7660 − 0.0020 = 1.7640

GBP/USD 3M Outright: 1.7620 / 1.7640

Step 3 — Compute 3-Month OUTRIGHT GBP/CHF:

3M Outright Bid = 1.7620 × 1.4655 = 2.5822

3M Outright Ask = 1.7640 × 1.4665 = 2.5869

3M Outright GBP/CHF: 2.5822 / 2.5869

Step 4 — Compute IMPLIED 3-Month Swap Points GBP/CHF:

Component	Spot	3M Outright	Swap (Outright − Spot)
Bid	2.5850	2.5822	−0.0028 (i.e., 28 points DISCOUNT)
Ask	2.5881	2.5869	−0.0012 (i.e., 12 points DISCOUNT)

IMPLIED 3-MONTH SWAP POINTS: 28 / 12 (DISCOUNT)

(iii) Premium or Discount?

DISCOUNT — Since Bid Points (28) > Ask Points (12), the swap is quoted as discount:

- Outright rate is LOWER than spot
- Points are SUBTRACTED from spot to derive outright
- Economically: GBP is expected to DEPRECIATE against CHF over 3 months (net of interest differentials in the two legs)

(iv) Bid/Ask Swap Point Convention

Convention Rule:

(i) If BID SWAP > ASK SWAP: The swap is at DISCOUNT — SUBTRACT from spot to get outright forward

(ii) If BID SWAP < ASK SWAP: The swap is at PREMIUM — ADD to spot to get outright forward

(iii) This preserves the correct bid-ask spread ordering in the outright forward

(iv) Applied consistently: If discount, bid outright < ask outright (bid subtracted more); If premium, bid outright < ask outright (bid added less)

Question 17 — Transaction Exposure — Multi-Currency Exporter-Importer (EUR + SGD)

Case Study — Voltas Limited (AC Exports to Germany, Component Imports from Singapore)

Anil George, Deputy Managing Director of Voltas Ltd. (Tata Group's air-conditioning company), is analyzing the FY27 profitability of Voltas' European AC business. Voltas exports 3,000 units of premium residential AC units to a German distributor (BSH Hausgeräte GmbH) each quarter, with cash flows in EUR. It imports high-precision compressor components from Panasonic Singapore, paying in SGD. All cash flows fall due in 4 months (October 2026).

Business Data (Per Unit):

Item	Value
Selling Price to BSH Germany	EUR 550 per unit
Component Cost from Panasonic Singapore	SGD 500 per unit
Fixed Cost per unit (INR)	₹2,000
Variable Cost per unit (INR)	₹2,500
Quarterly Units	3,000 units

Exchange Rates (INR per foreign currency):

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Currency	Current Rate (Jun-26)	Expected Rate at Maturity (Oct-26)
₹/EUR (Bid / Ask)	89.50 / 89.60	89.75 / 89.85
₹/SGD (Bid / Ask)	62.80 / 62.90	64.50 / 64.60

Forward Rates for Hedging (4-month, Available Today):

- ₹/EUR Forward: 90.10 / 90.20
- ₹/SGD Forward: 63.30 / 63.40

Required:

(i) Compute PER UNIT and TOTAL profit at CURRENT exchange rates (as if cash flows realized today).

(ii) Compute PER UNIT and TOTAL profit at EXPECTED FUTURE rates (Oct-26).

(iii) Determine the TRANSACTION EXPOSURE LOSS/GAIN due to expected FX movement.

(iv) DECOMPOSE the FX impact per unit between EUR revenue gain and SGD cost loss.

(v) Compute profit AFTER HEDGING via forward contracts (sell EUR forward, buy SGD forward). Show the hedge benefit vs unhedged position.

(vi) Recommend the hedging strategy and comment on risks.

Solution

(i) Per Unit Profit at CURRENT Rates

Convention: Voltas SELLS EUR (uses Bid ₹89.50), BUYS SGD (uses Ask ₹62.90)

Item	Computation	INR per unit
Revenue	EUR 550 × ₹89.50	49,225
Import Cost (SGD)	SGD 500 × ₹62.90	(31,450)
Fixed Cost	-	(2,000)
Variable Cost	**-**	**(2,500)**
Profit per unit		**₹13,275**

Total Profit at Current Rates (3,000 units):

= 3,000 × ₹13,275 = ₹3,98,25,000 = ₹398.25 lakh

(ii) Per Unit Profit at FUTURE (Expected Oct-26) Rates

Same conventions: SELL EUR at Future Bid ₹89.75, BUY SGD at Future Ask ₹64.60

Item	Computation	INR per unit
Revenue	EUR 550 × ₹89.75	49,362.50
Import Cost (SGD)	SGD 500 × ₹64.60	(32,300)
Fixed Cost	-	(2,000)
Variable Cost	**-**	**(2,500)**
Profit per unit		**₹12,562.50**

Total Profit at Future Rates (3,000 units):

= 3,000 × ₹12,562.50 = ₹3,76,87,500 = ₹376.88 lakh

(iii) Transaction Exposure Impact

Metric	Value (₹ lakh)
Total Profit at Current Rates	398.25
Total Profit at Future Rates	376.88
TRANSACTION EXPOSURE LOSS	**(21.38) lakh**

Per Unit Impact: ₹21.38 lakh / 3,000 units = ₹712.50 per unit LOSS

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(iv) Decomposition of FX Impact per Unit

EUR Revenue Impact (Favourable):

= EUR 550 × (₹89.75 − ₹89.50) = EUR 550 × ₹0.25 = +₹137.50 per unit GAIN

SGD Cost Impact (Unfavourable):

= SGD 500 × (₹64.60 − ₹62.90) = SGD 500 × ₹1.70 = ₹850.00 per unit LOSS

Net FX Impact per Unit:

= +₹137.50 (EUR gain) − ₹850.00 (SGD loss) = ₹(712.50) per unit

For 3,000 units: 3,000 × ₹(712.50) = ₹(21,37,500) = ₹(21.38) lakh — matches ✓

Key Insight:

SGD APPRECIATED significantly more (~2.7%) than EUR (~0.28%). Since Voltas is a NET SGD BUYER and NET EUR SELLER, the SGD move dominates. EUR gain is negligible; SGD cost blow-out drives the loss.

(v) Profit After Hedging via Forward Contracts

Hedge Structure:

- SELL EUR 550 × 3,000 = EUR 16,50,000 forward at ₹90.10 (bid) = ₹14.87 crore
- BUY SGD 500 × 3,000 = SGD 15,00,000 forward at ₹63.40 (ask) = ₹9.51 crore

Per Unit Profit Under Hedged Scenario:

Item	Computation	INR per unit
Revenue (Hedged EUR)	EUR 550 × ₹90.10	49,555
Import Cost (Hedged SGD)	SGD 500 × ₹63.40	(31,700)
Fixed Cost	-	(2,000)
Variable Cost	**-**	**(2,500)**
Profit per unit HEDGED		**₹13,355**

Total Hedged Profit (3,000 units):

= 3,000 × ₹13,355 = ₹4,00,65,000 = ₹400.65 lakh

Hedge Benefit Analysis:

Scenario	Total Profit (₹ lakh)	vs Current	vs Future Unhedged
Current Rates (Baseline)	398.25	-	-
Future Rates (Unhedged)	376.88	(21.38)	-
Hedged (Forwards)	400.65	+2.40	+23.78

Hedge PROTECTS Voltas from ₹23.78 lakh potential loss and even ADDS ₹2.40 lakh vs current baseline (favourable forward rates on both legs).

(vi) Recommendation and Risks

Recommendation: HEDGE 100% via Forward Contracts (Both Legs)

(i) SIGNIFICANT DOWNSIDE PROTECTION: Unhedged, Voltas faces ₹21.38 lakh loss. Hedged, gains ₹2.40 lakh — a swing of ₹23.78 lakh.

(ii) FAVOURABLE FORWARD RATES: EUR forward ₹90.10 > current spot ₹89.50 (premium); SGD forward ₹63.40 < future spot ₹64.60 (Voltas benefits by locking below expected future).

(iii) OPERATIONAL SIMPLICITY: Two forward contracts (one for each currency) is simple compared to option strategies.

(iv) COST: Zero upfront (unlike options); credit line utilization only.

(v) MATCHED CASH FLOWS: 4-month forward matches 4-month realization — no basis risk.

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(vi) REGULATORY: Under FEMA and RBI FX regulations, natural business exposures are eligible for forward hedges up to full amount.

Risks to Watch:

(i) COUNTERPARTY RISK: Forward with a bank exposes to bank credit risk over 4 months (mitigated by ISDA + CSA)

(ii) BASIS RISK: Actual receipt/payment could be delayed (customer late payment). If receipt > 4 months, forward matures early — early delivery or extension charges may apply

(iii) VOLUME RISK: Actual units sold could deviate from 3,000. Over-hedge (units < 3,000) creates surplus FX cover requiring cancellation

(iv) COMPETITIVE POSITION: If competitors don't hedge and USD/INR moves favourably, Voltas may appear less competitive on prices

(v) IND AS 109 COMPLIANCE: Forward hedges must be designated as cash flow hedges with quarterly effectiveness testing

Question 18 — REVERSE Working — Money Market Hedge (Derive INR Borrowing Rate)

Case Study — Reliance Industries USD Payable (Siemens Equipment Import)

Vinay Sharma, VP-Treasury at Reliance Industries Ltd., is analyzing the money market hedge executed for Reliance's USD 5 million payable to Siemens Germany for specialized petrochemical process equipment. The payment is due in 12 months.

Vinay's treasury team has executed the hedge through Reliance's internal treasury operations. The Board presentation states that the EFFECTIVE INR OUTFLOW PER USD under the hedge is ₹86.65. Vinay wants to verify this by deriving the INR borrowing rate at which the treasury borrowed to fund the USD purchase.

Transaction Details:

Parameter	Value
USD Payable Amount	USD 5,000,000
Payable Due Date	12 months from today
Current Spot USD/INR	₹83.50
USD Deposit Rate (12-month)	6% p.a.
Effective INR Rate under MMH (GIVEN)	₹86.65 per USD
INR Borrowing Rate (12-month)	TO BE DERIVED

Required:

(i) Compute the PRESENT VALUE of the USD payable using the USD deposit rate (this is the USD amount to be purchased and deposited today).

(ii) Compute the INR OUTFLOW TODAY needed to purchase this USD at the spot rate.

(iii) Compute the EFFECTIVE INR OUTFLOW AT MATURITY (using the given effective rate).

(iv) Working BACKWARDS, DERIVE the INR BORROWING RATE at which Reliance funded the INR outflow today.

(v) VERIFY the derived rate using the Interest Rate Parity (IRP) formula.

Solution

(i) PV of USD Payable at USD Deposit Rate

The USD amount to be deposited today should mature to USD 5,000,000 exactly at end of 12 months.

PV of USD = USD 5,000,000 / (1 + 6%)

= USD 5,000,000 / 1.06

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= USD 4,716,981.13

(ii) INR Outflow Today (Buy USD at Spot)

INR needed to buy USD 4,716,981.13 at spot ₹83.50:

= USD 4,716,981.13 × ₹83.50

= ₹39,38,67,925

= ₹39.3868 crore

(iii) Effective INR Outflow at Maturity

Given the effective rate of ₹86.65 per USD:

Effective INR Outflow = USD 5,000,000 × ₹86.65

= ₹43,32,50,000

= ₹43.3250 crore

(iv) DERIVED INR Borrowing Rate

Formula:

INR Maturity Value = INR Borrowed Today × (1 + INR Borrowing Rate)

Rearranging:

(1 + INR Borrowing Rate) = INR Maturity Value / INR Borrowed Today

= ₹43,32,50,000 / ₹39,38,67,925

= 1.100000

INR Borrowing Rate = 1.100000 − 1 = 0.10 = 10.00% p.a.

(v) Verification via Interest Rate Parity (IRP)

IRP Formula:

Forward Rate = Spot × (1 + INR Rate) / (1 + USD Rate)

Applying:

Implied Forward = ₹83.50 × (1 + 10%) / (1 + 6%)

= ₹83.50 × 1.10 / 1.06

= ₹91.85 / 1.06

= ₹86.65 per USD ✓

The IRP-implied forward rate matches the given effective rate ₹86.65 exactly, confirming:

- The derived INR borrowing rate of 10% p.a. is correct
- MMH is arbitrage-consistent with a market forward contract at ₹86.65
- Reliance's treasury is realizing the same economic outcome as if it had booked a 12-month forward at the IRP-implied rate

Summary Table

Metric	Value
USD Payable at Maturity	USD 5,000,000
USD Deposited Today	USD 4,716,981
INR Outflow Today	₹39.3868 crore
INR Repayment at Maturity	₹43.3250 crore
Interest on INR Borrowing (12M)	₹3.9382 crore
DERIVED INR Borrowing Rate	**10.00% p.a.**

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Metric	Value
Effective INR Outflow Rate	₹86.65 per USD

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CHAPTER 11 — INTERNATIONAL FINANCIAL MANAGEMENT

Question 1 — International Capital Budgeting — Home Currency NPV (Sun Pharma US Subsidiary)

Case Study — Sun Pharma US Manufacturing Subsidiary

Sudhir Valia, Executive Director of Sun Pharmaceutical Industries Ltd., is evaluating a proposal to set up a wholly-owned direct manufacturing subsidiary (Sun Pharma Manufacturing Inc.) in New Jersey, USA, to produce generic drugs for the American market. Currently, Sun Pharma exports these drugs from India, but competing MNCs setting up US manufacturing are undercutting on price and lead time.

Project Data:

Parameter	Value
Initial Investment (Plant + Working Capital)	USD 200 million
Project Life	5 years
Y1 Operating Cash Flow (Post-US Tax)	USD 30 million
Y2 Operating Cash Flow (Post-US Tax)	USD 50 million
Y3 Operating Cash Flow (Post-US Tax)	USD 70 million
Y4 Operating Cash Flow (Post-US Tax)	USD 80 million
Y5 Operating Cash Flow (Post-US Tax)	USD 90 million
Terminal Value at End Y5 (Post-Tax, expected sale to strategic buyer)	USD 180 million
Withholding Tax on Dividend Repatriation to India	10%
Current Spot USD/INR	₹83.50
Expected INR Depreciation per PPP	3% per annum
Sun Pharma's Cost of Capital (INR)	14%

Assumptions:

- All post-US-tax operating cash flows AND terminal value fully repatriated as dividends
- Withholding tax deducted before remittance
- Ignore Indian tax (assumed fully offset by foreign tax credit under India-US DTAA)
- No political risk adjustment (US is investment-grade sovereign)

Required:

(i) Compute the USD CASH FLOWS AVAILABLE to Sun Pharma India after withholding tax deduction each year.

(ii) Forecast the USD/INR SPOT RATES for each year using the PPP-implied depreciation of 3% p.a.

(iii) Convert USD cash flows to INR at forecast rates.

(iv) Discount INR cash flows at Sun Pharma's cost of capital (14%) to compute the INR NPV.

(v) State the accept/reject DECISION and comment on the strategic rationale.

(vi) Highlight three RISKS not captured in the NPV analysis that Sudhir should consider.

Solution

(i) USD Cash Flows After Withholding Tax

Withholding tax @ 10% deducted from operating CFs and terminal value before remittance to India.

Year	Gross USD CF (M)	WHT @ 10% (M)	Net USD CF to India (M)
Y1	30	3	27
Y2	50	5	45
Y3	70	7	63
Y4	80	8	72

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Year	Gross USD CF (M)	WHT @ 10% (M)	Net USD CF to India (M)
Y5 (Operating)	90	9	81
Y5 (Terminal)	180	18	162
Y5 (Total)	**270**	**27**	**243**

(ii) Forecast USD/INR Rates (3% p.a. INR Depreciation)

Forecast Rate (Year t) = Spot × (1 + 0.03)^t

Year	Computation	USD/INR Forecast
Y0 (Spot)	-	₹83.50
Y1	83.50 × 1.03	₹86.005
Y2	83.50×1.03^2	₹88.585
Y3	83.50×1.03^3	₹91.243
Y4	83.50×1.03^4	₹93.980
Y5	83.50×1.03^5	₹96.799

(iii) INR Cash Flows

INR CF = USD CF × Forecast Rate; convert to ₹ crore (divide by 10 to convert USD-M × INR/USD to INR crore)

Year	USD CF (M)	Forecast Rate	INR CF (₹ crore)
Y1	27	86.005	232.21
Y2	45	88.585	398.63
Y3	63	91.243	574.83
Y4	72	93.980	676.66
Y5	243	96.799	2,352.22

(iv) NPV Computation at 14% (INR Cost of Capital)

Year	INR CF (₹ cr)	PVIF @ 14%	PV (₹ cr)
Y1	232.21	0.8772	203.70
Y2	398.63	0.7695	306.74
Y3	574.83	0.6750	387.99
Y4	676.66	0.5921	400.63
Y5	2,352.22	0.5194	1,221.67
Total PV of Inflows			**2,520.73**
Less: Initial Investment (USD 200M × ₹83.50)			(1,670.00)
NET PRESENT VALUE (NPV)			**₹ 850.73 crore**

(v) Decision and Strategic Rationale

Decision: ACCEPT the project (NPV = +₹850.73 crore, IRR well above 14%)

Strategic Rationale:

(i) TARIFF & COMPETITIVE PROTECTION: US manufacturing avoids proposed pharma import tariffs and matches competitors' local presence (Teva, Aurobindo Pharma USA, Dr. Reddy's USA all have US plants)

(ii) REGULATORY PROXIMITY: Direct US FDA interaction from local manufacturing accelerates ANDA approvals and reduces cGMP inspection risk

(iii) SUPPLY CHAIN RESILIENCE: Reduces India-US shipping lead times from 30-45 days to 3-5 days; critical for high-value oncology and specialty drugs

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(iv) FOREX RISK MITIGATION: Revenue and cost matched in USD reduces transaction exposure

(v) MARKET ACCESS: US commercial team can leverage local manufacturing for better hospital contracts (GPO negotiations often prefer domestic manufacture)

(vi) Risks Not Captured in NPV

(i) US FDA REGULATORY RISK: A single Form 483 observation or Warning Letter can shut down operations; FDA has taken action against Sun Pharma's Halol facility (India) historically. US plant faces same risk.

(ii) PRICING PRESSURE: US generic pricing has been in secular decline (5-10% p.a. price erosion). Cash flow projections assume stable pricing; actual could be lower.

(iii) REPATRIATION UNCERTAINTY: US tax law changes (e.g., BEAT, GILTI provisions) could affect actual after-tax remittance. INR depreciation forecast (3% p.a.) may not materialize.

(iv) TECHNOLOGY RISK: Biosimilars and cell/gene therapies could disrupt small-molecule generic economics.

(v) POLITICAL RISK: US-India trade tensions or reshoring policies could affect operations (though less likely than emerging markets).

Question 2 — ADR vs GDR — Cost of Capital Analysis (Infosys Depository Receipt Issuance)

Case Study — Infosys Limited (ADR vs GDR Structuring Decision)

Jayesh Sanghrajka, CFO of Infosys Limited, is planning to raise USD equivalent 500 million through issuance of Depository Receipts to fund the acquisition of a European AI/Cloud services company. Two options are being evaluated:

- Option A: American Depository Receipts (ADRs) listed on NYSE (Infosys already has an existing ADR listing since 1999)
- Option B: Global Depository Receipts (GDRs) listed on London Stock Exchange

Common Parameters:

Parameter	Value
Current Domestic Share Price (BSE/NSE)	₹1,500 per share
Discount to Prevailing Price (both options)	3%
DR Ratio	1 DR = 1 underlying share
Number of DRs to be issued	30 million
Spot USD/INR	₹83.50
Expected Y1 Dividend per share	₹25
Expected Long-term Dividend Growth	10% p.a.

Option-Specific Costs:

Cost Component	ADR (NYSE)	GDR (LSE)
Total Issue Expenses (Underwriting + Legal + SEC + Listing)	5.0%	3.0%
Ongoing Annual Compliance Cost	USD 3M p.a.	USD 1M p.a.

Required:

(i) Compute the ISSUE PRICE per DR (in both INR and USD).

(ii) Compute GROSS and NET PROCEEDS in USD for each option.

(iii) Compute the COST OF DR CAPITAL under each option using the Gordon Growth Model.

(iv) State the RECOMMENDATION with rationale.

(v) Beyond pure cost-of-capital, identify FIVE STRATEGIC factors that would influence Infosys' choice.

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Solution

(i) Issue Price per DR

Issue Price = Current Share Price × (1 − Discount)

= ₹1,500 × 0.97 = ₹1,455 per share/DR

USD equivalent = ₹1,455 / ₹83.50 = USD 17.4251 per DR

(ii) Gross and Net Proceeds

Item	ADR (NYSE)	GDR (LSE)
Number of DRs	30 million	30 million
Issue price per DR (USD)	17.4251	17.4251
GROSS Proceeds	USD 522.75 M	USD 522.75 M
Issue Expenses %	5.0%	3.0%
Issue Expenses Amount	USD 26.14 M	USD 15.68 M
NET Proceeds	**USD 496.62 M**	**USD 507.07 M**
Net Proceeds in INR	₹4,146.71 crore	₹4,234.03 crore
Net Proceeds per DR (USD)	16.5539	16.9024

(iii) Cost of DR Capital

Dividend Y1 in USD:

D_1 = ₹25 / ₹83.50 = USD 0.2994 per DR

Cost of ADR Capital:

K_ADR = (D_1 / Net Proceeds per ADR) + g

= (0.2994 / 16.5539) + 0.10

= 0.01809 + 0.10

= 11.81%

Cost of GDR Capital:

K_GDR = (0.2994 / 16.9024) + 0.10

= 0.01771 + 0.10

= 11.77%

Difference: GDR cheaper by only 3.7 bps in cost of capital

BUT: GDR delivers USD 10.44 million MORE in net proceeds (2.1% more capital for same dilution)

(iv) Recommendation

Recommendation: PROCEED with GDR on LSE

Rationale (Pure Financial):

(i) Higher net proceeds (USD 507M vs USD 497M — additional USD 10.44M available for acquisition)

(ii) Lower ongoing compliance cost (USD 1M vs 3M annually — saves USD 2M p.a. or USD 20M over 10 years)

(iii) Slightly lower cost of capital (11.77% vs 11.81%)

(iv) Faster time-to-market (4-6 months vs 9-12 months) — critical if acquisition timing is time-sensitive

(v) Lighter regulatory burden — no US SOX compliance for new DR issue

(v) Strategic Factors Beyond Cost

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(i) EXISTING US LISTING: Infosys already has NYSE ADR listing since 1999. New ADR issue leverages existing infrastructure but may be constrained by US SEC's investment company or share issuance rules. GDR would be a NEW market.

(ii) INVESTOR TARGET: If acquisition is European, GDR issued to European investors creates natural investor alignment. If target is US-based, ADR may be more aligned.

(iii) REGULATORY OVERHEAD: US SOX Section 404 compliance is expensive but well-established at Infosys (already SOX-compliant). Marginal ADR compliance may not add much.

(iv) MARKET LIQUIDITY: NYSE ADR market is deeper and more liquid for large-cap tech names like Infosys. GDR liquidity in LSE is typically lower.

(v) CURRENCY MATCHING: If acquisition target is EUR-denominated, EUR-denominated GDR (some GDRs are EUR) provides natural hedge. USD-denominated DRs create translation exposure.

(vi) TAX TREATMENT: Withholding tax on ADR dividends to US holders (15% under India-US DTAA) vs GDR to UK holders (10% under India-UK DTAA).

(vii) REGULATORY APPROVAL SPEED: RBI/SEBI approvals for ADR vs GDR may differ; GDR often faster.

Question 3 — FCCB Analysis — Straight Bond Value + Conversion Option Value (Adani Green Energy)

Case Study — Adani Green Energy USD 100M FCCB Issue

Suresh Bhandari, CFO of Adani Green Energy Ltd., is finalizing the structure of a USD 100 million FCCB issue to fund the company's 20 GW solar capacity expansion target by 2030. The FCCB will be issued to European institutional investors via a Reg S offering, listed on the Singapore Exchange (SGX).

FCCB Terms:

Parameter	Value
Face Value	USD 100 million
Coupon	1.00% per annum, paid semi-annually
Tenor	5 years
Redemption (if not converted)	108% of Face Value (at maturity)
Fixed Reference FX Rate	₹83.50 / USD
Conversion Price	₹950 per equity share
Current Adani Green Share Price	₹900 per share
Market Yield for Adani Green STRAIGHT Bond (similar credit)	8% p.a.
Issue Price	At Par (100% of Face Value)

Required:

(i) Compute the STRAIGHT BOND VALUE using the given market yield of 8% p.a. (semi-annual compounding).

(ii) Compute the EMBEDDED CONVERSION OPTION VALUE.

(iii) Compute the YIELD TO MATURITY (YTM) implied by the issue price of USD 100M with 1% coupon and 108% redemption.

(iv) Compute the CONVERSION RATIO (shares per bond of USD 1,000 face value).

(v) Determine the BREAK-EVEN share price at maturity that would make conversion attractive (assume spot rate remains ₹83.50).

(vi) Comment on why the coupon is so LOW and what makes this instrument attractive to both issuer and investor.

Solution

(i) Straight Bond Value at 8% p.a. Market Yield

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Semi-annual computation:

- Coupon per period = USD 100M × 1% / 2 = USD 0.5M per semi-annual period
- Market yield per period = 8% / 2 = 4%
- Number of periods = 5 × 2 = 10
- Redemption at end period 10 = USD 100M × 108% = USD 108M

PVIFA (4%, 10 periods) = 8.1109

PVIF (4%, 10 periods) = 0.6756

Straight Value = 0.5 × 8.1109 + 108 × 0.6756

= 4.0554 + 72.9609

= USD 77.02 Million

(ii) Embedded Conversion Option Value

Option Value = Issue Price − Straight Bond Value

= USD 100 M − USD 77.02 M

= USD 22.98 Million

Investors are effectively paying USD 22.98M UPFRONT for the right to convert the bond into Adani Green equity at ₹950 per share.

(iii) YTM if Not Converted

Solving for YTM where PV of cash flows = USD 100M:

100 = 0.5 × PVIFA(r, 10) + 108 × PVIF(r, 10)

By iterative computation (bisection):

At r = 1.25% per period (2.5% p.a.): PV ≈ USD 100.06 M ✓

YTM per period ≈ 1.256%

YTM per annum ≈ 2.51% (semi-annual compounding)

This ultra-low YTM (2.51% vs market yield 8% for similar-credit straight bond) reflects the significant value of the embedded conversion option. Investors accept lower fixed income in exchange for equity upside.

(iv) Conversion Ratio

For each USD 1,000 face value bond:

INR equivalent at reference rate = USD 1,000 × ₹83.50 = ₹83,500

Number of shares = ₹83,500 / ₹950 = 87.89 shares

Conversion Ratio = ~87.9 shares per USD 1,000 bond

Total shares if fully converted:

USD 100M × ₹83.50 / ₹950 = ₹8,350 M / ₹950 = 8.7895 M shares = 87.89 lakh shares

- At current market cap of Adani Green (say USD 25B ≈ ₹2.09 lakh crore), this dilution is minimal (~0.4%)

(v) Break-Even Share Price for Conversion at Maturity

Investor's Decision at Maturity:

- Option A: Take REDEMPTION at 108% of face = USD 108 M
- Option B: CONVERT to shares (87.89 lakh shares) and sell at market

Assuming spot FX unchanged at ₹83.50, INR value of redemption:

USD 108M × ₹83.50 = ₹9,018 M = ₹901.80 crore

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Break-even share price for conversion:

87.89 lakh shares × Break-even price = ₹901.80 crore

Break-even price = ₹901.80 cr / 87.89 lakh = ₹102.60 per share... wait let me recompute

₹901.80 crore = ₹9,018 million; 8.789 million shares

Break-even = ₹9,018 M / 8.789 M shares = ₹1,026 per share

Break-even Share Price ≈ ₹1,026 per share

- Current share price: ₹900 → 14% BELOW break-even
- Adani Green needs to grow share price to ₹1,026 (14% total growth over 5 years) for conversion to be attractive
- If Adani Green share price rises above ₹1,026 by maturity, holders convert; else they redeem

Scenarios:

Share Price at Maturity	Conversion Value (₹ cr)	Redemption Value (₹ cr)	Investor Choice
₹800	703	902	REDEEM (take 108%)
₹1,026 (Break-Even)	902	902	Indifferent
₹1,200	1,055	902	CONVERT
₹1,500	1,318	902	CONVERT (large gain)
₹2,000	1,758	902	CONVERT (major upside)

(vi) Why the Coupon is So Low — Attractiveness

For the ISSUER (Adani Green):

(i) CHEAP FUNDING: 1% coupon vs 8% straight bond = 700 bps saving. On USD 100M, that's USD 7M p.a. or USD 35M over 5 years

(ii) EQUITY-LIKE FLEXIBILITY: If share price appreciates, bonds convert to equity — no cash outflow at maturity

(iii) DEFERRED DILUTION: Share dilution only if bonds convert, no upfront dilution

(iv) USD RESOURCES: Access to global capital markets for INR project (subject to FX risk on the debt principal)

(v) NO CURRENT INTEREST PRESSURE: Low cash coupon supports early-stage growth projects

For the INVESTOR (Global Institutions):

(i) DOWNSIDE PROTECTION: Bond floor at 108% redemption if share underperforms

(ii) EQUITY UPSIDE: Full participation if share price rises above break-even

(iii) INDIA GROWTH STORY: Access to India's renewable energy transition without direct equity exposure

(iv) USD-DENOMINATED: FX-hedged for USD-based portfolios

(v) DIVERSIFICATION: Asymmetric returns (equity upside + bond floor)

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Question 4 — International Capital Budgeting — NPV and MIRR (Grasim Industries Nepal Import)

Case Study — Grasim Industries Nepal Wood Pulp Sourcing

Ashish Adukia, CFO of Grasim Industries Ltd. (Aditya Birla Group), is evaluating a 3-year sourcing arrangement for imported wood pulp from Bhrikuti Pulp & Paper Nepal Ltd. Grasim's Nagda VSF (Viscose Staple Fibre) plant is one of India's largest, and secure supply of high-quality wood pulp is critical.

The proposal involves setting up a storage and quality-control facility in Kathmandu (investment made in Nepalese Currency 'NC') plus sourcing efficiencies realized in India (INR benefits). The investment horizon is 3 years, after which the arrangement will be reviewed.

Cash Flow Details:

Year	NC Cash Flow (Millions)	INR Cash Flow (₹ Millions)
Year 0	(40.000)	0
Year 1	5.000	6.000
Year 2	8.000	8.000
Year 3	9.000	10.000

Other Information:

- Grasim evaluates all investments using an INR discount rate of 10% per annum
- All Nepalese cash flows will be converted to INR at the PPP-implied FORWARD RATE
- Current spot exchange rate: ₹1 = NC 1.60
- Expected inflation rates: Nepal 7% p.a., India 5% p.a.

Discount Factors:

Year	PVF @ 10%	FVF @ 10%
Year 1	0.909	1.210
Year 2	0.826	1.100
Year 3	0.751	1.000

Required:

(i) Compute the PPP-implied FORWARD EXCHANGE RATES (₹/NC) for Years 1, 2, and 3.

(ii) Convert Nepalese Currency cash flows to INR using these forward rates.

(iii) Combine INR cash flows from both currencies to obtain TOTAL INR CASH FLOWS.

(iv) Compute the NET PRESENT VALUE (NPV) at 10% discount rate.

(v) Compute the MODIFIED INTERNAL RATE OF RETURN (MIRR) using the terminal-value approach with reinvestment at 10%.

(vi) State the ACCEPT/REJECT decision under both NPV and MIRR criteria. Comment on why MIRR is preferred over IRR for this analysis.

Solution

(i) PPP-Implied Forward Rates

Formula (Relative PPP):

Forward Rate (year t) = Current Rate × [(1 + Inflation_Nepal) / (1 + Inflation_India)]^t

= 1.60 × (1.07 / 1.05)^t

Year	Computation	Forward Rate (₹1 = NC ?)
Year 1	1.60 × (1.07/1.05)^1	NC 1.6305
Year 2	1.60 × (1.07/1.05)^2	NC 1.6615
Year 3	1.60 × (1.07/1.05)^3	NC 1.6932

Interpretation: NC is expected to DEPRECIATE against INR because Nepal's inflation (7%) exceeds India's (5%). Each INR will buy MORE Nepalese Currency over time — good for Grasim as a NC-outflow investor.

(ii) Conversion of NC Cash Flows to INR

Formula: INR CF = NC CF / Forward Rate

Year	NC CF (M)	Forward Rate	INR CF (₹ M)
Year 1	5.000	1.6305	3.067
Year 2	8.000	1.6615	4.815
Year 3	9.000	1.6932	5.315

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Initial Investment in INR:

= NC 40 M / 1.60 (current spot) = ₹25.000 M

(iii) Total INR Cash Flows

Year	INR from NC (₹M)	INR Direct (₹M)	TOTAL INR CF (₹M)
Year 0	(25.000)	0	(25.000)
Year 1	3.067	6.000	9.067
Year 2	4.815	8.000	12.815
Year 3	5.315	10.000	15.315

(iv) NPV Computation at 10%

Year	Total INR CF (₹M)	PVF @ 10%	PV (₹M)
Year 0	(25.000)	1.000	(25.000)
Year 1	9.067	0.909	8.242
Year 2	12.815	0.826	10.585
Year 3	15.315	0.751	11.502
NET PRESENT VALUE (NPV)			**₹ 5.329 Million**

NPV = +₹5.329 Million (POSITIVE)

(v) MIRR Computation

Step 1: Compound Interim Cash Flows to Year 3 at 10% (Reinvestment Rate):

Year	CF (₹M)	Years to Compound	FVF @ 10%	Terminal Value (₹M)
Year 1 → Y3	9.067	2	1.210	10.971
Year 2 → Y3	12.815	1	1.100	14.097
Year 3	15.315	0	1.000	15.315
TOTAL TERMINAL VALUE				**₹ 40.383 Million**

Step 2: Solve for MIRR:

MIRR = (Terminal Value / Initial Investment)^(1/n) − 1

= (₹40.383 M / ₹25.000 M)^(1/3) − 1

= (1.6153)^(1/3) − 1

= 1.1733 − 1

= 0.1733 = 17.33%

(vi) Decision and Commentary

Criterion	Value	Benchmark	Decision
NPV	+₹5.329 M	> 0	ACCEPT
MIRR	17.33%	> 10% (cost of capital)	ACCEPT

Why MIRR is Preferred Over IRR for This Analysis:

(i) Traditional IRR assumes reinvestment of interim cash flows AT THE IRR ITSELF. If IRR is high (say 20-30%), this implies unrealistic reinvestment opportunities.

(ii) MIRR uses an EXPLICIT and REALISTIC reinvestment rate — here, Grasim's cost of capital of 10%. This reflects the actual return Grasim can generate on interim cash reinvestments.

(iii) MIRR is always UNIQUE. Traditional IRR can produce MULTIPLE VALUES for cash flows with sign changes (though not applicable here, common in phased international projects with reinvestment stages).

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(iv) For cross-border projects with cash flows spread over multiple years, MIRR better captures the practical rate of value creation.

(v) In this case, both NPV and MIRR reinforce the ACCEPT decision, giving Ashish confidence in the recommendation.

Grasim Recommendation: PROCEED with Nepal wood pulp sourcing arrangement.

Question 5 — Multinational Cash Management — Multilateral Netting (Tata Group Global Treasury)

Case Study — Tata Group Global Treasury Optimization

Mohan Bhatia, Head of Group Treasury at Tata Sons, is optimizing intercompany payments across Tata's global entities. Currently, monthly intercompany flows across four regional entities generate high FX and wire costs. Mohan is evaluating implementation of a multilateral netting centre at GIFT City IFSC.

Monthly Intercompany Payment Matrix (in USD Million Equivalent):

From ↓ / To →	India	USA	UK	Singapore	TOTAL PAYS
India	-	75	50	30	155
USA	60	-	25	15	100
UK	40	35	-	20	95
Singapore	25	20	30	-	75
TOTAL RECEIVES	**125**	**130**	**105**	**65**	**425**

Cost Assumptions:

- FX Spread: 5 bps (0.05%) per FX transaction
- Wire Transfer Fee: USD 50 per wire (SWIFT wire including correspondent bank)
- GIFT City Netting Centre Setup: USD 500,000 one-time; USD 200,000 annual operating cost

Required:

(i) Compute the TOTAL GROSS INTERCOMPANY FLOW and cost under current no-netting scenario (monthly).

(ii) Compute the TOTAL FLOW under BILATERAL NETTING (each pair nets internally). Show the netting for each pair and total.

(iii) Compute the TOTAL FLOW under MULTILATERAL NETTING via centralized netting centre. Show each entity's NET POSITION and identify NET PAYERS and NET RECEIVERS.

(iv) Compute MONTHLY and ANNUAL cost savings from Bilateral vs Gross, and Multilateral vs Bilateral.

(v) Analyze the PAYBACK PERIOD for the GIFT City netting centre investment.

(vi) List FIVE ADDITIONAL BENEFITS of multilateral netting beyond direct FX and wire cost savings.

Solution

(i) Gross Intercompany Flow (No Netting)

Total Gross Flow = Sum of all 12 payment entries in matrix

= 155 + 100 + 95 + 75 = USD 425 M (monthly)

Monthly Cost:

Cost Component	Computation	Amount (USD)
FX Spread	USD 425M × 5 bps	212,500
Wire Fees (12 wires)	**12 × USD 50**	**600**
TOTAL MONTHLY		**213,100**
ANNUAL (× 12)		**2,557,200**

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(ii) Bilateral Netting

For each pair, compute NET amount and direction:

Pair	Gross Both Ways	Net Direction & Amount
India ↔ USA	155 (India→USA 75, USA→India 60)	India → USA: USD 15 M
India ↔ UK	90 (India→UK 50, UK→India 40)	India → UK: USD 10 M
India ↔ Singapore	55 (India→Sing 30, Sing→India 25)	India → Sing: USD 5 M
USA ↔ UK	60 (USA→UK 25, UK→USA 35)	UK → USA: USD 10 M
USA ↔ Singapore	35 (USA→Sing 15, Sing→USA 20)	Sing → USA: USD 5 M
UK ↔ Singapore	50 (UK→Sing 20, Sing→UK 30)	Sing → UK: USD 10 M
TOTAL BILATERAL NET FLOW		**USD 55 M**

Bilateral Reduction: 425 − 55 = 370 M (87.1% reduction in flow volume)

Monthly Cost under Bilateral:

Cost Component	Computation	Amount (USD)
FX Spread	USD 55M × 5 bps	27,500
Wire Fees (6 wires)	**6 × USD 50**	**300**
TOTAL MONTHLY		**27,800**
ANNUAL (× 12)		**333,600**

(iii) Multilateral Netting

Each entity's NET POSITION = Total Pays − Total Receives

Entity	Pays	Receives	Net Position	Status
India	155	125	+30	NET PAYER USD 30M
USA	100	130	-30	NET RECEIVER USD 30M
UK	95	105	-10	NET RECEIVER USD 10M
Singapore	75	65	+10	NET PAYER USD 10M
TOTALS	**425**	**425**	**0**	**Balanced ✓**

Total Multilateral Net Flow = USD 40 M (sum of net payer amounts = 30 + 10)

Multilateral Reduction: 425 − 40 = 385 M (90.6% reduction from gross)

Multilateral Wire Structure via GIFT City Netting Centre:

- India pays USD 30M to netting centre
- Singapore pays USD 10M to netting centre
- Netting centre pays USA USD 30M
- Netting centre pays UK USD 10M
- Total 4 wires (2 in + 2 out)

Monthly Cost under Multilateral:

Cost Component	Computation	Amount (USD)
FX Spread	USD 40M × 5 bps	20,000
Wire Fees (4 wires)	**4 × USD 50**	**200**
TOTAL MONTHLY		**20,200**
ANNUAL (× 12)		**242,400**

(iv) Cost Savings

Scenario	Monthly Cost (USD)	Annual Cost (USD)	Annual Saving vs Gross (USD)
Gross (No Netting)	213,100	2,557,200	Baseline

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Scenario	Monthly Cost (USD)	Annual Cost (USD)	Annual Saving vs Gross (USD)
Bilateral Netting	27,800	333,600	2,223,600
Multilateral Netting	20,200	242,400	2,314,800

Marginal Saving of Multilateral over Bilateral:

= Bilateral Annual Cost − Multilateral Annual Cost

= USD 333,600 − USD 242,400

= USD 91,200 per year

(v) Payback Period for GIFT City Netting Centre

Investment and Ongoing Cost:

- One-time setup cost: USD 500,000
- Annual operating cost: USD 200,000

Net Annual Benefit vs Current (assumed Gross):

Annual saving = USD 2,314,800

Less: Annual operating cost = USD 200,000

NET annual saving = USD 2,114,800

Payback Period:

= USD 500,000 / USD 2,114,800 = 0.24 years

= approximately 2.8 MONTHS

Extremely fast payback justifies investment easily.

Net Annual Benefit vs Bilateral (if already implemented):

Annual saving = USD 91,200

Less: Annual operating cost = USD 200,000

Net = USD (108,800) — Multilateral NOT justified on pure marginal cost basis

BUT: Multilateral provides other benefits (see part vi) that make it worthwhile.

(vi) Additional Benefits Beyond Direct Cost Savings

(i) REDUCED FX EXPOSURE: Aggregated netting reduces intercompany open FX positions. Group treasury can hedge NET exposure rather than individual bilateral flows.

(ii) IMPROVED CASH VISIBILITY: Real-time consolidated view of intercompany positions and needs across entities enables better cash forecasting.

(iii) STANDARDIZED PROCESSES: All subsidiaries follow the same intercompany invoicing, payment, and reconciliation format. Reduces disputes and delays.

(iv) TAX OPTIMIZATION: Netting centre in favorable jurisdiction (Singapore, Ireland, GIFT City) may enjoy lower withholding tax on interest and preferential tax on treasury income.

(v) STRATEGIC LIQUIDITY MANAGEMENT: Group treasury can DEPLOY excess cash from surplus entities to fund deficit entities without external borrowing.

(vi) REGULATORY COMPLIANCE: Single centralized reporting hub for cross-border payment compliance (FEMA, GST, transfer pricing).

(vii) SETTLEMENT RISK REDUCTION: Fewer wires = fewer opportunities for errors, wrong routing, or settlement failures.

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(viii) RELATIONSHIP MANAGEMENT: Consolidated dealing with fewer counterparty banks enables better negotiated pricing on FX and treasury services.

Question 6 — Adjusted Present Value (APV) — Cross-Border Acquisition (Wipro US Acquisition)

Case Study — Wipro Limited Acquisition of CloudTech USA

Rishad Premji, Chairman of Wipro Limited, is evaluating the acquisition of CloudTech USA, a Seattle-based cloud services and AI infrastructure company. This is a strategic acquisition to boost Wipro's Digital Services segment in the US enterprise cloud market.

Acquisition Details:

Parameter	Value
Purchase Consideration	USD 200 million (all-cash)
Project Life	5 years (analysis horizon)
Financing Structure	USD 100M debt + USD 100M internal equity
Debt Terms	5-year bullet loan @ 6% p.a. (USD)
US Corporate Tax Rate on CloudTech Earnings	25%
Wipro's UNLEVERED Cost of Equity (USD)	11%
US Risk-Free Rate (5-year Treasury)	4%
Current Spot USD/INR	₹83.50
US Government Tax Credit for Tech M&A	USD 5M per year for 3 years

Expected Unlevered Cash Flows (Post-US-Tax, USD Millions):

Year	Operating CF (M)	Terminal Value (M)	Total CF (M)
Year 1	25	-	25
Year 2	35	-	35
Year 3	45	-	45
Year 4	50	-	50
Year 5	55	120 (exit sale)	175

Required:

(i) Compute the BASE CASE NPV assuming the acquisition is financed 100% by equity (using the unlevered cost of equity of 11%).

(ii) Compute the PV of INTEREST TAX SHIELDS from the USD 100M debt financing.

(iii) Compute the PV of the US GOVERNMENT TAX CREDIT subsidy for 3 years.

(iv) Compute the ADJUSTED PRESENT VALUE (APV) of the acquisition.

(v) Convert the APV to INR at the current spot rate for Wipro Board presentation.

(vi) State the accept/reject decision and identify the SOURCE-WISE VALUE CREATION (operating value vs financing value).

Solution

(i) Base Case NPV (Unlevered)

Discount all unlevered cash flows at Ke_unlevered = 11%

Year	CF (USD M)	PVF @ 11%	PV (USD M)
Y1	25.000	0.9009	22.523
Y2	35.000	0.8116	28.407

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Year	CF (USD M)	PVF @ 11%	PV (USD M)
Y3	45.000	0.7312	32.904
Y4	50.000	0.6587	32.937
Y5	175.000	0.5935	103.854
Total PV of Unlevered CFs			**220.623**
Less: Initial Investment			(200.000)
BASE CASE NPV			**USD 20.623 M**

(ii) PV of Interest Tax Shields

Annual Interest Tax Shield:

Annual Interest = USD 100M × 6% = USD 6.0 M

Annual Tax Shield = USD 6.0M × 25% = USD 1.5 M

PV of Tax Shield Annuity (Discount at Debt Rate 6% for 5 years):

PVIFA(6%, 5) = [1 − (1.06)^(−5)] / 0.06 = 4.2124

PV of Tax Shield = USD 1.5M × 4.2124

= USD 6.319 Million

(iii) PV of US Government Tax Credit Subsidy

Subsidy Details:

- USD 5 M per year for 3 years
- Being a government-guaranteed subsidy, discount at RISK-FREE rate (4%)

PV Computation:

PVIFA(4%, 3) = [1 − (1.04)^(−3)] / 0.04 = 2.7751

PV of Subsidy = USD 5M × 2.7751

= USD 13.875 Million

(iv) Adjusted Present Value (APV)

Component	Value (USD M)	% of APV
Base Case NPV	20.623	50.5%
+ PV of Interest Tax Shields	6.319	15.5%
+ PV of Government Subsidy	13.875	34.0%
ADJUSTED PRESENT VALUE (APV)	**USD 40.817 M**	**100%**

(v) APV in INR at Current Spot

APV in INR = USD 40.817 M × ₹83.50

= ₹3,408.22 Million

= ₹340.82 Crore

(vi) Decision and Source-Wise Value Creation

Decision: PROCEED with acquisition

APV = +USD 40.82 M / ₹340.82 crore — Strongly positive

Source-Wise Value Decomposition:

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Value Source	USD M	Interpretation
Base Case (Operating)	20.62	Value from CloudTech operations if all-equity funded — genuine business value
Tax Shield (Financing)	6.32	Value from tax deductibility of interest on debt — modest boost
Govt Subsidy (Policy)	13.88	Value from US federal tech M&A incentive — one-time boost
Total APV	**40.82**	

Strategic Insights for Rishad Premji:

(i) OPERATING VALUE DOMINATES (50.5% of APV): CloudTech's underlying business creates half the value — this is genuine, sustainable value.

(ii) SUBSIDY IS SIGNIFICANT BUT TIME-BOUND (34% of APV): USD 13.88M from US tax credit is material. Wipro should ensure eligibility conditions are locked-in before deal close.

(iii) TAX SHIELD MODEST (15.5%): Debt financing adds USD 6.32M — a meaningful but not decisive contribution. Higher leverage would increase this but also raise financial distress risk.

(iv) SENSITIVITY TO SUBSIDY: If US Congress changes the tax credit rules (a real risk given policy shifts), Wipro loses USD 13.88M of the APV. Consider structuring deal with subsidy contingency clauses.

(v) DEAL FEASIBILITY: Base NPV alone (USD 20.6M) is positive but modest. Financing side effects (USD 20.2M combined) DOUBLE the total value — showcasing APV's power to reveal hidden value sources.

Question 7 — APV with Multi-Currency Debt Financing — Indian Company in Europe (May 2026 Q3(a) Style)

Case Study — Indian Company European Project (May 2026 Q3(a))

An Indian company is investing in a 2-year project in Europe (EURO). The company's Board is evaluating three financing options for the 50% debt requirement, with the balance funded through internal equity.

Project Data:

Parameter	Value
Initial Investment	€ 4,000,000
Project Life	2 years
Annual After-Tax Operating Cash Flow (Y1 & Y2)	€ 2,500,000
Unlevered Cost of Capital	12%
Spot Rate	₹ 90 per €
Corporate Tax Rate (India)	30%
Debt Financing Required (50% of investment)	€ 2,000,000 / ₹ 18 crore equivalent

Financing Options Available:

Option	Borrowing Currency	Interest Rate (p.a.)
A	India (INR)	9%
B	Europe (EUR)	5%
C	USA (USD)	3%

Additional Data (for IRP-based Forward Rate Computation):

Parameter	Value
Spot USD/INR	₹ 75
Spot EUR/USD	1.20
Interest Rate in USA	3% p.a.
Interest Rate in Europe	5% p.a.

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Parameter	Value
Interest Rate in India	9% p.a.
Assumptions	IRP holds; No transaction cost

Present Value Factors:

Rate	Year 1	Year 2
12% (Unlevered Ke)	0.893	0.797
9% (Cost of Debt - INR)	0.917	0.842
5% (Cost of Debt - EUR)	0.952	0.907

Required:

(i) Identify which financing option is the CHEAPEST and explain why.

(ii) Compute the ADJUSTED PRESENT VALUE (APV) under the cheapest financing option.

Solution

Working Note — Forward Rates via Interest Rate Parity

Applying IRP: Forward Rate = Spot × [(1 + Interest_Home) / (1 + Interest_Foreign)]^t

Rate	USD/INR	EUR/USD	EUR/INR (Cross)
Spot	INR 75	USD 1.20	75 × 1.20 = INR 90
Year 1 Forward	75 × (1.09/1.03) = INR 79.37	1.20 × (1.03/1.05) = USD 1.177	79.37 × 1.177 = INR 93.42
Year 2 Forward	75 × $(1.09/1.03)^2$ = INR 83.99	1.20 × $(1.03/1.05)^2$ = USD 1.155	83.99 × 1.155 = INR 97.01

Interpretation:

- USD is expected to DEPRECIATE against INR (Y2 spot expected at ₹83.99 vs ₹75) — reflects INR higher interest rate
- EUR is expected to DEPRECIATE against USD (from USD 1.20 to USD 1.155) — reflects EUR higher interest rate
- EUR is expected to APPRECIATE against INR (from ₹90 to ₹97.01) — net effect via cross

(i) Cheapest Financing Option — Total INR Outflow Comparison

Initial Investment in INR:

€ 4,000,000 × ₹ 90 = ₹ 36,00,00,000 (₹36 crore)

Debt Required (50%): ₹ 18,00,00,000 (₹18 crore INR) OR € 2,000,000 OR USD 24,00,000

(EUR to USD conversion at spot: € 2,000,000 × USD 1.20 = USD 24,00,000)

Option A — Borrowing in INR at 9%:

Item	Computation	Amount (₹)
Interest for 2 Years	₹ 18,00,00,000 × 9% × 2	3,24,00,000
Repayment of Principal (Y2)	₹ 18,00,00,000	18,00,00,000
TOTAL INR OUTFLOW		**₹ 21,24,00,000**

Option B — Borrowing in EUR at 5%:

Item	Computation	Amount (₹)
Annual Interest (EUR)	€ 2,00,00,000... corr: € 20,00,000 × 5%	€ 1,00,000
Interest Y1 in INR	€ 1,00,000 × ₹ 93.42	93,42,000
Interest Y2 in INR	€ 1,00,000 × ₹ 97.01	97,01,000
Repayment Principal Y2	€ 20,00,000 × ₹ 97.01	19,40,20,000
TOTAL INR OUTFLOW		**₹ 21,30,63,000**

Option C — Borrowing in USD at 3%:

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Item	Computation	Amount (₹)
Annual Interest (USD)	USD 24,00,000 × 3%	USD 72,000
Interest Y1 in INR	USD 72,000 × ₹ 79.37	57,14,640
Interest Y2 in INR	USD 72,000 × ₹ 83.99	60,47,280
Repayment Principal Y2	USD 24,00,000 × ₹ 83.99	20,15,76,000
TOTAL INR OUTFLOW		**₹ 21,33,37,920**

Comparison of Total INR Outflow:

Option	Total INR Outflow	Rank
A — INR borrowing	₹ 21,24,00,000	1 (CHEAPEST)
B — EUR borrowing	₹ 21,30,63,000	2
C — USD borrowing	₹ 21,33,37,920	3

Conclusion: Option A (INR borrowing) is the CHEAPEST, with the lowest total INR outflow of ₹21.24 crore.

Rationale — Why IRP Neutralizes Nominal Interest Advantage:

- USD has the lowest nominal rate (3%) but IRP predicts USD to APPRECIATE against INR (spot ₹75 → Y2 ₹83.99)
- This USD appreciation increases the INR cost of USD principal repayment, offsetting the low interest advantage
- Similarly for EUR at 5%: EUR appreciates against INR (₹90 → ₹97.01), offsetting its interest advantage vs INR
- Under strict IRP, all three options should give SIMILAR total outflow — the small difference (₹9.38 lakh between A and C) is due to compounding rounding effects

Alternative Method — Post-Tax Rate Comparison (yields Option B as cheapest):

- Option A: Post-tax cost = 9% × (1 − 30%) = 6.30%
- Option B: Post-tax cost = 5% × (1 − 30%) = 3.50%
- Option C: Effective EUR cost via IRP = 3% × (1.05/1.03) ≈ 5%; Post-tax ≈ 3.50%
- By this method, Options B and C tie at 3.50% post-tax; Option A appears most expensive
- ICAI has accepted BOTH approaches — this analysis proceeds with the comprehensive Method 2 (Option A)

(ii) APV Computation Under Option A (INR Debt)

Step 1: Base NPV (Unlevered)

Discount project cash flows (in EUR converted to INR at forward rates) at unlevered Ke of 12%.

Year	CF (EUR)	Applicable Rate (₹/€)	Amount in INR (₹)	PVF @ 12%	PV (₹)
0	(40,00,000)	90.00	(36,00,00,000)	1.000	(36,00,00,000)
1	25,00,000	93.42	23,35,50,000	0.893	20,85,60,150
2	25,00,000	97.01	24,25,25,000	0.797	19,32,92,425
BASE NPV					**₹ 4,18,52,575**

Step 2: PV of Interest Tax Shield (INR Debt)

Annual Interest = ₹ 18,00,00,000 × 9% = ₹ 1,62,00,000

Annual Tax Shield = ₹ 1,62,00,000 × 30% = ₹ 48,60,000

Discount at pre-tax cost of debt = 9% (Ind AS convention)

Year	Interest (₹)	Tax Shield (₹)	PVF @ 9%	PV in INR (₹)
1	1,62,00,000	48,60,000	0.917	44,56,620
2	1,62,00,000	48,60,000	0.842	40,92,120
TOTAL PV of Tax Shield				**₹ 85,48,740**

Step 3: Adjusted Present Value (APV)

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Component	Value (₹)
Base NPV	4,18,52,575
Add: PV of Tax Shield	85,48,740
ADJUSTED PRESENT VALUE (APV)	**₹ 5,04,01,315**
APV in Crores	**₹ 5.0401 crore**

Decision

APV = ₹ 5,04,01,315 (POSITIVE) → ACCEPT the project financed with INR debt (Option A)

Value Decomposition:

Source of Value	₹	% of APV
Base Case (Operating Value)	4,18,52,575	83.0%
Interest Tax Shield (Financing Value)	85,48,740	17.0%
TOTAL APV	**5,04,01,315**	**100%**

Operating value contributes 83% of total APV; interest tax shield from INR debt financing adds 17%. Both components positive — strong project economics reinforced by tax-efficient financing choice.

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CHAPTER 12 — INTEREST RATE RISK MANAGEMENT

Question 1 — FRA Strip vs Single FRA + Mid-life Mark-to-Market + Settlement

Case Study — JSW Steel Working Capital Hedge

Seshagiri Rao, Joint MD of JSW Steel, needs to hedge ₹500 crore of working capital funding that will be raised in 6 months for a 6-month period (i.e., borrowing during months 6-12 from today). Two hedging strategies are being evaluated with Kotak Mahindra Bank (Dealer):

Available FRA Rates:

FRA	Rate (% p.a.)	Coverage
6×12 FRA	8.25%	180 days starting in 6 months
6×9 FRA	8.10%	90 days starting in 6 months
9×12 FRA	8.40%	90 days starting in 9 months

Day-count basis: Actual/365; Notional: ₹500 crore

Required:

(i) Compare STRATEGY A (single 6×12 FRA) with STRATEGY B (FRA strip 6×9 + 9×12) on effective annualized rate. Recommend which strategy JSW should adopt.

(ii) MID-LIFE MTM: Assume JSW selected Strategy A (single 6×12 FRA at 8.25%). Three months later, the market 3×9 FRA rate has moved to 8.70% (rates rose). Compute the MTM value of JSW's FRA position at that point. 3-month discount rate = 7.50%.

(iii) SETTLEMENT SCENARIO: At the settlement date (end of month 6), 6-month MIBOR fixes at 8.75%. Compute the settlement amount and identify who pays whom.

Solution

(i) Strategy A vs Strategy B — Effective Rate Comparison

Strategy A: Single 6×12 FRA at 8.25% (for 180 days)

Effective annualized rate = 8.25% (as quoted)

Strategy B: FRA Strip (6×9 at 8.10% + 9×12 at 8.40%)

Compound growth factor over 180 days:

$(1 + 0.0810 \times 90/365) \times (1 + 0.0840 \times 90/365)$

$= 1.019973 \times 1.020712$

$= 1.041101$

Effective 180-day return = 4.1101%

Annualized = 4.1101% × 365/180 = 8.3339%

Comparison:

Strategy	Effective Annualized Rate	Rank
A: Single 6×12 FRA	8.2500%	1 (CHEAPER)
B: FRA Strip (6×9 + 9×12)	8.3339%	2
Difference	8.39 bps	Strategy A saves ~₹20.7 lakh on ₹500 cr for 6 months

RECOMMENDATION: JSW should choose STRATEGY A (Single 6×12 FRA at 8.25%).

Reasons: (a) Lower effective locked rate; (b) No reset-rate basis risk between FRAs; (c) Single counterparty exposure vs two.

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ii) Mid-life MTM at End of Month 3

Given: JSW is FIXED PAYER at 8.25% (locked-in rate). Market 3×9 FRA now = 8.70%.

Since rates ROSE, JSW's fixed-payer position is IN-THE-MONEY (contracted rate < market rate).

Step 1: Rate benefit to JSW (as fixed payer):

Rate benefit = 8.70% − 8.25% = 0.45% (45 bps)

Step 2: Accrued rate benefit over the 180-day contract period:

Accrued benefit (as it economically arises across Month 6 to Month 12):

= ₹500 crore × 0.45% × 180/365 = ₹1,10,95,890

Step 3: Discount to FRA settlement date (Month 6) at new 8.70% rate:

Because an FRA settles at the START of the reference period, the benefit must first be discounted across the 180-day contract period at the rate prevailing at the settlement date (i.e. the new 3×9 FRA rate of 8.70%).

Divisor = 1 + 8.70% × 180/365 = 1.042904

Value at Month 6 = ₹1,10,95,890 / 1.042904 = ₹1,06,39,416

Step 4: Discount from Month 6 back to today (Month 3) at 90-day 7.50%:

Divisor = 1 + 7.50% × 90/365 = 1.018493

Today's MTM = ₹1,06,39,416 / 1.018493 = ₹1,04,46,232 (approx ₹1.04 crore)

MTM VALUE: ₹1,04,46,232 (POSITIVE / ASSET) to JSW

Note on the two-stage discounting:

- First discount uses the NEW rate (8.70%) — it is the rate governing the period being settled
- Second discount uses the CURRENT 90-day rate (7.50%) — it is the carry-back to today's date
- Skipping the settlement-date discount overstates the MTM (the ₹1.09 crore intermediate figure was NOT the answer)

Implication:

- If JSW wanted to UNWIND the FRA today, it could receive ₹1.04 crore from a market counterparty
- For accounting: Under Ind AS 109, if designated as cash flow hedge, MTM goes to OCI
- For risk management: MTM movement signals JSW's forecasting has been correct — rates did rise as feared

(iii) Settlement at End of Month 6 (MIBOR = 8.75%)

FRA Settlement Formula:

Settlement = [Notional × (Reference Rate − FRA Rate) × (Days/365)] / [1 + Reference Rate × Days/365]

Numerator = ₹500 cr × (8.75% − 8.25%) × 180/365

= ₹500 cr × 0.50% × 0.4932

= ₹1,23,28,767

Denominator = 1 + 8.75% × 180/365

= 1 + 0.04315

= 1.04315

Settlement = ₹1,23,28,767 / 1.04315 = ₹1,18,19,110 (approx ₹118 lakh)

Payment Direction: Reference rate (8.75%) > FRA rate (8.25%) → KOTAK PAYS JSW ₹1,18,19,110

Effective Cost Reconciliation:

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Component	Amount
Actual interest on ₹500 cr at 8.75% for 180 days	₹21.5754 crore
Less: FRA settlement received from Kotak	(₹1.1819 crore)
Net interest cost	**₹20.3935 crore**
Equivalent locked rate	= ₹20.3935 cr / (₹500 cr × 180/365) = 8.2694% ≈ 8.25%

Effective rate matches the FRA rate of 8.25% (small rounding). Hedge worked perfectly.

Question 2 — Plain Vanilla IRS + Mid-Life MTM + CVA + Counterparty Novation

Case Study — TCS + IDFC First Bank IRS with 3-Year Update

Sameer Seksaria, Head of Treasury at TCS, entered into a 5-year Plain Vanilla IRS structure via HDFC Bank Dealer in April 2024. TCS and IDFC First Bank swapped their comparative advantages using the QSD framework. Two years into the swap (April 2026), significant market and credit events prompt a review.

Original Swap Structure (April 2024):

Party	Fixed Rate Access	Floating Rate Access	Preference
TCS (AAA)	7.50%	MIBOR + 30 bps	Floating
IDFC First Bank (AA)	9.00%	MIBOR + 100 bps	Fixed
Rate spread	1.50%	0.70%	

QSD = 1.50% − 0.70% = 80 bps

Split (via HDFC dealer): TCS 30 bps + IDFC 30 bps + HDFC 20 bps

Structure Established:

- TCS borrows 7.50% fixed externally; enters swap PAY MIBOR, RECEIVE 7.50% from HDFC → Net = MIBOR flat
- IDFC borrows MIBOR + 100 bps externally; enters swap PAY 7.70% fixed to HDFC, RECEIVE MIBOR → Net = 8.70% fixed
- HDFC earns 20 bps arbitrage as dealer margin

Notional: ₹500 crore | Tenor: 5 years | Reset: Annual

April 2026 — Two Years Later (3 Years Remaining):

Market Event 1:

- RBI has cut rates aggressively. Current 3-year swap fixed rate now = 6.75% (down from 7.50% at inception)

Market Event 2:

- IDFC First Bank's credit rating downgraded to A- (from AA). Its CDS spread widened by 250 bps

Required:

(i) Compute TCS's MTM position on the swap as of April 2026. Interpret whether it's an asset or liability for TCS.

(ii) Compute the CREDIT VALUATION ADJUSTMENT (CVA) using a simplified model (MTM × CDS Spread × Avg Life Factor of 0.5). Determine TCS's net exposure after CVA.

(iii) TCS is evaluating three actions: (a) HOLD position; (b) UNWIND at current MTM; (c) NOVATE to another AAA counterparty (Deutsche Bank charges 30 bps upfront novation fee on notional). Recommend the best action.

Solution

(i) TCS MTM Position as of April 2026

TCS's Position in Swap:

- PAYS MIBOR (floating) to HDFC — worth today's PV of MIBOR expectations

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- RECEIVES 7.50% fixed from HDFC — locked in at above-market rate now

MTM Computation:

Since TCS RECEIVES 7.50% and market swap fixed rate is now 6.75%, TCS is receiving above-market:

Annual benefit to TCS = (7.50% − 6.75%) × ₹500 crore

= ₹3.75 crore per year

PV of 3-year benefit stream at market rate 6.75%:

PVIFA(6.75%, 3 years) = [1 − (1.0675)^−3] / 0.0675 = 2.6363

TCS MTM = ₹3.75 crore × 2.6363 = ₹9.886 crore (approx ₹988.63 lakh)

Interpretation:

- TCS's swap is a ₹9.89 crore ASSET on its books
- Rate decline (7.50% → 6.75%) has increased value of TCS's fixed-receipt right
- Under Ind AS 109 (Fair Value through P&L for non-hedge accounting), TCS books ₹9.89 crore gain to P&L

(ii) Credit Valuation Adjustment (CVA)

Rationale:

TCS's ₹9.89 crore claim is on HDFC Bank (dealer) who has back-to-back exposure to IDFC. If IDFC defaults, HDFC's ability to pay TCS is impaired. Since IDFC's CDS spread widened by 250 bps, TCS must adjust the MTM downward.

Simplified CVA Formula:

CVA = MTM Exposure × CDS Spread × Average Life Factor

Average Life Factor for a 3-year exposure ≈ (Remaining tenor / 2) = 3/2 × normalized = 1.5

However, since exposure amortizes toward zero at maturity, use 3 × 0.5 = 1.5, then CVA rate applies per year adjusted

Applied Method:

CVA = ₹988.63 lakh × 2.5% (CDS spread) × 1.5 (avg life adj)

= ₹988.63 × 0.0375

= ₹37.07 lakh

Net MTM after CVA = ₹988.63 lakh − ₹37.07 lakh = ₹951.56 lakh (₹9.5156 crore)

Item	₹ Lakh
Gross MTM (economic value)	988.63
Less: CVA (credit adjustment)	(37.07)
NET MTM (fair value on balance sheet)	**951.56**

(iii) Action Recommendation — Hold, Unwind, or Novate

Option A: HOLD current swap (do nothing)

- Continue receiving ₹3.75 crore annual net benefit for 3 more years
- Bears counterparty risk to HDFC/IDFC (worsening credit)
- Position value: ₹988.63 lakh gross / ₹951.56 lakh net of CVA

Option B: UNWIND at MTM (₹951.56 lakh)

- Receive ₹951.56 lakh today (net of CVA)
- Eliminates all counterparty risk
- But: TCS now needs to re-establish its floating→fixed synthetic exposure via new instrument at prevailing (worse) 6.75% market
- Opportunity cost: New swap at 6.75% instead of 7.50% = ₹3.75 cr/yr foregone

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Option C: NOVATE to Deutsche Bank (AAA)

- TCS pays HDFC ₹951.56 lakh (net MTM already reflects credit); receives from Deutsche Bank an equivalent replacement position at that value
- Actually — TCS keeps the SWAP TERMS INTACT (still receives 7.50%) but Deutsche Bank replaces HDFC as counterparty
- Deutsche Bank charges 30 bps upfront on notional = ₹500 cr × 30/10,000 = ₹1.50 crore fee

Comparison Table:

Metric	Hold	Unwind	Novate to DB
Immediate cash flow	0	+₹9.5156 cr	−₹1.50 cr (fee)
Future annual benefit (3 years)	₹3.75 cr/yr	0 (must re-swap at 6.75%)	₹3.75 cr/yr (preserved)
PV of future benefit @ 6.75%	₹9.8863 cr	0	₹9.8863 cr
Counterparty risk	IDFC/HDFC (deteriorated)	None	Deutsche Bank (AAA)
Net Present Economic Value	**₹9.5156 cr (with CVA)**	**₹9.5156 cr**	**₹9.8863 cr − ₹1.50 cr = ₹8.3863 cr**
Best Financial Outcome	**₹9.5156 cr**	**₹9.5156 cr**	**₹8.3863 cr**

Recommendation: TCS should choose between HOLD (₹9.52 cr) and UNWIND (₹9.52 cr) based on TCS's outlook:

(i) If TCS believes counterparty risk is LOW despite credit widening (HDFC is intermediary, not IDFC directly): HOLD

(ii) If TCS wants to eliminate all counterparty risk and re-invest proceeds: UNWIND, take ₹9.52 cr today

(iii) NOVATION to DB is LEAST attractive purely on economics (loses ₹1.13 cr to novation fee), but preserves hedge continuity + AAA counterparty. Only choose if TCS urgently needs to preserve the exact swap structure

Practitioner Judgement: HOLD (₹9.52 cr) is optimal if TCS views HDFC (as intermediary) as isolated from IDFC's credit issues, as HDFC would absorb the first loss before TCS is affected.

Question 3 — Hedge Strategy Selection — Cap vs Collar vs Swap vs Do Nothing (Probability-Weighted)

Case Study — Torrent Pharmaceuticals ECB Hedging Decision

Sudhir Menon, CFO of Torrent Pharmaceuticals, has raised a USD-equivalent ₹300 crore ECB at floating SOFR (semi-annual reset) for its EU biosimilar plant. The 3-year loan is fully drawn, and Sudhir must select an interest rate hedging strategy.

Torrent's Risk Committee has developed probabilistic view of SOFR:

SOFR Scenarios and Probabilities (Annual Rates for Y1-Y2-Y3):

Scenario	Probability	Y1 SOFR	Y2 SOFR	Y3 SOFR
Bearish (rates rise)	30%	6.0%	7.0%	7.5%
Base case	50%	5.5%	6.0%	6.0%
Bullish (rates fall)	20%	5.0%	4.5%	4.0%

Available Hedge Instruments (from Citi India Fixed Income Desk):

Strategy	Terms	Upfront Cost
1. Do Nothing	Remain on SOFR floating	₹ Nil
2. Buy Cap	Strike 5.50%; 3-year cap	50 bps of notional = ₹1.50 cr
3. Zero-Cost Collar	Buy Cap 5.50% / Sell Floor 4.50%	₹ Nil
4. Pay-Fixed Swap	Pay 5.85% fixed / Receive SOFR	₹ Nil

Notional: ₹300 crore | Tenor: 3 years | Reset: Annual for simplicity

Required:

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(i) For each strategy, compute the TOTAL 3-YEAR INTEREST COST in each of the three SOFR scenarios.

(ii) Compute the EXPECTED (probability-weighted) 3-year interest cost for each strategy.

(iii) Identify the strategy with LOWEST EXPECTED COST and the strategy with LOWEST WORST-CASE COST.

(iv) Recommend the optimal strategy considering both expected cost and risk profile.

Solution

(i) 3-Year Interest Cost Under Each Strategy × Scenario

Notional = ₹300 crore. All amounts in ₹ crore.

Strategy 1: Do Nothing (SOFR floating)

Scenario	Y1 (SOFR × 300cr)	Y2	Y3	Total 3-Yr
Bearish	6% × 300 = 18.00	21.00	22.50	61.50
Base	16.50	18.00	18.00	52.50
Bullish	15.00	13.50	12.00	40.50

Strategy 2: Buy Cap at 5.50% (Premium ₹1.50 cr upfront)

Effective rate each year = MIN(SOFR, 5.50%) → cap kicks in when SOFR > 5.50%

Scenario	Effective Rates Y1/Y2/Y3	Interest (3yr)	Plus Premium	Total
Bearish	5.5% / 5.5% / 5.5%	49.50	1.50	51.00
Base	5.5% / 5.5% / 5.5%	49.50	1.50	51.00
Bullish	5.0% / 4.5% / 4.0%	40.50	1.50	42.00

Strategy 3: Zero-Cost Collar (bounded 4.5% - 5.5%)

Effective rate = MAX(4.50%, MIN(SOFR, 5.50%))

Scenario	Effective Rates Y1/Y2/Y3	Total Interest 3yr
Bearish	5.5% / 5.5% / 5.5%	49.50
Base	5.5% / 5.5% / 5.5%	49.50
Bullish	5.0% / 4.5% / 4.5%	42.00 (floor kicks in Y3)

Strategy 4: Pay-Fixed Swap at 5.85%

Effective rate = 5.85% every year regardless of SOFR

Scenario	All Years	Total Interest 3yr
All 3 scenarios	5.85% × ₹300 cr = ₹17.55 cr/yr	52.65

(ii) Expected Cost Computation (Probability-Weighted)

Strategy	Bearish (0.30)	Base (0.50)	Bullish (0.20)	Expected Cost
1. Do Nothing	61.50	52.50	40.50	0.30×61.50 + 0.50×52.50 + 0.20×40.50 = 52.80
2. Cap 5.5%	51.00	51.00	42.00	0.30×51 + 0.50×51 + 0.20×42 = 49.20
3. Collar 4.5-5.5%	49.50	49.50	42.00	0.30×49.5 + 0.50×49.5 + 0.20×42 = 48.00
4. Swap 5.85%	52.65	52.65	52.65	52.65

(iii) Ranking on Expected Cost and Worst-Case Cost

Rank	By Expected Cost (lowest)	By Worst-Case Cost (lowest)
1	Collar (₹48.00 cr)	Collar (₹49.50 cr worst case)
2	Cap (₹49.20 cr)	Cap (₹51.00 cr — includes ₹1.50 cr premium)
3	Swap (₹52.65 cr)	Swap (₹52.65 cr — same across all scenarios)
4	Do Nothing (₹52.80 cr)	Do Nothing (₹61.50 cr worst)

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Note: In the bearish scenario the Collar caps all three years at 5.50%, giving 5.50% × ₹300 cr × 3 = ₹49.50 cr. The Cap does the same but adds ₹1.50 cr upfront premium, taking the total to ₹51 cr. The Collar therefore strictly beats the Cap on both metrics.

(iv) Recommendation

Best Choice: STRATEGY 3 — ZERO-COST COLLAR

Justification:

(i) LOWEST expected cost across all strategies: ₹48.00 crore (₹1.20 cr better than Cap, ₹4.65 cr better than Swap)

(ii) LOWEST worst-case cost at ₹49.50 crore — strictly beats Cap's ₹51 crore (worst case includes cap premium)

(iii) ZERO upfront premium (unlike Cap which costs ₹1.50 cr upfront regardless of outcome)

(iv) Sacrifices some benefit only if rates fall below 4.50% (Y3 bullish scenario) — a limited tail-risk giveup

When to prefer alternatives:

- If Torrent had STRONG conviction rates will fall (>60% bullish prob): Do Nothing dominates
- If Torrent needed COMPLETE CERTAINTY for debt covenants: Swap eliminates variance (only strategy with ZERO deviation)
- If Torrent had budget flexibility and wanted to keep bullish upside: Cap (retains rate-decline benefit above collar's floor)

Risk Profile Summary:

Strategy	Expected	Std Dev	Interpretation
Do Nothing	₹52.80 cr	Highest	Maximum uncertainty
Cap	₹49.20 cr	Low	Capped upside, floating downside
Collar	₹48.00 cr	Lowest	Narrow bounded range
Swap	₹52.65 cr	Zero	Complete certainty; forgoes all upside

Question 4 — Off-Market Cross-Currency Swap + Mid-Life Unwind + FX Gain/Loss Attribution

Case Study — TCS USD ECB with Off-Market CCS and Prepayment

Kedar Shirali, Head of Global Treasury at Tata Consultancy Services, executed a 5-year USD 100 million ECB in April 2024 at 4% USD fixed, spot ₹83.50. TCS entered into a CROSS-CURRENCY SWAP with State Bank of India (SBI) Treasury with the following unique structure:

Original CCS Structure (Off-Market Design):

Element	Detail
USD ECB Notional (Underlying)	USD 100 million
USD ECB Coupon	4% p.a. fixed (semi-annual, simplified as annual)
Spot at Inception	₹83.50 per USD
INR Notional	₹835 crore
Tenor	5 years bullet
CCS Structure	TCS pays INR fixed / receives USD fixed 4% (offsets ECB)
TCS INR Fixed Rate under CCS	7.75% (OFF-MARKET — market rate is 7.50%; TCS OVERPAYS)
Market CCS INR Rate at Inception	7.50% p.a.
Upfront to TCS	Equivalent PV of 25 bps annuity for 5 years (compensation for overpaying)
Principal Re-exchange at Maturity	At original spot ₹83.50

April 2027 — Three Years Later (2 Years Remaining):

Market Update:

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- INR has depreciated: New spot = ₹86.00 per USD (vs ₹83.50 at inception)
- Market 2-year CCS INR rate is now 6.50% (fallen from 7.50%)
- TCS is evaluating early exit from the ECB + CCS combination

Required:

(i) Compute the UPFRONT RECEIPT to TCS at inception, given TCS has agreed to pay an above-market 7.75% INR fixed rate (vs 7.50% market).

(ii) Compute the MTM LOSS on the CCS if TCS unwinds today (April 2027, 2 years remaining), given new market CCS INR rate is 6.50%.

(iii) Compute the FX GAIN or LOSS that TCS would face on ECB principal prepayment WITHOUT the CCS (using new spot ₹86).

(iv) Compute NET COST TO TCS of unwinding the full ECB+CCS package today. Compare with the alternative of holding to maturity.

Solution

(i) Upfront Receipt at Inception (Off-Market Design)

Excess Paid by TCS per Semi-Annual Period:

TCS's contract rate: 7.75% p.a. (3.8750% per half-year)

Market rate: 7.50% p.a. (3.7500% per half-year)

Semi-annual excess = (3.8750% − 3.7500%) × ₹835 crore

= 0.1250% × ₹835 crore = ₹1.04375 crore per half-year

TCS is committing to pay 12.5 bps ABOVE market every half-year for 10 semi-annual periods. SBI, as the recipient of the above-market coupon, must compensate TCS upfront with the PV of that annuity.

PV of 10-Period Excess Annuity (at Semi-Annual Market Rate 3.75%):

PVIFA(3.75%, 10) = $[1 - (1.0375)^{-10}] / 0.0375 = 8.2128$

Upfront to TCS = ₹1.04375 crore × 8.2128 = ₹8.5721 crore (approximately)

TCS's Perspective:

- Receives ₹8.57 crore CASH UPFRONT from SBI as compensation for accepting above-market coupon
- In exchange, pays above-market rate 7.75% p.a. (semi-annual) for 5 years (₹1.04 cr per half-year higher than market)
- Economic value: NEUTRAL at inception (upfront receipt = PV of semi-annual excess payments)
- Accounting: The ₹8.57 cr is treated as DAY-1 FINANCING (like a loan), amortized over swap life

(ii) MTM Loss on CCS Unwind (April 2027)

TCS's Position at Unwind:

- PAYING 7.75% p.a. (3.8750% per half-year) INR fixed on ₹835 crore for 2 more years (4 semi-annual periods)
- Market rate for 2-year CCS INR is now 6.50% p.a. (3.2500% per half-year), fallen from 7.50% at inception
- TCS is paying ABOVE MARKET by 125 bps p.a. (62.5 bps per half-year) → CCS has DEEPLY NEGATIVE MTM

Excess Payment per Semi-Annual Period (loss to TCS):

= (3.8750% − 3.2500%) × ₹835 crore = 0.625% × ₹835 crore = ₹5.21875 crore per half-year

PV of 4-Period Excess (Discount at new semi-annual market rate 3.25%):

PVIFA(3.25%, 4) = $[1 - (1.0325)^{-4}] / 0.0325 = 3.6950$

MTM Loss = ₹5.21875 crore × 3.6950 = ₹19.2832 crore

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MTM Loss on CCS Unwind = ₹19.28 crore (TCS pays SBI to terminate)

Note: The rate move was doubly adverse — TCS started 25 bps p.a. above market and rates then fell 100 bps p.a., widening the gap to 125 bps p.a. (62.5 bps per period). The ₹8.57 cr upfront TCS received at inception has been partly amortised in the semi-annual interest payments already made across the elapsed 6 periods; the ₹19.28 cr is the pure market MTM on the remaining 4 semi-annual periods.

(iii) FX Gain/Loss on ECB Prepayment WITHOUT CCS

Without CCS Protection:

If TCS were to prepay ECB USD 100M today without CCS re-exchange:

INR required = USD 100 million × ₹86.00 = ₹860 crore

INR originally raised = USD 100 million × ₹83.50 = ₹835 crore

FX Loss = ₹860 crore – ₹835 crore = ₹25 crore

This ₹25 crore FX loss reflects INR's depreciation from ₹83.50 to ₹86.00 during the loan tenor.

(iv) Net Cost of Unwinding ECB+CCS Package

Cash Flow Sequence at Unwind:

Step 1: CCS Principal Re-exchange (Baked into CCS Contract)

- TCS PAYS: ₹835 crore (INR notional to SBI)
- TCS RECEIVES: USD 100 million (at original spot ₹83.50)
- Net FX Effect: NIL — this is contractual, not at market spot

Step 2: TCS uses the USD 100 million to prepay the ECB

- TCS PAYS: USD 100 million (to ECB lender)
- USD 100 million from CCS exactly matches ECB principal → NO FX loss

Step 3: CCS MTM Settlement

- TCS PAYS SBI: ₹19.28 crore (MTM loss on unwind, from (ii))

Total Net Cost of Unwind:

Component	Amount
ECB Prepayment (USD 100M covered by CCS, no FX loss)	₹ Nil
CCS Principal re-exchange at ₹83.50 (contractual)	₹ Nil (offset)
MTM Loss on CCS unwind	₹19.28 crore
NET COST OF UNWIND	**₹19.28 crore**

Comparison with Unhedged Prepayment (if no CCS existed):

Scenario	Cost
Without CCS: FX loss on principal	₹25.00 crore
With CCS: MTM loss on unwind	₹19.28 crore
CCS Value Preserved	**₹5.72 crore saved**

Key Insight:

- Even with the doubly adverse rate move (25 bps p.a. above market at inception plus 100 bps p.a. rate decline), the CCS still preserved ₹5.72 crore of value against the ₹25 crore FX loss on the unhedged principal
- CCS Principal Re-exchange at Original Spot = insurance against USD principal exposure
- Interest-rate MTM losses (even at ₹19.28 cr) remain smaller than the FX exposure the CCS eliminated

Alternative: Hold to Maturity (2 more years / 4 semi-annual periods)

If TCS holds:

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- Pays ₹32.36 cr semi-annually × 2 = ₹64.7125 cr / yr on INR leg (offset by USD receipts equivalent to ECB coupons)
- If rates stay at 6.50%, TCS overpays ₹5.22 cr / half-year × 4 = ₹20.88 crore total on undiscounted basis
- But TCS avoids the ₹19.28 cr immediate MTM crystallization and keeps the FX hedge intact
- Choice depends on TCS's cash needs, tax planning, and view on rate direction

Recommendation:

Given rates have fallen 100 bps and future direction is uncertain, TCS should evaluate:

- (a) If rates likely to fall further → UNWIND now (avoid deepening MTM loss)
- (b) If rates likely to rise → HOLD (MTM will improve; can even become gain)
- (c) If unwind proceeds can be redeployed at attractive returns → UNWIND

Question 5 — Fixed-to-Floating Interest Rate Swap + Mid-Life MTM Valuation

Case Study — Bajaj Finance Fixed-to-Floating Conversion

Sandeep Jain, Chief Financial Officer of Bajaj Finance Ltd., has issued ₹1,000 crore of 5-year Non-Convertible Debentures (NCDs) in April 2026 at a FIXED coupon of 8.50% p.a. Bajaj Finance's asset side is predominantly FLOATING RATE (SME loans, personal loans reset annually to MIBOR + spread). This creates an ALM MISMATCH — fixed liabilities vs. floating assets.

To synchronize the liability profile with the asset side and to benefit from expected RBI rate cuts, Sandeep enters into a Fixed-to-Floating IRS with SBI Capital Markets:

Swap Terms:

Parameter	Value
Notional Principal	₹1,000 crore
Tenor	5 years (matching NCD tenor)
Bajaj Finance PAYS	1-Year MIBOR (floating, annual reset)
Bajaj Finance RECEIVES	8.20% Fixed p.a.
Reset Dates	Annual
Counterparty	SBI Capital Markets

Underlying NCD Coupon: 8.50% p.a. Fixed

Net Effective Rate = 8.50% (NCD) − 8.20% (Swap Receive) + MIBOR (Swap Pay) = MIBOR + 30 bps

Realized MIBOR at Each Annual Reset:

Year	1-Yr MIBOR
Y1	7.50%
Y2	7.80%
Y3	8.00%
Y4	7.30%
Y5	6.80%

Required:

(i) Prepare a YEAR-BY-YEAR CASH FLOW SCHEDULE showing NCD Coupon, Swap Pay Floating, Swap Receive Fixed, Net Cost, and Effective Rate for each year.

(ii) Compute the TOTAL 5-YEAR EFFECTIVE INTEREST COST and compare with the UNHEDGED cost of ₹1,000 cr × 8.50% × 5 years.

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(iii) MID-LIFE MTM: At end of Year 2, the 3-year swap fixed rate has fallen to 7.50%. Compute Bajaj Finance's MTM on the swap and interpret whether it is an asset or liability.

(iv) Discuss the ALM benefit and rate-view rationale for undertaking this Fixed-to-Floating conversion.

Solution

(i) Year-by-Year Cash Flow Schedule (₹ crore)

Year	MIBOR	NCD Coupon (8.50%)	Swap Pay MIBOR	Swap Receive 8.20%	Net Cost	Effective Rate
Y1	7.50%	85.00	75.00	(82.00)	78.00	7.80%
Y2	7.80%	85.00	78.00	(82.00)	81.00	8.10%
Y3	8.00%	85.00	80.00	(82.00)	83.00	8.30%
Y4	7.30%	85.00	73.00	(82.00)	76.00	7.60%
Y5	6.80%	85.00	68.00	(82.00)	71.00	7.10%
TOTAL 5-YR		**425.00**	**374.00**	**(410.00)**	**389.00**	

Formula: Net Cost = NCD Coupon + Swap Pay Floating − Swap Receive Fixed

= (8.50% × ₹1,000 cr) + (MIBOR × ₹1,000 cr) − (8.20% × ₹1,000 cr)

= ₹1,000 cr × (0.30% + MIBOR)

Effective Rate = MIBOR + 30 bps (spread between NCD rate 8.50% and Swap Receive 8.20%)

(ii) Total Effective Cost Comparison

Scenario	Total 5-Year Cost (₹ crore)	Average Annual Rate
Unhedged (NCD only at 8.50% fixed)	425.00	8.50%
Hedged (with Fixed-to-Floating Swap)	389.00	7.78%
SAVINGS FROM SWAP	**₹36.00 crore**	**72 bps**

Analysis:

- Average realized MIBOR: (7.50 + 7.80 + 8.00 + 7.30 + 6.80) / 5 = 7.48%
- Average effective cost: 7.48% + 0.30% = 7.78%
- Savings of ₹36 crore (72 bps) reflects that AVERAGE MIBOR realized was BELOW the swap fixed rate of 8.20%
- Ex-ante, Bajaj's view that rates would decline was CORRECT and monetized via the swap

(iii) Mid-Life MTM at End of Year 2

Bajaj Finance's Position in Swap:

- PAYS MIBOR (floating) for 3 more years
- RECEIVES 8.20% Fixed for 3 more years

Market Update: New 3-Year Swap Fixed Rate = 7.50% (fallen from earlier levels)

MTM Computation:

Since Bajaj RECEIVES 8.20% and market rate for 3-year swap is now 7.50%, Bajaj is receiving ABOVE-MARKET fixed.

Annual benefit to Bajaj = (8.20% − 7.50%) × ₹1,000 crore

= ₹7.00 crore per year

PV of 3-year benefit stream (discount at new market rate 7.50%):

PVIFA(7.50%, 3) = [1 − (1.075)^−3] / 0.075 = 2.6005

MTM = ₹7.00 crore × 2.6005 = ₹18.20 crore

MTM VALUE = ₹18.20 crore (POSITIVE / ASSET on Bajaj Finance's Balance Sheet)

Interpretation:

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- If Bajaj were to UNWIND today, it would receive ₹18.20 crore from SBI
- Under Ind AS 109 (Fair Value through P&L for non-hedge accounting), Bajaj books ₹18.20 crore gain
- If designated as a HEDGE for the underlying floating-rate assets, MTM goes to OCI (Other Comprehensive Income)
- This MTM asset validates Bajaj's initial view — rates did fall

(iv) ALM Benefit and Rate-View Rationale

A. ALM Benefit (Asset-Liability Matching):

Item	Before Swap	After Swap
Liability (NCD)	₹1,000 cr @ 8.50% FIXED	₹1,000 cr @ MIBOR + 30 bps (FLOATING)
Assets (SME + Personal Loans)	Predominantly FLOATING (MIBOR-linked)	Same
Rate sensitivity mismatch	HIGH (fixed liability vs floating asset)	LOW (floating liability matches floating asset)
Net Interest Margin (NIM) volatility	HIGH	LOW (moves in lockstep with assets)

B. Rate-View Rationale:

(i) Bajaj expected rates to DECLINE (RBI dovish, inflation cooling)

(ii) Fixed-to-Floating swap monetizes this view — every basis point rate cut translates into lower cost

(iii) Ex-post: Average MIBOR 7.48% vs 8.20% swap fixed rate → correct view, ₹36 cr saved over 5 years

(iv) In addition, MTM asset of ₹18.20 crore represents unrealized gain on the remaining 3 years of the swap

C. Risk Considerations:

- If Bajaj's view was WRONG (rates rise), effective cost would have exceeded 8.50% — swap creates OPPOSITE exposure
- Counterparty risk to SBI (mitigated by CSA collateralization if in place)
- Basis risk if NCDs re-price differently from swap (mitigated as both are periodic reset)

Question 6 — Choice of Three Collar Structures — Symmetric / Asymmetric / Participating

Case Study — HDFC AMC Multi-Structure Collar Selection

Anupam Joshi, Fund Manager of HDFC Credit Risk Fund, manages a ₹200 crore floating rate corporate bond portfolio paying MIBOR flat. Given uncertain rate direction and the fund's mandate to protect NAV while retaining some upside, Anupam is choosing among three collar structures offered by JPMorgan India:

Three Collar Structures Available:

Structure	Floor Strike (bought)	Cap Strike (sold)	Participation Above Cap	Net Premium
1. Symmetric	6.50%	8.50%	0% (hard cap)	Zero
2. Asymmetric	7.00%	9.50%	0% (hard cap)	Zero
3. Participating	7.00%	8.00%	50% (soft cap)	Zero

Expected 5-Year MIBOR Scenarios:

Year	MIBOR
Year 1	5.50%
Year 2	7.50%
Year 3	8.50%
Year 4	9.50%
Year 5	7.00%

Notional: ₹200 crore | Tenor: 5 years

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Required:

(i) For EACH structure, compute the EFFECTIVE COUPON RATE each year based on realized MIBOR.

(ii) Compute the TOTAL 5-YEAR INCOME under each structure.

(iii) Rank the three structures by 5-year income; explain why the ranking may not equal the best choice.

(iv) Recommend the optimal structure considering upside participation, downside protection, and NAV volatility.

Solution

(i) Effective Rate Each Year Under Each Structure

Structure 1 (Symmetric): Effective Rate = MAX(6.50%, MIN(MIBOR, 8.50%))

Structure 2 (Asymmetric): Effective Rate = MAX(7.00%, MIN(MIBOR, 9.50%))

Structure 3 (Participating):

- If MIBOR < 7.00%: Rate = 7.00% (floor kicks in)
- If 7.00% ≤ MIBOR ≤ 8.00%: Rate = MIBOR (in the sweet spot)
- If MIBOR > 8.00%: Rate = 8.00% + 50% × (MIBOR − 8.00%) [participating]

Year	MIBOR	Symmetric (%)	Asymmetric (%)	Participating (%)
1	5.50	6.50 (floor)	7.00 (floor)	7.00 (floor)
2	7.50	7.50 (mid)	7.50 (mid)	7.50 (mid)
3	8.50	8.50 (cap)	8.50 (mid)	8.25 [8% + 50%×0.5%]
4	9.50	8.50 (cap)	9.50 (cap)	8.75 [8% + 50%×1.5%]
5	7.00	7.00 (mid)	7.00 (floor)	7.00 (floor)

(ii) 5-Year Income Under Each Structure

Annual Income = Effective Rate × ₹200 crore

Year	MIBOR	Sym Income (₹cr)	Asym Income (₹cr)	Part Income (₹cr)
1	5.50%	13.00	14.00	14.00
2	7.50%	15.00	15.00	15.00
3	8.50%	17.00	17.00	16.50
4	9.50%	17.00	19.00	17.50
5	7.00%	14.00	14.00	14.00
5-YEAR TOTAL		**76.00**	**79.00**	**77.00**

(iii) Ranking by 5-Year Income

Rank	Structure	5-Year Income (₹cr)
1	Asymmetric (Structure 2)	79.00
2	Participating (Structure 3)	77.00
3	Symmetric (Structure 1)	76.00

Why the Highest Income Structure May NOT Be Best:

(i) Asymmetric had HIGHER FLOOR (7% vs 6.5%) which paid off in Y1 and Y5 (low-MIBOR years)

(ii) AND had HIGHER CAP (9.5% vs 8.5%) which paid off in Y4 (high-MIBOR year)

(iii) BUT this comes with hidden trade-off: If MIBOR had stayed persistently BETWEEN 5.50% and 7.00% for many years, Asymmetric wouldn't participate above floor → downside is real

(iv) Participating structure gave up income in Y3 and Y4 (bounded above 8%) but retained partial upside

This analysis is scenario-dependent — the 'best' structure depends on THE ACTUAL RATE PATH.

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(iv) Recommendation Framework

For Anupam's Fund (NAV stability, retail investor mandate):

Criterion	Best Structure	Rationale
Highest expected income (in the given scenario)	Asymmetric	₹79 cr total
Least NAV volatility (tightest range)	Participating	Narrower bounds: 7%-8% mostly
Best downside protection	Asymmetric or Participating	Both have 7% floor vs 6.5% for Symmetric
Best upside capture in extreme rate rise	Asymmetric	Full participation up to 9.5%
Simplicity / lowest counterparty complexity	Symmetric	Standard structure, easy to explain to investors

RECOMMENDATION:

If Anupam is BULLISH on rates rising: ASYMMETRIC — captures the rising rate benefit up to 9.5%

If Anupam wants BALANCED risk-return: PARTICIPATING — retains upside above 8% with 50% participation, tighter income range

If Anupam is CONSERVATIVE and wants zero-cost simplicity: SYMMETRIC — standard, well-understood, least model risk

The final choice hinges on Anupam's RATE VIEW and INVESTOR EXPECTATIONS. In this specific scenario (rates rise then fall), Asymmetric performs best (₹79 cr), but the choice must be made ex-ante without perfect foresight.

Question 7 — Cheapest-to-Deliver (CTD) Bond Identification — G-Sec Futures Delivery

Case Study — ICICI Bank Treasury Delivery on NSE 10Y G-Sec Futures

Anindya Banerjee, Chief Dealer (Fixed Income) at ICICI Bank Treasury, has a SHORT POSITION of 5,000 contracts in the NSE 10-Year G-Sec Futures expiring on 30-June-2026. Each contract has a face value of ₹2 lakh, giving ICICI a total delivery obligation of ₹100 crore face value G-Secs. Anindya must identify which of four eligible bonds is CHEAPEST-TO-DELIVER.

Given Data:

Parameter	Value
Futures Settlement Price (as of today)	₹100.00 per ₹100 face
Notional Coupon Rate (NSE spec)	6.00% p.a.
Number of Contracts (Short)	5,000
Face Value per Contract	₹2 lakh
Total Face Value to Deliver	₹100 crore
Days to Delivery	90 days

Four Eligible Deliverable Bonds:

Bond	Coupon	Residual Maturity	Cash Market Price (₹)	Conversion Factor
Bond A	7.00%	8.5 years	107.20	1.0620
Bond B	6.50%	9.0 years	104.10	1.0340
Bond C	6.00%	10.0 years	100.50	1.0000
Bond D	5.50%	11.0 years	95.30	0.9634

Required:

(i) Compute the INVOICE PRICE (Futures × CF) and COST OF DELIVERY for each of the four bonds.

(ii) Identify the CHEAPEST-TO-DELIVER (CTD) bond and interpret why it is cheapest.

(iii) Compute the IMPLIED REPO RATE (annualized on 365-day basis) for each bond and verify CTD choice.

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(iv) Compute the TOTAL P&L to ICICI Bank on delivering the CTD bond for ₹100 crore face value.

(v) Show the BREAK-EVEN FUTURES PRICE for each bond (at which delivery becomes cost-neutral).

Solution

(i) Invoice Price and Cost of Delivery

Formulas:

Invoice Price = Futures × CF

Cost of Delivery = Cash Price − Invoice Price

Bond	Cash Price (₹)	CF	Invoice Price (100 × CF)	Cost of Delivery (₹)
Bond A	107.20	1.0620	100 × 1.0620 = 106.2000	107.20 − 106.20 = +1.0000
Bond B	104.10	1.0340	100 × 1.0340 = 103.4000	104.10 − 103.40 = +0.7000
Bond C	100.50	1.0000	100 × 1.0000 = 100.0000	100.50 − 100.00 = +0.5000
Bond D	95.30	0.9634	100 × 0.9634 = 96.3400	95.30 − 96.34 = −1.0400

Interpretation of Cost of Delivery:

- POSITIVE cost = Short LOSES on delivery (bought bond for more than invoice receipt)
- NEGATIVE cost = Short GAINS on delivery (bought bond for less than invoice receipt)

(ii) CTD Identification

Ranking by Cost of Delivery (Lowest = Cheapest):

Rank	Bond	Cost of Delivery (₹)
1 (CTD)	Bond D	−1.0400 (PROFIT)
2	Bond C	+0.5000
3	Bond B	+0.7000
4	Bond A	+1.0000

CTD BOND: BOND D (5.50% coupon, 11-year maturity)

Why Bond D is CTD:

(i) Bond D has the LOWEST COUPON (5.50% vs notional 6.00%) which makes its CF < 1 (0.9634)

(ii) In current market where yields (~6%) EXCEED coupon of Bond D, its market price (95.30) is at a DISCOUNT to par

(iii) The CF adjustment (0.9634 × ₹100 = ₹96.34 invoice) more than compensates for the low market price (95.30)

(iv) General rule: When market yields > notional coupon (6%), LOW-COUPON, LONG-DURATION bonds tend to be CTD

(v) Conversely, when yields < notional coupon, HIGH-COUPON, SHORT-DURATION bonds tend to be CTD

(iii) Implied Repo Rate Analysis

Formula:

Implied Repo (Annualized) = [(Futures × CF − Cash Price) / Cash Price] × (365 / Days to Delivery)

Computations (Days to Delivery = 90):

Bond	Invoice − Cash	÷ Cash Price	Period Return	Annualized (× 365/90)
Bond A	106.20 − 107.20 = −1.00	÷ 107.20	−0.9328%	−3.7832% p.a.
Bond B	103.40 − 104.10 = −0.70	÷ 104.10	−0.6724%	−2.7271% p.a.
Bond C	100.00 − 100.50 = −0.50	÷ 100.50	−0.4975%	−2.0177% p.a.
Bond D	96.34 − 95.30 = +1.04	÷ 95.30	+1.0913%	+4.4258% p.a.

Ranking by Implied Repo Rate (Highest = CTD):

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Rank	Bond	Implied Repo Rate (p.a.)
1 (CTD)	Bond D	+4.4258%
2	Bond C	−2.0177%
3	Bond B	−2.7271%
4	Bond A	−3.7832%

CTD by Implied Repo: Bond D (highest, and only POSITIVE)

VERIFICATION: Both methods (Cost of Delivery and Implied Repo) confirm BOND D as CTD.

Interpretation of Implied Repo:

- Bond D offers +4.43% annualized return via 'cash-and-carry' — buying and delivering into futures
- Bonds A, B, C offer NEGATIVE implied repo — delivering them would generate a LOSS
- Rational short position ALWAYS delivers CTD (Bond D here) to maximize profit

(iv) Total P&L on Delivering CTD (Bond D)

Delivery Structure:

- Total face value to deliver: 5,000 contracts × ₹2 lakh = ₹100 crore
- Cost of delivery per ₹100 face for Bond D: −₹1.04 (PROFIT to ICICI)

Total P&L:

Total P&L = − (Cost of Delivery per ₹100) × (Total Face Value / 100)

= − (−1.04) × (₹100 crore / 100)

= +1.04 × ₹1 crore

= ₹1.04 crore (PROFIT to ICICI Bank)

Alternate Computation (Per Contract):

Item	Value
Per contract face value	₹2,00,000
Profit per ₹100 face (Bond D)	₹1.04
Profit per contract	₹2,00,000 × 1.04/100 = ₹2,080
Number of contracts	5,000
TOTAL PROFIT	**5,000 × ₹2,080 = ₹1,04,00,000 (₹1.04 crore)**

(v) Break-Even Futures Price for Each Bond

Break-Even Formula:

At break-even: Cost of Delivery = 0

→ Cash Price = Futures × CF

→ Break-Even Futures = Cash Price / CF

Bond	Cash Price / CF	Break-Even Futures Price (₹)	vs Current Futures ₹100.00
Bond A	107.20 / 1.0620	100.9416	Futures need to rise by 0.94
Bond B	104.10 / 1.0340	100.6770	Futures need to rise by 0.68
Bond C	100.50 / 1.0000	100.5000	Futures need to rise by 0.50
Bond D	95.30 / 0.9634	98.9205	Futures can FALL by 1.08 and Bond D remains profitable

Interpretation:

- Bond D has the WIDEST profit margin — even if futures fall to 98.92, delivering Bond D remains cost-neutral
- Bonds A, B, C would require futures to RISE to become profitable to deliver

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- This asymmetric profit margin makes Bond D the ROBUST CTD choice — even under adverse futures moves

Strategic Implication for ICICI Bank:

- ICICI should PURCHASE Bond D in the cash market NOW (₹95.30 × ₹100 cr = ₹95.30 crore outlay)
- Hold to delivery (90 days), deliver into futures
- Receive from long counterparty: Invoice Price ₹96.34 × ₹100 cr = ₹96.34 crore
- NET PROFIT: ₹96.34 crore − ₹95.30 crore = ₹1.04 crore (+4.43% annualized cash-and-carry return)

Question 8 — Swaption STRADDLE Strategy + Break-Even Analysis + Payoff Profile

Case Study — Bharat Forge Straddle Ahead of RBI Policy Decision

Kishore Saletore, CFO of Bharat Forge Ltd., is planning a ₹500 crore 5-year bond issue in 6 months. He is UNCERTAIN of the RBI's rate direction ahead of the June 2026 monetary policy meeting, which could either cut rates aggressively (bond issue cheaper) or hike due to inflation surprise (bond issue costlier).

Kishore consults with Deutsche Bank India's Rates Desk and structures a SWAPTION STRADDLE to profit from a large rate move either way, ahead of the bond issue:

Straddle Structure:

Component	Details
Underlying Swap	5-year IRS starting in 6 months
Notional	₹500 crore
Strike (Both Options)	7.00% (at-the-money vs current forward swap rate)
Expiry	6 months
Buy Payer Swaption	30 bps premium = ₹1.50 crore
Buy Receiver Swaption	30 bps premium = ₹1.50 crore
TOTAL STRADDLE PREMIUM	60 bps = ₹3.00 crore

Bharat Forge's rationale: Kishore expects at least 50 bps move in either direction over 6 months, driven by upcoming inflation data + potential Fed rate action.

Required:

(i) Compute the UPFRONT PREMIUM (total) for the straddle.

(ii) Determine the BREAK-EVEN RATE MOVE in basis points that Bharat Forge needs for the straddle to be profitable.

(iii) Compute the STRADDLE PAYOFF at expiry for the following market swap rate scenarios: 5.50%, 6.00%, 6.50%, 7.00%, 7.50%, 8.00%, 8.50%.

(iv) Recommend whether Bharat Forge should proceed with the straddle given a 50 bps expected move.

Solution

(i) Total Straddle Premium

Total Premium = Payer Premium + Receiver Premium

= 30 bps × ₹500 cr + 30 bps × ₹500 cr

= ₹1.50 crore + ₹1.50 crore

= ₹3.00 crore upfront (60 bps of notional)

(ii) Break-Even Rate Move

Formula: Break-even Move = Total Premium / (Notional × PVIFA at Strike)

PVIFA(7%, 5 years) = [1 − (1.07)^−5] / 0.07 = 4.1002

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Break-even Move = ₹3.00 crore / (₹500 cr × 4.1002)

= ₹3.00 cr / ₹2,050.10 crore

= 0.0014634 = 14.63 bps

Break-even Rate Move ≈ 15 bps (approx)

Interpretation:

- Rates must move MORE THAN 15 BPS in either direction from 7.00% for straddle to be profitable
- Upside break-even: 7.00% + 15 bps = 7.15%
- Downside break-even: 7.00% − 15 bps = 6.85%

(iii) Straddle Payoff Under Various Market Rates

Formula: Gross Payoff = |Market Rate − 7.00%| × ₹500 cr × PVIFA(Market Rate, 5)

Market Rate	Rate Move	PVIFA(Rm, 5)	Gross Payoff (₹ lakh)	Net P&L (after ₹300L premium)
5.00%	−200 bps	4.3295	4,329.48	+4,029.48
5.50%	−150 bps	4.2703	3,202.71	+2,902.71
6.00%	−100 bps	4.2124	2,106.18	+1,806.18
6.50%	−50 bps	4.1557	1,038.92	+738.92
6.85%	−15 bps (BE)	4.1173	308.80	≈ 8.80 (~ 0)
7.00%	0	4.1002	0	−300.00 (max loss)
7.15%	+15 bps (BE)	4.0833	306.25	≈ 6.25 (~ 0)
7.50%	+50 bps	4.0459	1,011.47	+711.47
8.00%	+100 bps	3.9927	1,996.36	+1,696.36
8.50%	+150 bps	3.9406	2,955.48	+2,655.48
9.00%	+200 bps	3.8896	3,889.65	+3,589.65

Payoff Profile Characteristics:

- MAXIMUM LOSS: ₹3.00 crore (occurs if rates settle exactly at 7.00%)
- BREAK-EVEN: ±15 bps move (rates at 6.85% or 7.15%)
- PROFITABLE ZONE: Rates < 6.85% OR rates > 7.15%
- PAYOFF IS SYMMETRIC in dollar terms but slightly asymmetric in bp terms due to PVIFA changing with rate

(iv) Recommendation for Bharat Forge

Kishore's Expectation: 50 bps move in either direction over 6 months

Analysis:

Scenario	Rate at Expiry	Straddle Net P&L
Rates fall 50 bps (RBI cuts)	6.50%	+₹738.92 lakh (₹7.39 crore)
Rates rise 50 bps (Inflation surprise)	7.50%	+₹711.47 lakh (₹7.11 crore)
Rates unchanged	7.00%	−₹300 lakh (₹3.00 cr loss = full premium)

Decision Framework:

(i) PROCEED with straddle IF: Kishore has HIGH conviction rates will move at least 50 bps either way

(ii) PROCEED IF: Implied volatility (in swaption pricing) is significantly BELOW Kishore's expected realized volatility

(iii) DO NOT PROCEED IF: Rates likely to stay range-bound (6.85% - 7.15%) → premium fully lost

(iv) CONSIDER STRANGLE (out-of-the-money puts and calls) INSTEAD IF: Kishore wants to reduce upfront premium and can accept wider break-even bounds

RECOMMENDATION:

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If Kishore's 50 bps expectation is well-founded (backed by macro data), the straddle offers ~2.4× reward-to-risk (₹7.1 cr expected profit vs ₹3.0 cr max loss). The straddle should be PROCEEDED with, PROVIDED the expected move is at least 25-30 bps (comfortably above break-even). If Bharat Forge is less confident, consider a smaller-notional straddle (say ₹250 cr) to limit downside.

Additional Consideration:

The straddle is INDEPENDENT of the eventual bond issue economics. It's a pure volatility play. If Bharat Forge wanted a CONTINGENT hedge on the bond issuance directly, a Payer Swaption alone (₹1.50 cr premium) would suffice — it only pays off if rates rise (adverse for the bond issuer).

Question 9 — Earnings at Risk (EAR) — Interest Rate Gap Analysis and Hedging

Case Study — Sundaram Housing Finance Ltd

Sundaram Housing Finance Ltd (SHFL) is a mid-sized NBFC-HFC with ₹50,000 crore Assets Under Management. Anjali Ramaswamy, Treasury Head, is preparing the quarterly Interest Rate Sensitivity Report for the Board's ALCO. The balance sheet as at 31 March 2026 has been decomposed into RBI's prescribed time buckets.

Rate-Sensitive Balance Sheet as at 31 March 2026 (₹ crore):

Time Bucket	RSA (₹ cr)	RSL (₹ cr)
1-30 days	3,500	5,500
31-90 days	5,000	7,000
91-180 days	8,000	5,500
181-365 days	10,500	6,500
TOTAL (1-year)	**27,000**	**24,500**

Composition Notes:

- RSA: Housing loans on floating rate (monthly, quarterly, semi-annual, annual reset), maturing investments, short-term deposits
- RSL: Commercial paper (monthly rollover), bank borrowings on MCLR (quarterly reset), NCDs on floating rate, public deposits

Base Financial Data (FY26 estimated):

Item	Amount
Interest Income (₹50,000 cr × 11%)	₹5,500 crore
Interest Expense (₹45,000 cr × 8%)	₹3,600 crore
Net Interest Income (NII)	₹1,900 crore
Average Earning Assets	₹47,500 crore
Net Interest Margin (NIM)	4.00%
ALCO's EAR tolerance	±₹19 crore (±1% of NII)

Hedge Alternative:

- Pay-fixed Interest Rate Swap on ₹2,000 crore notional (short-end floating liabilities)
- SHFL pays 7.00% fixed, receives 1-month MIBOR
- Current MIBOR + spread: ~6.50% — swap costs approximately 50 bps annually at current rates (~₹10 crore per year)

Required:

(i) Prepare the INTEREST RATE SENSITIVITY REPORT showing periodic gap and cumulative gap.

(ii) Compute EAR under parallel shifts of +100 bps, -100 bps, +50 bps and -50 bps.

(iii) Compute EAR under a BEAR FLATTENING yield curve scenario (short rates +150 bps, long rates +50 bps).

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(iv) Compute the impact on NII and NIM under the worst-case scenario.

(v) Evaluate the pay-fixed IRS hedge and recommend whether ALCO should approve it.

Solution

(i) Interest Rate Sensitivity Report

Bucket	RSA (₹ cr)	RSL (₹ cr)	Periodic Gap	Cumulative Gap
1-30 days	3,500	5,500	(2,000)	(2,000)
31-90 days	5,000	7,000	(2,000)	(4,000)
91-180 days	8,000	5,500	+2,500	(1,500)
181-365 days	10,500	6,500	+4,000	+2,500
TOTAL (1-yr)	**27,000**	**24,500**	**+2,500**	

Observations:

- Cumulative 1-year gap is POSITIVE at +₹2,500 crore — SHFL is ASSET-SENSITIVE overall
- However, short-end gaps (1-30 and 31-90 days) are NEGATIVE by ₹2,000 crore each — reliance on short-term funding creates concentration risk
- Positive long-end gaps (91-180 and 181-365 days) more than offset in aggregate, but leave SHFL exposed to yield-curve twists

(ii) EAR under Parallel Shifts

EAR = Cumulative 1-year Gap × Interest Rate Change

Δr (bps)	Cumulative Gap (₹ cr)	EAR (₹ cr)	NII Impact
+100	+2,500	+25.00	Gain
-100	+2,500	(25.00)	Loss
+50	+2,500	+12.50	Gain
-50	+2,500	(12.50)	Loss

Interpretation: SHFL's ₹2,500 crore positive gap means the bank GAINS when rates rise and LOSES when rates fall on a parallel basis.

(iii) EAR under Bear Flattening

Bear flattening occurs when RBI hikes short rates aggressively while long rates rise only modestly — typical of an inflation-fighting monetary tightening cycle. Buckets 1 and 2 face +150 bps; buckets 3 and 4 face +50 bps.

Bucket	Periodic Gap (₹ cr)	Δr	EAR Contribution (₹ cr)
1-30 days	(2,000)	+1.50%	(30.00)
31-90 days	(2,000)	+1.50%	(30.00)
91-180 days	+2,500	+0.50%	+12.50
181-365 days	+4,000	+0.50%	+20.00
TOTAL EAR — BEAR FLATTENING			**(27.50)**

Key Insight — Why Bear Flattening Hurts:

- Under a PARALLEL +100 bps shift, SHFL gains ₹25 crore (its overall positive gap works in its favour)
- Under BEAR FLATTENING, SHFL loses ₹27.50 crore despite an average rate rise similar to parallel
- Reason: Negative gaps in short-end buckets get hit by the LARGER rate rise (+150 bps), while positive gaps in longer buckets get only a modest boost (+50 bps)
- Bear flattening is materially worse than parallel — and exceeds ALCO's ±₹19 crore tolerance

(iv) NII and NIM Impact

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Scenario	EAR (₹ cr)	New NII (₹ cr)	New NIM
Base	—	1,900.00	4.00%
Parallel +100 bps	+25.00	1,925.00	4.05%
Parallel -100 bps	(25.00)	1,875.00	3.95%
Bear Flattening (worst case)	(27.50)	1,872.50	3.94%

Worst-Case Impact:

- Under bear flattening, NII falls ₹27.50 crore (1.45% of base NII)
- NIM compresses 6 bps from 4.00% to 3.94%
- ₹27.50 crore loss exceeds the ALCO tolerance of ₹19 crore — hedging is warranted

(v) Hedge Evaluation

Mechanics:

- SHFL enters pay-fixed IRS on ₹2,000 crore matching short-end floating liabilities
- Pays 7.00% fixed; receives 1-month MIBOR
- Net effect: converts ₹2,000 crore of short-end floating exposure to fixed rate — reduces negative gaps in buckets 1 and 2 by ₹1,000 crore each

Post-Hedge Gap Structure:

Bucket	Original Gap	Post-Hedge Gap
1-30 days	(2,000)	(1,000)
31-90 days	(2,000)	(1,000)
91-180 days	+2,500	+2,500
181-365 days	+4,000	+4,000
Cumulative 1-year	**+2,500**	**+4,500**

Post-Hedge EAR under Bear Flattening (Worst Case):

EAR = (−1,000 × 1.5% × 2) + (2,500 × 0.5%) + (4,000 × 0.5%)

= (−15 − 15 + 12.50 + 20) = ₹2.50 crore

Cost-Benefit Summary:

Metric	Pre-Hedge	Post-Hedge
EAR under bear flattening (worst case)	(₹27.50 cr)	+₹2.50 cr
EAR under parallel +100 bps	+₹25.00 cr	+₹45.00 cr
EAR under parallel -100 bps	(₹25.00 cr)	(₹45.00 cr)
Annual cost of hedge (current rates)	0	₹10.00 cr

Recommendation to ALCO: APPROVE THE HEDGE

(i) The hedge cost of ₹10 crore per year is small relative to the ₹27.50 crore worst-case EAR it eliminates

(ii) Bear flattening is the most likely near-term scenario given RBI's inflation focus — the hedge directly addresses this concentration risk

(iii) Under a parallel +100 bps rise, the hedge INCREASES the EAR benefit from ₹25 crore to ₹45 crore — hedge is asymmetrically favourable in tightening cycles

(iv) TRADE-OFF: If rates FALL, the hedge worsens the EAR loss (₹45 crore vs ₹25 crore pre-hedge). ALCO must be comfortable with this asymmetry

(v) STAGED EXECUTION: enter ₹1,000 crore first, monitor MIBOR direction for 3 months, add the remaining ₹1,000 crore if rate view unchanged

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Question 10 — Embedded Option Risk — Prepayment, Call, Put and Deposit Withdrawal Analysis

Case Study — Kotak Mahindra Bank Ltd, Treasury Department

Manian Ravi, Head of Interest Rate Risk at Kotak Mahindra Bank, is conducting the semi-annual Embedded Option Risk assessment as required by the RBI's ALM guidelines. The bank's ALM Committee needs quantified estimates of NII impact under two rate scenarios: a 100 bps parallel FALL, and a 100 bps parallel RISE. The bank has four distinct instrument categories with material embedded option exposure.

Portfolio Snapshot (₹ crore):

Instrument	Book Value	Coupon / Rate	Embedded Option
Home Loan Book (fixed-rate)	40,000	10.50% avg	Prepayment (no penalty portion)
Callable NCDs ISSUED by Kotak	5,000	8.50% coupon	Call at par after Year 5
Puttable NCDs HELD by Kotak	3,000	7.50% coupon	Put at par at end of Year 3
Retail Fixed Deposits	10,000	7.00% avg	Premature withdrawal (1% penalty)
Bulk Fixed Deposits (>₹2cr)	15,000	7.25% avg	Premature withdrawal (1% penalty)

Instrument-Specific Additional Data:

Home Loans:

- 40% of book is eligible for penalty-free prepayment (rest have restrictions)
- Behavioural prepayment probability at 100 bps rate savings: 30% of eligible book
- Average residual tenor of prepaid loans: 12 years

Callable NCDs (Kotak as issuer):

- Original tenor 10 years; currently at end of Year 4
- Callable at par at end of Year 5 (1 year away)
- Kotak's marginal borrowing cost post-100bps fall: 7.50%
- Call transaction cost (refinancing/issuance): 0.50% of notional

Puttable NCDs (Kotak as holder):

- Original tenor 8 years; currently at end of Year 2
- Put at par at end of Year 3 (1 year away)
- Reinvestment rate for equivalent credit if put exercised: 9.00% (assumes 150 bps rise on this segment)

Retail Fixed Deposits:

- Fresh FD rate after 100 bps rise: 8.00%
- Fraction of book with >1 year residual tenor (economically worth withdrawing): 25%
- Behavioural probability of actual withdrawal (net of friction): 15%

Bulk Fixed Deposits:

- Fresh bulk FD rate after 125 bps rise (more sensitive): 8.50%
- Fraction at risk of withdrawal: 40% (institutional depositors more sophisticated)
- Behavioural withdrawal probability: 35%
- Average residual tenor of withdrawn FDs: 1.5 years

Required:

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(i) Compute the PREPAYMENT OPTION cost to Kotak on the home loan book under a 100 bps rate fall.

(ii) Value the CALL OPTION on the ₹5,000 crore NCDs issued by Kotak. Recommend whether Kotak should exercise the call at Year 5.

(iii) Value the PUT OPTION on the ₹3,000 crore NCDs held by Kotak. Recommend whether Kotak should exercise the put.

(iv) Estimate the PREMATURE FD WITHDRAWAL impact (net of penalty income) under a 100 bps rate rise.

(v) Consolidate the embedded option exposure under BOTH scenarios (rates fall / rates rise) and comment on the asymmetry.

(vi) Explain how the GAP STATEMENT should be ADJUSTED to reflect embedded option risk, and recommend three MITIGATION STRATEGIES.

Solution

(i) Prepayment Option Cost on Home Loan Book

Trigger and Expected Prepayment Volume:

Rate savings for borrower = 10.50% − 9.50% = 100 bps

Eligible book (no penalty) = 40% × ₹40,000 = ₹16,000 crore

Behavioural prepayment rate at 100 bps savings = 30%

Expected prepayment volume = ₹16,000 × 30% = ₹4,800 crore

NII Loss Quantification:

Annual NII loss = Prepaid amount × Rate differential

= ₹4,800 × (10.50% − 9.50%) = ₹4,800 × 1% = ₹48 crore per year

Present Value over Residual Tenor:

PVIFA(9.5%, 12 years) = $[1 - (1.095)^{-12}] / 0.095 = 6.9838$

PV of prepayment option cost = ₹48 × 6.9838 = ₹335.22 crore

This ₹335 crore represents the PV of NII foregone because prepaid loans must be redeployed at the new lower rate of 9.5% (or held as low-yielding cash). It is the mirror image of the option value that the borrowers extract from Kotak.

(ii) Value of Call Option on NCDs Issued by Kotak

Trigger Test — Should Kotak Call?

Existing coupon: 8.50% | New borrowing cost: 7.50%

Savings if refinanced: 100 bps

Annual coupon savings = ₹5,000 × 1% = ₹50 crore per year for 5 remaining years

Gross Call Benefit at Call Date (End of Year 5):

PVIFA(7.5%, 5 years) = $[1 - (1.075)^{-5}] / 0.075 = 4.0459$

Gross benefit = ₹50 × 4.0459 = ₹202.29 crore

Less Call Transaction Costs:

Refinancing / issuance costs = 0.50% × ₹5,000 = ₹25 crore

Net benefit at Call Date = ₹202.29 − ₹25 = ₹177.29 crore

PV of Net Benefit Today (Discount 1 Year at 7.5%):

Call Option Value = ₹177.29 / 1.075 = ₹164.92 crore

RECOMMENDATION: EXERCISE THE CALL at Year 5.

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- The ₹164.92 crore net benefit far exceeds the transaction cost of the refinancing
- Refinancing preserves Kotak's balance sheet capacity while cutting funding cost by 100 bps
- Standard finance-theory prediction: bond issuers ALWAYS call when call benefit is materially positive

(iii) Value of Put Option on NCDs Held by Kotak

Trigger Test — Should Kotak Put?

Existing coupon received: 7.50% | Reinvestment rate available: 9.00%

Reinvestment pickup: 150 bps

Annual pickup = ₹3,000 × 1.5% = ₹45 crore per year for 5 remaining years

Gross Put Benefit at Put Date (End of Year 3):

PVIFA(9%, 5 years) = $[1 - (1.09)^{-5}] / 0.09 = 3.8897$

Gross benefit = ₹45 × 3.8897 = ₹175.03 crore

PV of Benefit Today (Discount 1 Year at 9%):

Put Option Value = ₹175.03 / 1.09 = ₹160.58 crore

RECOMMENDATION: EXERCISE THE PUT at Year 3.

- The ₹160.58 crore benefit is a direct pickup on Kotak's investment book
- Redeploying at 9% for 5 more years locks in the higher rate environment
- Put exercise is the mirror-image right of a call — investors exercise when it's economically rational

(iv) Premature FD Withdrawal Impact (PV Basis)

The interest loss on withdrawn deposits accrues over the AVERAGE RESIDUAL TENOR of the withdrawn FDs (1.5 years). Because this loss is spread across time, its Present Value must be computed by discounting. As a practical simplification, the total 1.5-year NII loss is treated as a lump sum and discounted for 1 year at the new deposit rate (approximating the mid-point of the 1.5-year period).

Retail FD Segment:

Expected withdrawal = ₹10,000 × 25% × 15% = ₹375 crore

Annual NII loss = ₹375 × 1.00% = ₹3.75 crore per year

Total NII loss over 1.5 years (undiscounted) = ₹3.75 × 1.5 = ₹5.625 crore

PV factor at 1 year at new deposit rate 8% = 1 / 1.08 = 0.9259

PV of retail NII loss = ₹5.625 / 1.08 = ₹5.21 crore

Bulk FD Segment:

Expected withdrawal = ₹15,000 × 40% × 35% = ₹2,100 crore

Annual NII loss = ₹2,100 × 1.25% = ₹26.25 crore per year

Total NII loss over 1.5 years (undiscounted) = ₹26.25 × 1.5 = ₹39.375 crore

PV factor at 1 year at new bulk deposit rate 8.5% = 1 / 1.085 = 0.9217

PV of bulk NII loss = ₹39.375 / 1.085 = ₹36.29 crore

Penalty Income (received immediately at time of withdrawal, no discounting):

Total withdrawal × penalty rate = (₹375 + ₹2,100) × 1% = ₹24.75 crore

Net FD Embedded Option Cost (PV Basis):

Item	Amount (₹ cr)
PV of retail NII loss	5.21

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Item	Amount (₹ cr)
PV of bulk NII loss	36.29
Total PV of NII loss	41.50
Less: Penalty income (upfront)	(24.75)
NET FD Embedded Option Cost (PV)	**16.75**

Note the discounting logic: penalty is received the moment withdrawal happens (no PV needed); the NII loss accrues over 1.5 years as the bank must fund the withdrawn ₹2,475 crore at higher new rates, so the total loss stream is discounted using a 1-year discount factor as a mid-point approximation.

(v) Consolidated Embedded Option Impact

Instrument	Scenario A: Rates Fall 100bps (₹cr)	Scenario B: Rates Rise 100bps (₹cr)
Home Loan Prepayment	(335.22)	0 (not triggered)
Callable NCD Issued	+164.92	0 (not called)
Puttable NCD Held	0 (not put)	+160.58
FD Premature Withdrawal (PV)	0 (not triggered)	(16.75)
NET EMBEDDED OPTION IMPACT	**(170.30)**	**+143.83**

Key Observation — Structural Asymmetry:

(i) Under RATES FALL scenario, Kotak faces net ₹170.30 crore embedded option COST

(ii) Under RATES RISE scenario, Kotak has net ₹143.83 crore embedded option GAIN

(iii) The bank is STRUCTURALLY SHORT on falling-rate scenarios — prepayment cost (₹335 cr) dwarfs the call benefit (₹165 cr)

(iv) This is typical of a retail banking book: home loan portfolios are the dominant source of embedded option risk, and prepayment always hurts the bank

(v) The 'gain' under rising rates depends on Kotak's investment book being sizeable enough to exercise the put; retail depositor behaviour absorbs some of the pickup through the FD withdrawal cost of ₹16.75 crore

(vi) Gap Statement Adjustment and Mitigation Strategies

How the Gap Statement Should Be Adjusted:

The ICAI SM warns that the Gap Report assumes all assets and liabilities repriced at SCHEDULED dates. Embedded options break this assumption exactly when it matters most. The Gap Statement must be re-cast under BOTH scenarios:

- Under RATES FALL: Shift ₹4,800 crore of home loans from long-tenor buckets INTO the 1-30 day bucket (representing accelerated repricing via prepayment and redeployment at lower rates)
- Under RATES FALL: Shift ₹5,000 crore of Callable NCDs to Year 5 bucket (call date) rather than Year 10 (original maturity)
- Under RATES RISE: Shift ₹3,000 crore of Puttable NCDs held from Year 8 (maturity) to Year 3 bucket (put date)
- Under RATES RISE: Shift ₹2,475 crore of expected FD withdrawals into the 1-30 day bucket

This 'behavioural gap' is often materially different from the 'contractual gap' and is the more accurate measure of true interest rate risk.

Three Mitigation Strategies (per ICAI SM Guidance):

1. Impose Opportunity-Cost-Based Penalties

- On prepayment: link penalty to rate differential × remaining tenor rather than a flat 2% fee
- On premature FD withdrawal: 1% is too low for a 100 bps rate move — restructure at 1.5% or scale to residual tenor
- The ICAI SM explicitly recommends penalties calibrated to opportunity cost as the primary mitigation lever

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2. Structural Product Design

- Issue NON-callable NCDs (removes issuer flexibility but eliminates investor demand for compensation for call risk)
- Buy PUTTABLE bonds selectively (bank captures the option value rather than paying for it)
- Design 'sticky' deposit products with rate-differential adjustments to reduce premature exit

3. Off-Balance-Sheet Hedging

- Buy INTEREST RATE FLOORS to hedge prepayment risk (floor pays when rates fall = when prepayment accelerates)
- Buy CAPS to hedge FD-withdrawal risk (cap pays when rates rise = when withdrawal accelerates)
- Cost of caps/floors is comparable to the embedded option cost, but shifts uncertainty to certain premium expense

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CHAPTER 13 — BUSINESS VALUATION

Question 1 — Startup Valuation — Applying All Six ICAI Methods to a Pre-Series A Company

Case Study — AgriConnect Technologies Pvt Ltd

AgriConnect Technologies, a Pre-Series A agri-tech startup headquartered in Bengaluru, operates a B2B platform connecting Indian farmers with corporate buyers and providing integrated logistics. Founded in July 2024 by three co-founders (previously with Ninjacart and DeHaat), the company has spent two years building the product, network of farmers, and buyer partnerships. The company is raising a Pre-Series A round of ₹15 crore.

Financial and Operating Snapshot (FY26):

Metric	Value
Revenue (FY26)	₹8 crore (early monetisation)
Cash burn	₹4 crore per year
Runway	15 months
States operational	3 (Maharashtra, Karnataka, MP)
Registered farmers	25,000
Active farmers (transacting monthly)	8,000
Corporate buyer partnerships	12
Cumulative tech build spend (2 years)	₹4 crore
Physical assets (offices, warehouse)	₹1.5 crore
Regulatory / registrations	₹0.5 crore
Farmer & buyer acquisition (cumulative)	₹5 crore
Team cost (founders' ESOP + opportunity)	₹3 crore
Data / network base cost	₹2 crore

Market Data for Application of Methods:

- Recent Pre-Series A comparable transactions in Indian agri-tech:
- FarmerZeus: ₹35 crore pre-money at 12,000 active users → ~₹29,167 per active user
- CropAI: ₹42 crore pre-money at 15,000 active users → ~₹28,000 per active user
- AgroBuddy: ₹28 crore pre-money at 8,000 active users → ~₹35,000 per active user
- Average per-active-user valuation across peers: ~₹30,722
- Average pre-money valuation for Pre-Series A Indian agri-tech peers: ₹35 crore
- Prospective investor requires 10x return over 5-year horizon (equivalent 40% IRR)
- Expected exit revenue multiple at Year 5 (industry benchmark): 6.5x
- Projected revenue CAGR: 55% (realistic for Pre-Series A → Series C progression)

Required:

(i) Value AgriConnect using EACH of the six ICAI startup valuation methods separately, applying the given data.

(ii) Compare the six valuations and comment on the range. Which methods are most and least appropriate for Pre-Series A stage?

(iii) Recommend a WEIGHTED final valuation with reasoning for the weights chosen.

Solution

(i-a) Berkus Approach

The Berkus Method assigns value to five critical success factors, each capped at approximately ₹4 crore. The method caps TOTAL enterprise value at approximately ₹16 crore for pre-revenue companies and ₹20 crore post-revenue.

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Success Factor	Assessment for AgriConnect	Value (₹ cr)
Basic value (sound idea)	Strong — clear market need, established playbook	4.00
Technology (prototype working)	Product live, 2 years in production	4.00
Execution (quality management)	Ex-Ninjacart / DeHaat founders	4.00
Strategic relationships	12 corporate buyer partnerships in place	4.00
Production & sales rollout	8,000 active farmers, 3 states	4.00
TOTAL BERKUS VALUE	**(at cap)**	**20.00**

Berkus Valuation: ₹20 crore

Observation: The Berkus method is ideally suited to Pre-Series A companies like AgriConnect — the cap reflects the natural ceiling for pre-scale ventures. Beyond Series A, the method becomes an artificial constraint.

(i-b) Cost-to-Duplicate Approach

This method aggregates all costs that would be required to recreate the business from scratch.

Cost Component	Amount (₹ cr)
Cumulative tech build (2 years)	4.00
Physical assets (offices, warehouse)	1.50
Regulatory / registrations	0.50
Farmer & buyer acquisition (cumulative)	5.00
Team cost (founders' ESOP + opportunity)	3.00
Data / network base cost	2.00
TOTAL COST-TO-DUPLICATE	**16.00**

Cost-to-Duplicate Valuation: ₹16 crore

Observation: This method captures INVESTED capital but ignores brand pull, network effects, first-mover advantages, and future upside. It sets a FLOOR value — a rational buyer would not pay less than the cost to build the same business themselves.

(i-c) Comparable Transactions Method

Value is derived from per-user metrics of recent transactions in comparable startups.

Peer Transaction	Per-Active-User Value (₹)
FarmerZeus	29,167
CropAI	28,000
AgroBuddy	35,000
Average per active user	**30,722**

Valuation on Active Users:

₹30,722 × 8,000 active users = ₹24.58 crore

Valuation on Registered Base (at 15% of active rate — reflects lower engagement):

₹30,722 × 15% × 25,000 registered = ₹11.52 crore

Blended Comparable Transactions Valuation: (₹24.58 + ₹11.52) / 2 = ₹18.05 crore

Observation: This method anchors to CURRENT market sentiment. The peer per-user values used here are well-supported by recent Indian agri-tech deals in the 2024-2026 vintage.

(i-d) Scorecard Valuation Method

Adjusts the peer-average pre-money by a weighted qualitative score.

Comparable Pre-Series A Indian agri-tech average pre-money: ₹35 crore

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Quality	Max Weight	Comparison	Product
Strength of team	30%	130% (top-tier)	0.3900
Size of opportunity	25%	120% (large TAM)	0.3000
Product / service	15%	100% (at par)	0.1500
Competitive environment	10%	80% (crowded)	0.0800
Marketing / sales channels	10%	100%	0.1000
Need for additional investment	5%	90%	0.0450
Others	5%	100%	0.0500
TOTAL WEIGHTED FACTOR	**100%**		**1.1150**

Scorecard Valuation: ₹35 crore × 1.1150 = ₹39.02 crore

(i-e) First Chicago Method

Probability-weighted valuation across three scenarios. Each scenario's exit value is discounted to today at the required IRR of 40% over 5 years.

Scenario	Probability	Exit Value (₹ cr)	PV @ 40%	Weighted
Best case: IPO exit	15%	300.00	55.78	8.37
Normal case: Strategic exit	55%	100.00	18.59	10.23
Worst case: Down round	30%	15.00	2.79	0.84
FIRST CHICAGO VALUATION				**19.43**

First Chicago Valuation: ₹19.43 crore

Observation: This method explicitly handles the wide outcome distribution typical of startups. The 30% probability of a down-round captures downside honestly.

(i-f) Venture Capital Method

Backwards from investor's required exit multiple.

- New investment: ₹15 crore
- Target investor return: 10× over 5 years (40% IRR)
- Projected FY31 revenue at 55% CAGR: ₹8 × 1.55^5 = ₹71.57 crore
- Exit value at 6.5× revenue multiple: ₹71.57 × 6.5 = ₹465.22 crore
- Required investor ownership to earn 10× on ₹15 crore = ₹150 crore / ₹465.22 crore = 32.24%
- Post-money valuation = ₹15 crore / 32.24% = ₹46.52 crore
- Pre-money valuation = ₹46.52 crore − ₹15 crore = ₹31.52 crore

VC Method Valuation: ₹31.52 crore (pre-money)

(ii) Comparison and Stage Appropriateness

Method	Valuation (₹ cr)	Fit for Pre-Series A
Berkus	20.00	IDEAL — designed for this stage
Cost-to-Duplicate	16.00	FLOOR value — sets minimum
Comparable Transactions	18.05	STRONG — good peer data
Scorecard	39.02	IDEAL — designed for this stage
First Chicago	19.43	STRONG — captures range
VC Method	31.52	STRONG — aligns with investor thinking

Key Observations:

- All six methods produce values in the ₹16–₹39 crore range — a spread of about 2.44x (max/min)

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- This tight spread is a signature of proper stage alignment — when applied to the RIGHT stage, the methods substantially agree
- Berkus and Cost-to-Duplicate sit at the LOW end (₹16–20 crore) — anchoring on invested capital and factor caps
- Scorecard and VC Method sit at the HIGH end (₹31–39 crore) — anchoring on peer averages and exit expectations
- Comparable Transactions and First Chicago sit in the middle (₹18–19 crore) — cross-check role

(iii) Weighted Final Valuation

For a Pre-Series A stage company, all six methods have legitimate roles. Apply weights that reflect the reliability of each method at this stage:

Method	Weight	Value (₹ cr)	Contribution
Berkus Approach	15%	20.00	3.00
Cost-to-Duplicate	10%	16.00	1.60
Comparable Transactions	20%	18.05	3.61
Scorecard Valuation	25%	39.02	9.75
First Chicago Method	15%	19.43	2.91
Venture Capital Method	15%	31.52	4.73
WEIGHTED FAIR VALUE	**100%**		**25.60**

RECOMMENDED VALUATION: ~₹26 crore (pre-money) for the Pre-Series A round

Justification for weights:

- Scorecard (25%) — most reliable for Pre-Series A; anchors to peer averages with explicit quality adjustment
- Comparable Transactions (20%) — market anchors are critical for negotiation with investors
- Berkus (15%) — validates the ceiling for pre-scale ventures
- First Chicago (15%) — explicitly captures downside, disciplines optimism
- VC Method (15%) — aligns with investor psychology and exit thinking
- Cost-to-Duplicate (10%) — sets the floor but ignores intangibles

At ₹26 crore pre-money with a ₹15 crore raise, AgriConnect would close its Pre-Series A at a post-money valuation of ~₹41 crore, giving new investors ~36% ownership. This is within the norm for a Pre-Series A agri-tech round in the 2026 Indian market.

Question 2 — Valuation of a Professional/Consultancy Firm — Multi-Method with Earn-Out

Case Study — Sharma Advisory Partners LLP

Sharma Advisory Partners LLP is a mid-sized management consultancy headquartered in Mumbai with satellite offices in Bengaluru and Gurgaon. Founded by CA Rajiv Sharma in 2014, the firm has 8 partners, 45 professionals, and specialises in operational transformation for BFSI clients. In April 2026, Deloitte India Consulting Partners has offered to acquire 100% of the firm, structured as ₹150 crore cash upfront plus a 3-year earn-out capped at ₹100 crore.

Firm Snapshot (FY25):

Item	Amount / Detail
Revenue	₹120 crore
Reported EBITDA	₹36 crore (30% margin)
Reported PAT	₹22 crore
Net Worth (Paid-up + Reserves)	₹45 crore
Partners	8 (Managing Partner Rajiv Sharma holds 40% stake)

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Item	Amount / Detail
Aggregate Partner Salary (P&L)	₹18 crore
Notable clients	3 top-4 private banks, 2 large NBFCs
Applicable tax rate	30%

Adjustments Required to Reported Financials:

- Partner salaries include ₹10 crore of excess compensation above market benchmark (₹8 crore aggregate is market-rate for equivalent professional partners)
- ₹1.50 crore of founder's personal expenses (car lease, foreign personal travel) booked to firm
- ₹1.20 crore of one-off legal costs from an arbitration case (now settled)
- ₹0.80 crore non-recurring bad debt from a client insolvency
- Firm occupies the Managing Partner's owned Mumbai premises at NIL rent; market rent would be ₹2.40 crore per year

Market Data:

- Risk-free rate: 7% | Equity risk premium: 6% | Small firm premium: 3% | Key-person premium: 4%
- Industry average ROI for professional services firms: 15%
- Years' purchase for goodwill on professional firms: 3 years (standard for consultancies given retention risk)
- Annuity method horizon: 5 years

Deloitte Deal Structure:

- Upfront cash: ₹150 crore at closing
- Earn-out cap: ₹100 crore over 3 years, contingent on (a) retention of top 4 partners and (b) 15% revenue growth
- Estimated earn-out realisation probability: 40% full, 40% partial (50% of cap), 20% zero

Required:

(i) NORMALISE the reported PAT by adjusting for the items listed above.

(ii) Compute intrinsic value by the CAPITALIZATION OF EARNINGS method using an appropriate cap rate.

(iii) Compute intrinsic value by the GOODWILL — SUPER PROFITS method (3 years' purchase).

(iv) Compute intrinsic value by the GOODWILL — ANNUITY method (5-year horizon).

(v) Compute the RISK-ADJUSTED VALUE of the Deloitte offer, weighting the earn-out probability and discounting to present value.

(vi) RECONCILE the methods and recommend whether Sharma should accept the Deloitte offer.

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Solution

(i) Normalisation of PAT (₹ crore)

Item	Amount
Reported PAT (FY25)	22.00
Add: Excess partner compensation (₹18 – ₹8)	10.00
Add: Founder personal expenses booked to firm	1.50
Add: One-off legal costs (arbitration settled)	1.20
Add: Non-recurring bad debt (client insolvency)	0.80
Less: Notional rent for founder-owned premises	(2.40)
Gross normalisation adjustments (pre-tax)	11.10
Less: Tax @ 30%	(3.33)
Net addback (after tax)	7.77

Item	Amount
NORMALIZED PAT	**29.77**

(ii) Capitalization of Earnings Method

Capitalization Rate Determination:

Rf 7% + Equity Risk Premium 6% + Small Firm Premium 3% + Key-Person Premium 4% = 20%

Value = Normalized PAT / Cap rate = ₹29.77 crore / 0.20 = ₹148.85 crore

Value by Capitalized Earnings: ₹148.85 crore

(iii) Super Profits Method

Step 1: Compute Normal Profit at Industry ROI

Normal Profit = Net Worth × Industry ROI = ₹45 crore × 15% = ₹6.75 crore

Step 2: Compute Super Profit

Super Profit = Normalized PAT − Normal Profit = ₹29.77 − ₹6.75 = ₹23.02 crore

Step 3: Goodwill (3 years' purchase)

Goodwill = ₹23.02 × 3 = ₹69.06 crore

Step 4: Total Value

Total Value = Tangible Net Worth + Goodwill = ₹45 + ₹69.06 = ₹114.06 crore

Value by Super Profits: ₹114.06 crore

(iv) Annuity Goodwill Method

PVIFA(20%, 5 years) = $[1 - (1.20)^{-5}] / 0.20 = 2.9906$

Goodwill (annuity) = Super Profit × PVIFA = ₹23.02 × 2.9906 = ₹68.84 crore

Total Value = ₹45 + ₹68.84 = ₹113.84 crore

Value by Annuity Method: ₹113.84 crore

(v) Risk-Adjusted Value of Deloitte's Offer

Probability-Weighted Earn-Out:

Scenario	Probability	Earn-out (₹ cr)	Weighted
Full earn-out achieved	40%	100.00	40.00
Partial (50% of cap)	40%	50.00	20.00
Zero (retention or growth fails)	20%	0.00	0.00
Expected earn-out			**60.00**

Present Value of earn-out (3 years @ 20% cap rate):

PV = ₹60 crore / $(1.20)^3$ = ₹60 / 1.728 = ₹34.72 crore

Risk-Adjusted Deal Value = ₹150 (upfront) + ₹34.72 (PV of earn-out) = ₹184.72 crore

(vi) Reconciliation and Recommendation

Valuation Method	Value (₹ cr)	Weight	Contribution
Capitalization of Earnings	148.85	40%	59.54
Super Profits + Book Value	114.06	30%	34.22
Annuity Goodwill + Book Value	113.84	30%	34.15
WEIGHTED INTRINSIC VALUE		**100%**	**127.91**

Comparison:

- Weighted intrinsic value of Sharma Advisory: ₹127.91 crore

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- Deloitte risk-adjusted offer: ₹184.72 crore
- Strategic premium offered by Deloitte: ₹56.81 crore (44.4% above intrinsic)

Recommendation: ACCEPT the Deloitte offer, with the following negotiation points:

(i) The 44% strategic premium reflects Deloitte's ability to CROSS-SELL to its existing BFSI relationships — Sharma cannot capture this synergy on its own

(ii) The 40% probability weighting on full earn-out is arguably conservative — Sharma partners should push for LOWER growth threshold (12% instead of 15%) to improve the achievement probability

(iii) Sharma should insist on a KEY-PERSON INDEMNITY: if any of the 8 partners exits within the earn-out period for reasons attributable to Deloitte (culture, comp changes), full earn-out crystallizes

(iv) Managing Partner should negotiate for RETENTION BONUS structure separate from earn-out, converting some contingent value to certain compensation

(v) If Sharma prefers to remain independent, the ₹127.91 crore intrinsic represents a floor for any private-equity minority investment

Question 3 — Digital Platform Valuation — Kirana Connect (B2B Marketplace)

Case Study — Kirana Connect Technologies Pvt Ltd

Kirana Connect operates a B2B marketplace connecting India's 1.3 crore neighbourhood kirana stores with FMCG brands. Founded in 2019 by Anil Iyer and Sanjay Bhandari, the platform aggregates demand from small retailers and enables direct sourcing from manufacturers at wholesale prices, cutting out multi-tier distributor margins. The company is preparing for a Series D round led by SoftBank India.

Operational Snapshot (FY25):

Metric	Value
Registered kiranas	8,00,000 (8 lakh)
Monthly Active Users (MAU)	5,20,000 (5.2 lakh)
Gross Merchandise Value (GMV) FY25	₹4,800 crore
Take rate	2.5% (industry standard for B2B marketplaces)
Net Revenue	₹120 crore
Contribution margin	45%
EBITDA	(₹25) crore (still investing for scale)
Cash burn	₹35 crore per year
Runway	20 months
YoY revenue growth	80%

Market Data for Valuation:

- Peer per-active-user valuations (Indian B2B marketplaces): Udaan ~₹25,000, ElasticRun ~₹18,000, Jumbotail ~₹22,000
- Peer EV/GMV multiple range for Indian B2B marketplaces: 0.25x – 0.35x
- Peer EV/Revenue multiple range for growth-adjusted marketplaces: 12x – 18x
- Base P/S multiple for Rule of 40 anchor: 15x
- Assumed WACC (growth-stage): 18%; terminal growth: 6%
- Assumed tax rate: 25%

Required:

(i) Value Kirana Connect using the PRICE PER ACTIVE SUBSCRIBER method (on MAU basis).

(ii) Value using EV/GMV multiple midpoint.

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(iii) Value using EV/REVENUE multiple midpoint.

(iv) Compute the RULE OF 40 score and adjust the base EV/Revenue multiple based on the tier.

(v) Value using DCF WITH J-CURVE: 7-year projection where margins turn positive from Year 4.

(vi) RECONCILE the methods, recommend a final valuation, and cross-check the implied per-user, per-GMV and per-revenue metrics.

Solution

(i) Price per Active Subscriber Method

Average peer per-active-user value = (₹25,000 + ₹18,000 + ₹22,000) / 3 = ₹21,667

Valuation on MAU basis: ₹21,667 × 5,20,000 = ₹1,126.67 crore

Price per Active Subscriber Valuation: ₹1,127 crore

(ii) EV / GMV Multiple

Peer range: 0.25x to 0.35x GMV

Low end: 0.25 × ₹4,800 = ₹1,200 crore

High end: 0.35 × ₹4,800 = ₹1,680 crore

EV/GMV midpoint valuation: ₹1,440 crore

(iii) EV / Revenue Multiple

Peer range for high-growth marketplaces: 12x to 18x revenue

Low end: 12 × ₹120 = ₹1,440 crore

High end: 18 × ₹120 = ₹2,160 crore

EV/Revenue midpoint valuation: ₹1,800 crore

(iv) Rule of 40 Adjusted Multiple

Rule of 40 = Revenue Growth % + EBITDA Margin %

EBITDA margin = (₹25) / ₹120 = (20.8%)

Rule of 40 score = 80% + (−20.8%) = 59.2

Rule of 40 Score	Tier	Multiple Adjustment
> 60	Top tier	1.5x base
40 – 60	Healthy	1.0x base
20 – 40	Subpar	0.6x base
< 20	Struggling	0.3x base

Kirana Connect's score of 59.2 falls in the HEALTHY tier — 1.0x adjustment

Adjusted EV/Revenue = 15 × 1.0 = 15x

Valuation = 15 × ₹120 = ₹1,800 crore

Rule of 40 Adjusted Valuation: ₹1,800 crore

(v) DCF with J-Curve

Project 7 years of revenue and EBITDA, with FCF turning positive from Year 4. FCF approximation: EBITDA × (1 − tax) − Capex (5% of revenue) − Working capital change (10% of revenue growth).

Year	Rev Growth	Revenue (₹cr)	EBITDA Margin	EBITDA (₹cr)	FCF (₹cr)	PV @ 18% (₹cr)
1	80%	216	(20.0%)	(43)	(52.8)	(44.7)
2	65%	356	(10.0%)	(36)	(58.6)	(42.1)
3	50%	535	5.0%	27	(24.5)	(14.9)

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Year	Rev Growth	Revenue (₹cr)	EBITDA Margin	EBITDA (₹cr)	FCF (₹cr)	PV @ 18% (₹cr)
4	35%	722	15.0%	108	26.4	13.6
5	25%	902	22.0%	198	85.7	37.5
6	20%	1,083	25.0%	271	130.8	48.5
7	15%	1,245	28.0%	349	183.0	57.4

Sum of explicit PV: ₹55.23 crore

Terminal Value:

Terminal FCF (Year 8) = Year 7 FCF grown at 6% = ₹207 crore

Terminal Value = ₹207 / (0.18 − 0.06) = ₹1,728 crore

PV of Terminal Value = ₹1,728 / $(1.18)^7$ = ₹542.59 crore

Enterprise Value (DCF) = ₹55.23 + ₹542.59 = ₹597.82 crore

DCF J-Curve Valuation: ₹598 crore

(vi) Reconciliation and Recommendation

Method	Value (₹ cr)	Weight	Contribution
Price per Active Subscriber	1,127	15%	169.05
EV/GMV midpoint	1,440	25%	360.00
EV/Revenue midpoint	1,800	20%	360.00
Rule of 40 adjusted	1,800	15%	270.00
DCF with J-Curve	598	25%	149.50
WEIGHTED FAIR VALUE		**100%**	**1,308.55**

Recommended Series D Valuation: ~₹1,310 crore (post-money)

Cross-Check: Implied Metrics at ₹1,310 crore Valuation

- Per active user: ₹25,163 (in line with Udaan's ~₹25,000; slightly above ElasticRun and Jumbotail)
- Per rupee of GMV: ₹0.273 (within peer 0.25–0.35 range)
- Per rupee of revenue: 10.9x (below peer 12–18x range — conservative)

Key Insight — The DCF vs Multiples Divergence:

DCF gives ₹598 crore while multiples give ₹1,127–1,800 crore. This 2–3x gap is NORMAL for growth-stage platforms and reflects the market pricing GROWTH OPTIONALITY that DCF struggles to capture. The final ₹1,310 crore weighted valuation balances the two — heavier on GMV (real transaction volume) and DCF (fundamental anchor), with less weight on Rule of 40 and per-subscriber (which are directionally supportive but relatively softer).

Question 4 — ESG-Adjusted DCF — Impact of Environmental, Social and Governance Risks on Valuation

Case Study — Bharat Cement Corporation Ltd

Bharat Cement Corporation (BCC), a large listed cement producer, is being valued for a potential strategic partnership with a European cement major. The European partner insists on ESG-aware valuation given their own reporting standards under the EU Taxonomy for Sustainable Activities.

Baseline Financial and Operational Data:

Metric	Value
FY25 Revenue	₹18,000 crore
FY25 EBITDA	₹4,500 crore (25% margin)
FY25 Free Cash Flow to Firm (FCFF)	₹2,800 crore
Explicit growth (Years 1–5)	8% p.a.

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Metric	Value
Terminal growth (Year 6 onwards)	4%
Base WACC (before ESG adjustment)	11%
Corporate tax rate	30%
Annual cement production	45 million tonnes

ESG-Specific Data:

Environmental (E):

- BCC's CO_2 emissions: 700 kg per tonne cement vs industry average 620 kg (80 kg excess)
- India carbon tax expected at ₹500 per tonne CO_2 by 2027
- Additional water and waste-management capex required: ₹80 crore per year

Social (S):

- Historical CSR spend at 0.5% of PAT vs statutory 2% — recovery needed: ₹40 crore per year
- Employee retention and safety programme: ₹60 crore per year (workforce attrition is 22% vs industry 12%)
- Community development in mining areas (mining rights depend on this): ₹30 crore per year

Governance (G):

- Independent director recruitment, audit strengthening: ₹25 crore per year
- Regulatory penalty provision (based on historical exposure): ₹15 crore per year

Discount Rate Approach Parameters:

- ESG risk premium (to be added to WACC under Method 2): 150 basis points

Required:

(i) Compute BASELINE Enterprise Value using traditional DCF (no ESG adjustment).

(ii) Quantify the ANNUAL ESG CASH FLOW IMPACT for each of E, S, G (post-tax).

(iii) Compute ESG-adjusted DCF using METHOD 1 (cash flow adjustment).

(iv) Compute ESG-adjusted DCF using METHOD 2 (discount rate adjustment at +150bps).

(v) Compare the three valuations and recommend which method is preferred for BCC.

(vi) SENSITIVITY: If BCC achieves 60% ESG improvement from Year 4 onwards, what is the value uplift?

Solution

(i) Baseline DCF (No ESG Adjustment)

Year	FCFF (₹cr)	PVF @ 11%	PV (₹cr)
1	3,024.00	0.9009	2,724.32
2	3,265.92	0.8116	2,650.69
3	3,527.19	0.7312	2,579.05
4	3,809.37	0.6587	2,509.35
5	4,114.12	0.5935	2,441.53
Sum of explicit PV			**12,904.95**

Terminal FCFF (Year 6) = ₹4,114.12 × 1.04 = ₹4,278.68 crore

Terminal Value = ₹4,278.68 / (0.11 − 0.04) = ₹61,124.05 crore

PV of Terminal Value = ₹61,124.05 × 0.5935 = ₹36,274.15 crore

BASELINE ENTERPRISE VALUE = ₹12,904.95 + ₹36,274.15 = ₹49,179.10 crore

(ii) Quantifying Annual ESG Cash Flow Impact

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Factor	Component	Amount (₹ cr/yr)
ENVIRONMENT (E)	Excess CO_2 carbon cost: 45M × 80/1000 × ₹500 = 36 lakh tonnes × ₹500	180
ENVIRONMENT (E)	Water & waste management capex	80
	E subtotal	260
SOCIAL (S)	CSR shortfall recovery	40
SOCIAL (S)	Employee retention and safety	60
SOCIAL (S)	Community development	30
	S subtotal	130
GOVERNANCE (G)	Governance upgrades (ID, audit)	25
GOVERNANCE (G)	Regulatory penalty provision	15
	G subtotal	40
TOTAL PRE-TAX ESG IMPACT		**430**
TOTAL POST-TAX ESG IMPACT @ 30%		**301**

(iii) ESG-Adjusted DCF — Method 1: Cash Flow Adjustment

Year	Base FCFF	ESG Adj (post-tax)	Adj FCFF	PVF @ 11%	PV (₹cr)
1	3,024.00	(301)	2,723.00	0.9009	2,453.15
2	3,265.92	(301)	2,964.92	0.8116	2,406.40
3	3,527.19	(301)	3,226.19	0.7312	2,358.96
4	3,809.37	(301)	3,508.37	0.6587	2,311.07
5	4,114.12	(301)	3,813.12	0.5935	2,262.90
Sum of explicit PV					**11,792.49**

Terminal FCFF (adjusted) = ₹4,278.68 − ₹301 = ₹3,977.68 crore

Terminal Value = ₹3,977.68 / (0.11 − 0.04) = ₹56,824.00 crore

PV of TV = ₹56,824.00 × 0.5935 = ₹33,722.31 crore

EV under Cash Flow Method = ₹11,792.49 + ₹33,722.31 = ₹45,514.79 crore

(iv) ESG-Adjusted DCF — Method 2: Discount Rate Adjustment

ESG-adjusted WACC = 11.0% + 1.5% = 12.5%

Year	FCFF (₹cr)	PVF @ 12.5%	PV (₹cr)
1	3,024.00	0.8889	2,688.00
2	3,265.92	0.7901	2,580.48
3	3,527.19	0.7023	2,477.26
4	3,809.37	0.6243	2,378.17
5	4,114.12	0.5549	2,283.04
Sum of explicit PV			**12,406.95**

Terminal Value = ₹4,278.68 / (0.125 − 0.04) = ₹50,337.35 crore

PV of TV = ₹50,337.35 × 0.5549 = ₹27,933.71 crore

EV under Discount Rate Method = ₹12,406.95 + ₹27,933.71 = ₹40,340.66 crore

(v) Comparison and Recommendation

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Method	Enterprise Value (₹ cr)	vs Baseline
Baseline DCF (no ESG)	49,179.10	—
ESG-Adjusted — Cash Flow Method	45,514.79	−7.5%
ESG-Adjusted — Discount Rate Method	40,340.66	−18.0%

Recommendation: Cash Flow Method is preferred for BCC.

(i) ESG risks at BCC are largely SPECIFIC AND QUANTIFIABLE (carbon tax, CSR, compliance) — not diffuse market risks that WACC captures well

(ii) The Cash Flow method makes each ESG lever visible in rupees, enabling investors and management to identify highest-impact interventions

(iii) The Discount Rate method compounds the ESG cost over the Terminal Value period, producing disproportionately harsh valuations (−18% vs the more reasonable −7.5%)

(iv) The Cash Flow method facilitates target-setting: 'if BCC cuts emissions to industry average, what does the ₹180 cr carbon cost reduce to?' becomes a live valuation lever

(v) The European partner's own reporting under EU Taxonomy will require line-item ESG cash flow disclosure, which Method 1 already produces

(vi) Sensitivity — BCC Achieves 60% ESG Improvement from Year 4

If BCC executes a credible ESG action plan and reduces ESG cost drag by 60% from Year 4 onwards:

- Years 1–3: full ₹301 crore post-tax drag continues
- Years 4–5 onwards: drag reduces to ₹301 × 40% = ₹120.4 crore post-tax
- Terminal Year: ₹120.4 crore drag continues in perpetuity

Revised computation yields Enterprise Value = ₹47,272 crore

- ESG improvement uplift over unimproved ESG-adjusted case: ₹47,272 − ₹45,515 = ₹1,757 crore (+3.9%)
- Still below baseline by ₹1,907 crore (−3.9%) — reflecting that even improved ESG carries residual cost
- The ₹1,757 crore uplift potential is a QUANTIFIED CAPITAL ALLOCATION SIGNAL: BCC's Board can justify ESG capex up to this NPV threshold

Question 5 — Complex Relative Valuation with Peer, PEG, Ind AS 116 and SOTP Adjustments

Case Study — Zenith Pharma India Ltd

Zenith Pharma is a mid-cap listed Indian pharma company with three distinct business segments: branded formulations (domestic prescriptions), generics (domestic + regulated export markets), and API / bulk drugs. A private equity fund is evaluating a large secondary purchase of 15% stake and needs a rigorous valuation before making an offer to existing promoter.

Zenith Pharma — Segmental Snapshot (FY25):

Segment	Revenue (₹cr)	EBITDA (₹cr)	Margin	Growth
Branded formulations	3,200	800	25.0%	15%
Generics (Domestic + Export)	4,200	840	20.0%	10%
API / Bulk drugs	1,000	250	25.0%	8%
TOTAL	**8,400**	**1,890**	**22.5%**	**11%**

Corporate Financials:

Item	Amount
PAT (FY25)	₹950 crore
Number of shares outstanding	20 crore

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Item	Amount
EPS	₹47.50
Net Debt	₹1,200 crore
Current Market Capitalisation	₹19,000 crore (₹950/share)
Current Enterprise Value	₹20,200 crore
Annual operating lease payments (rental / warehouse)	₹280 crore
Average lease tenor	6 years
Discount rate for lease capitalisation	8%

Peer Set — Trading Multiples:

Peer	EV/EBITDA	EV/Sales	P/E	Growth
Sun Pharma	22x	4.5x	32x	12%
Cipla	18x	3.8x	28x	10%
Dr Reddy's Laboratories	15x	3.2x	24x	8%
Torrent Pharma	20x	4.0x	30x	13%
Peer Average	**18.8x**	**3.88x**	**28.5x**	**10.8%**

Required:

(i) Compute STRAIGHT VALUATIONS using peer average EV/EBITDA, EV/Sales and P/E multiples.

(ii) Compute PEG-NORMALIZED P/E valuation, adjusting Zenith's P/E for the growth differential vs peers.

(iii) Compute SUM-OF-PARTS valuation using segment-specific EV/EBITDA multiples (Branded 22x, Generics 14x, API 10x).

(iv) RECONCILE all methods, provide a valuation range, compute WEIGHTED FAIR VALUE and comment on the discount to market.

(i) Straight Multiple Application

EV/EBITDA:

Enterprise Value = 18.8 × ₹1,890 = ₹35,438 crore

Equity Value = ₹35,438 − ₹1,200 (Net Debt) = ₹34,238 crore

EV/Sales:

Enterprise Value = 3.88 × ₹8,400 = ₹32,550 crore

Equity Value = ₹32,550 − ₹1,200 = ₹31,350 crore

P/E:

Equity Value = 28.5 × ₹950 = ₹27,075 crore

(ii) PEG-Normalized P/E Valuation

PEG Ratio measures how much investors are paying per unit of growth.

Peer average PEG = Peer avg P/E / Peer avg growth (%) = 28.5 / 10.8 = 2.651

Zenith's implied P/E at peer PEG × Zenith growth = 2.651 × 11.0 = 29.16x

Zenith Equity Value by PEG-normalised P/E = 29.16 × ₹950 = ₹27,705 crore

PEG-Normalized Valuation: ₹27,705 crore

Note: PEG normalisation slightly INCREASES the P/E-based valuation because Zenith's 11% growth is marginally above the peer average of 10.8%.

(iii) Sum-of-Parts (SOTP) Valuation

Segment-specific EV/EBITDA multiples reflecting business quality:

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Segment	EBITDA (₹cr)	Multiple	Segment EV (₹cr)	Rationale
Branded formulations	800	22x	17,600	Brand pull, pricing power (~Sun Pharma)
Generics (Domestic + Export)	840	14x	11,760	Pricing pressure (~Dr Reddy's)
API / Bulk drugs	250	10x	2,500	Low value-add, cyclic (Divi's discount)
TOTAL SOTP ENTERPRISE VALUE	**1,890**		**31,860**	

Less: Net Debt = ₹1,200 crore

SOTP Equity Value: ₹30,660 crore

(iv) Reconciliation and Recommendation

Method	Equity Value (₹ cr)	Per Share (₹)	Weight	Contribution
EV/EBITDA (straight)	34,238	1,712	25%	8,559.50
EV/Sales (straight)	31,350	1,568	25%	7,837.50
P/E (straight)	27,075	1,354	—	—
P/E — PEG normalised	27,705	1,385	25%	6,926.25
Sum-of-Parts	30,660	1,533	25%	7,665.00
WEIGHTED FAIR VALUE			**100%**	**30,988.25**

Note: Straight P/E is EXCLUDED from weighted average (replaced by PEG-normalised version).

Valuation Summary:

- Range: ₹27,075 crore to ₹38,193 crore
- Median: ₹31,350 crore
- WEIGHTED FAIR VALUE: ₹30,988.25 crore (₹1,549.41 per share)
- Current Market Cap: ₹19,000 crore (₹950 per share)
- Upside to fair value: 63%

Interpretation and Recommendation:

(i) Zenith trades at 10.7x EV/EBITDA vs peer average 18.8x — a ~43% discount that is difficult to justify on fundamentals alone (growth is comparable to peers)

(ii) The market's discount likely reflects: (a) governance concerns around promoter holding structure, (b) lack of scale relative to Sun/Cipla, or (c) recent segment mix shift toward lower-margin generics

(iii) For a PE fund evaluating a 15% secondary purchase, the ₹32,217 crore fair value indicates the fund can pay up to ~₹1,600 per share and still hold significant upside — a compelling entry

(iv) The negotiation range should be ₹1,100 to ₹1,400 per share, offering the promoter a meaningful premium over market (16%–47%) while retaining upside for the fund

(v) SOTP gets the highest weight (30%) because segment-level multiples reflect the ACTUAL business mix; PEG gets 20% because growth normalisation is critical when comparing across peers

Question 6 — Reverse Working — Detecting Analyst Error and Deriving Implied Terminal Growth

Case Study — Bharat Petrochemicals Ltd (BPL)

Bharat Petrochemicals Ltd is a listed mid-cap petrochemicals company. Aakash Vora, an equity research analyst at a boutique firm, has issued a BUY report with a target Enterprise Value of ₹11,224 crore. Vishnu Mehta, a competing analyst at Motilal Oswal, believes the number is inflated because Vora used BOOK VALUE weights for WACC — a common error since book-value data is easier to obtain.

BPL Financial Data:

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Item	Value
FCFF (FY26)	₹500 crore
Growth rate (Years 1-5, explicit)	8% per annum
Terminal growth (Year 6 onwards)	4% per annum
Cost of Equity (Ke)	14.00%
Cost of Debt (after tax) (Kd)	6.50%
Book value of equity	₹2,000 crore
Book value of debt	₹3,000 crore
Market value of equity (3x book — public traded)	₹6,000 crore
Market value of debt (0.95x book)	₹2,850 crore

Vora's Reported EV: ₹11,224 crore

Management's Target EV (for internal board presentation): ₹8,500 crore

Required:

(i) Verify that Vora used BOOK VALUE weights in his WACC by computing his implied WACC and reproducing his ₹11,224 crore Enterprise Value.

(ii) Recompute the correct EV using MARKET VALUE weights.

(iii) Quantify the overstatement in absolute rupees and as a percentage.

(iv) Given Management's target EV of ₹8,500 crore, derive the IMPLIED TERMINAL GROWTH RATE that would justify the target (assuming all other inputs remain correct).

(v) Comment on whether the implied terminal growth is plausible given India's long-run nominal GDP growth of ~10-12%.

Solution

(i) Reproducing Vora's ₹11,224 crore EV Using Book Weights

Vora's Implied WACC (Book Weights):

Book weight of equity = 2,000 / (2,000 + 3,000) = 40%

Book weight of debt = 3,000 / (2,000 + 3,000) = 60%

WACC = 40% × 14% + 60% × 6.5% = 5.6% + 3.9% = 9.50%

FCFF Projections and Present Values (Discounted at 9.50%):

Year	FCFF (₹ cr)	PV Factor @ 9.5%	PV (₹ cr)
1	540.00	0.9132	493.15
2	583.20	0.8340	486.51
3	629.86	0.7617	479.96
4	680.24	0.6956	473.51
5	734.66	0.6353	467.14
Sum of explicit period			**2,400.27**

Terminal Value at Year 5:

Terminal FCFF (Year 6) = ₹734.66 × 1.04 = ₹764.05 crore

TV = 764.05 / (0.095 − 0.04) = ₹13,891.82 crore

PV of TV = ₹13,891.82 × 0.6353 = ₹8,825.65 crore

Vora's EV (verifying he used book weights):

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EV = ₹2,400.27 + ₹8,824.47 = ₹11,224 crore ✓ (matches his report)

(ii) Correct EV Using MARKET Weights

Correct WACC (Market Weights):

Market weight of equity = 6,000 / (6,000 + 2,850) = 67.80%

Market weight of debt = 2,850 / (6,000 + 2,850) = 32.20%

WACC = 67.80% × 14% + 32.20% × 6.5% = 9.492% + 2.093% = 11.585%

FCFF Projections and Present Values (at Correct WACC 11.585%):

Year	FCFF (₹ cr)	PV Factor @ 11.585%	PV (₹ cr)
1	540.00	0.8962	483.86
2	583.20	0.8032	468.42
3	629.86	0.7198	453.32
4	680.24	0.6451	438.68
5	734.66	0.5781	424.85
Sum of explicit period			**2,269.13**

Terminal Value:

TV = 764.05 / (0.11585 − 0.04) = ₹10,073.34 crore

PV of TV = ₹10,073.34 × 0.5781 = ₹5,823.14 crore

Correct EV = ₹2,269.13 + ₹5,823.14 = ₹8,092 crore

(iii) Quantifying the Overstatement

Metric	Value
Vora's EV (using book weights)	₹11,224 crore
Correct EV (using market weights)	₹8,092 crore
Overstatement (absolute)	₹3,132 crore
Overstatement (percentage)	38.7%

The 38.7% overstatement arises because book-value weights UNDERSTATE the equity component (equity typically trades at a premium to book), giving too much weight to the cheaper debt in WACC computation. This artificially depresses WACC by ~208 basis points (11.585% vs 9.50%), and the low WACC then compounds through the terminal value, causing a highly leveraged overstatement of enterprise value.

(iv) Implied Terminal Growth to Justify Management's ₹8,500 Cr Target

Setup — Fix all inputs except terminal growth:

- Correct WACC: 11.585% (using market weights)
- PV of explicit period 5 years: ₹2,269.13 crore (unchanged)
- Required PV of Terminal Value = ₹8,500 − ₹2,269.13 = ₹6,230.87 crore

Algebraic Solution:

Required TV at end of Year 5 = ₹6,230.87 × $(1.11585)^5$ = ₹6,230.87 / 0.5781 = ₹10,779 crore

TV = FCFF_Y5 × (1 + g) / (WACC − g)

₹10,779 = ₹734.66 × (1 + g) / (0.11585 − g)

Solving for g:

₹10,779 × (0.11585 − g) = ₹734.66 × (1 + g)

₹1,248.79 − ₹10,779 × g = ₹734.66 + ₹734.66 × g

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₹1,248.79 − ₹734.66 = ₹10,779 × g + ₹734.66 × g

₹514.13 = ₹11,513.66 × g

g = ₹514.13 / ₹11,513.66 = 4.465% ≈ 4.5%

Verification:

TV = ₹734.66 × 1.04465 / (0.11585 − 0.04465) = ₹767.47 / 0.0712 = ₹10,780 cr ✓

PV of TV = ₹10,780 × 0.5781 = ₹6,232 cr

Total EV = ₹2,269 + ₹6,232 = ₹8,500 crore ✓

(v) Plausibility of the Implied Terminal Growth

(i) Implied terminal growth of 4.5% is HIGHER than the base case assumption of 4.0%

(ii) India's long-run nominal GDP growth: 10-12%. For terminal growth, most analysts use a rate SIGNIFICANTLY BELOW nominal GDP because a mature company cannot grow perpetually faster than the economy

(iii) A terminal growth of 4.5% is within the reasonable range (typically 3-5% for Indian companies in mature sectors like petrochemicals)

(iv) However, 4.5% is at the UPPER END of what's justifiable — closer to real GDP growth than to the more conservative 3-3.5% often used

(v) Management's ₹8,500 crore target is achievable ONLY IF the company convinces the market that its terminal growth is at least 4.5% — this is a defensible but not conservative assumption

(vi) Recommendation to Management: Rather than assuming higher terminal growth, they should focus on justifying higher explicit-period growth (e.g., 10% for 5 years instead of 8%), which is a more concrete lever than the abstract terminal growth assumption

Question 7 — Non-Going Concern Valuation — Net Realizable Value and Going Concern Sale

Case Study — SkyAir India Ltd (Distressed Sale Situation)

SkyAir India, a domestic budget airline operating 15 owned aircraft on 32 routes, has faced severe financial distress following default on ₹450 crore of NCDs in April 2026. The Board, chaired by Vishal Bhat, has appointed EY as valuation adviser to assess strategic alternatives. Interglobe Aviation (IndiGo) has approached the Board with a preliminary bid of ₹2,800 crore for a strategic acquisition. The Board needs a rigorous NRV and going-concern analysis to evaluate whether to accept IndiGo's bid, negotiate for a higher price, or pursue piecemeal liquidation.

Book Balance Sheet at 15 May 2026 (₹ crore):

Assets	Book Value	Liabilities & Equity	Book Value
Aircraft (owned fleet of 15)	1,500	Secured lenders (banks)	2,000
Airport slots (Delhi/Mumbai/Blr)	200	Unsecured NCDs (retail)	800
Land & Property (HQ + hangars)	300	ECB (foreign lenders)	700
Inventory (spares)	200	Trade payables	1,000
Trade Receivables	150	Statutory dues (GST, TDS, EPF)	200
Investments (mutual funds)	80	Workmen dues	250
Cash & Bank	20	Other unpaid dues	300
Intangibles (brand, tech)	550	Equity capital & reserves	(1,750)
Deferred tax asset	100		
Goodwill	400		
Total Assets	**3,500**	**Total L&E**	**3,500**

Asset-Class Specific Haircuts / Premiums to Apply:

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Asset Class	Adjustment to Book Value	Rationale
Aircraft (owned fleet)	Haircut 30%	Aged fleet, limited resale market
Airport slots	Premium 75%	Scarce Delhi/Mumbai slots command premium
Land & Property	Premium 50%	Andheri property appreciation over book
Inventory (spares)	Haircut 70%	Model-specific obsolete stock
Trade Receivables	Haircut 53%	Corporate travel accounts weak collectibility
Investments (mutual funds)	Haircut 6%	Near-liquid, minimal impairment
Cash & Bank	No adjustment	Full recovery at face value
Intangibles (brand, tech)	Haircut 95%	Brand value negligible in distress
Deferred tax asset	Haircut 100%	No future taxable income to offset
Goodwill	Haircut 100%	Worthless in liquidation

Additional Assumption:

- Going Concern Sale Value = Piecemeal NRV × (1 + 65% network premium)
- The 65% network premium reflects the value of an operating fleet, established slot network, brand recognition and route rights — all of which are destroyed in piecemeal sale

Required:

(i) Compute the Net Realizable Value (NRV) of each asset applying the haircuts/premiums given above.

(ii) Compute the total Piecemeal Liquidation Value.

(iii) Compute the Going Concern Sale Value using the 65% network premium.

(iv) Evaluate IndiGo's ₹2,800 crore bid against both piecemeal and going-concern values.

(v) Recommend whether the Board should accept the IndiGo bid, negotiate for a higher price, or pursue an alternative outcome.

Solution

(i) Net Realizable Value with Class-Specific Adjustments

Asset	Book (₹ cr)	Adjustment	NRV (₹ cr)
Aircraft (owned fleet)	1,500	Haircut 30%	1,050.00
Airport slots	200	Premium 75%	350.00
Land & Property	300	Premium 50%	450.00
Inventory (spares)	200	Haircut 70%	60.00
Trade Receivables	150	Haircut 53%	70.50
Investments (MF)	80	Haircut 6%	75.20
Cash & Bank	20	No adjustment	20.00
Intangibles (brand)	550	Haircut 95%	27.50
Deferred tax asset	100	Haircut 100%	0.00
Goodwill	400	Haircut 100%	0.00
TOTAL NRV	**3,500**		**2,103.20**

Sample Calculations:

- Aircraft: ₹1,500 × (1 − 0.30) = ₹1,050 crore
- Airport slots: ₹200 × (1 + 0.75) = ₹350 crore (premium reflects scarcity)
- Land & Property: ₹300 × (1 + 0.50) = ₹450 crore
- Intangibles: ₹550 × (1 − 0.95) = ₹27.50 crore

(ii) Piecemeal Liquidation Value

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Piecemeal Liquidation Value = Sum of NRVs = ₹2,103.20 crore

Interpretation: If SkyAir India were to be broken up and each asset sold separately in the market, total realizations would be ₹2,103 crore. This is 40% below the book value of ₹3,500 crore, reflecting the market's discount for distressed and non-going-concern assets.

(iii) Going Concern Sale Value

A going-concern sale — where the business is transferred as an operating unit rather than dismantled — captures three sources of value that piecemeal liquidation destroys:

- Network value of an integrated fleet operating on established routes
- Slot-portfolio synergies (10 slots at Delhi are worth more together than individually)
- Employee know-how, licenses, operating agreements not captured in book value

Applying the 65% network premium:

Going Concern Sale Value = ₹2,103.20 × 1.65 = ₹3,470.28 crore

The ₹1,367 crore premium over piecemeal NRV (₹3,470 − ₹2,103) represents the going-concern value of the airline as an operating unit.

(iv) Evaluation of IndiGo's ₹2,800 crore Bid

Valuation Alternative	Value (₹ crore)	IndiGo Bid Comparison
Piecemeal Liquidation NRV	2,103.20	IndiGo bid is ₹696.80 HIGHER
Going Concern Sale Value	3,470.28	IndiGo bid is ₹670.28 LOWER
IndiGo bid (offer on table)	2,800.00	—

Positioning of the Bid:

- The IndiGo bid sits BETWEEN the piecemeal value (₹2,103 cr) and going concern value (₹3,470 cr)
- As a percentage: IndiGo bid is 133% of piecemeal but only 81% of going concern
- IndiGo is effectively offering to pay 33% above liquidation but capture 65% of the network premium for themselves

(v) Recommendation to the Board

Recommendation: NEGOTIATE FOR A HIGHER PRICE — DO NOT ACCEPT ₹2,800 CRORE AS FINAL

Rationale:

(i) The IndiGo bid of ₹2,800 crore is materially below the ₹3,470 crore going-concern estimate — accepting it transfers 65% of the network premium to IndiGo

(ii) Piecemeal liquidation at ₹2,103 crore is inferior to the bid, so the bid is a valid NEGOTIATION FLOOR, not a walk-away price

(iii) The Board should initiate a competitive bid process with the ₹3,470 crore going-concern value as the RESERVE PRICE

Board's Negotiation Strategy:

- Approach 2-3 additional strategic buyers (Air India, Vistara's post-merger entity, Akasa Air) to create competitive tension
- Communicate the ₹3,470 crore going-concern estimate as the fair value the Board expects
- Structure a bid process where interested parties submit sealed bids by a defined date
- Set a REALISTIC minimum acceptable price of ₹3,200 crore — captures 80% of the going-concern premium and provides some acquirer discount for execution risk
- If no bid above ₹3,200 crore materializes within 60 days, accept IndiGo's revised bid at whatever level it reaches — piecemeal liquidation is the alternative floor and is significantly worse

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Key Considerations:

- Time pressure: Continued operations without acquisition mean daily cash burn — extended negotiation reduces value
- Slot licenses have expiry dates — delay may cause slot forfeiture, reducing going-concern value
- Fleet age is deteriorating — the ₹1,050 crore aircraft NRV assumes near-term sale; each month of delay adds 2-3% depreciation
- Employee attrition risk: skilled pilots and engineers are leaving weekly, eroding the going-concern premium
- If the negotiation stretches beyond 90 days, the fair value declines toward ₹3,000 crore rather than ₹3,470 crore — the value erodes with time

Question 8 — Modified DCF — Probability-Weighted Cash Flows and Distress-Adjusted WACC

Case Study — JSW Steel Ltd

JSW Steel is India's largest private-sector integrated steel producer. Prashant Jain, Head of Corporate Finance, has been asked by the Investment Committee to update the enterprise valuation ahead of a potential capital raise. The vanilla DCF he inherited from a junior analyst uses a single 6% growth rate, ignoring the well-documented cyclicality of steel prices, iron ore costs, and capacity utilisation.

Baseline Financial Data (FY26):

Item	Value
FCFF (base case)	₹8,000 crore
Explicit growth (Years 1-5)	6% per annum
Terminal growth (Year 6 onwards)	4% per annum
Baseline WACC	12.00%

Scenarios for Modified DCF:

Scenario	Probability	Annual Growth Rate	Rationale
Bull	30%	+15%	Global capex boom, China rebound
Base	50%	+6%	Normal industrial demand
Bear	20%	−8%	Recession, oversupply, raw material spike

Distress Adjustment for WACC:

- The 20% bear-case probability implies non-trivial distress risk
- Distress-adjusted WACC = Baseline WACC + 200 bps = 14.00%

Required:

(i) Compute Enterprise Value under VANILLA DCF (baseline).

(ii) Compute Enterprise Value under MODIFIED DCF Method 1: probability-weighted expected FCFFs at BASELINE WACC.

(iii) Compute Enterprise Value under FULL MODIFIED DCF: probability-weighted expected FCFFs at DISTRESS-ADJUSTED WACC (14%).

(iv) Compare the three valuations, quantify the compression, and comment on which method the Investment Committee should adopt.

Solution

(i) Vanilla DCF (Baseline)

Year	FCFF (₹cr)	PV Factor @ 12%	PV (₹cr)
1	8,480	0.8929	7,571

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Year	FCFF (₹cr)	PV Factor @ 12%	PV (₹cr)
2	8,989	0.7972	7,164
3	9,528	0.7118	6,782
4	10,100	0.6355	6,419
5	10,706	0.5674	6,076
Sum of explicit PV			**34,013**

Terminal FCFF = ₹10,706 × 1.04 = ₹11,134 crore

Terminal Value = ₹11,134 / (0.12 − 0.04) = ₹1,39,177 crore

PV of TV = ₹1,39,177 × 0.5674 = ₹78,972 crore

Vanilla DCF Enterprise Value = ₹34,013 + ₹78,972 = ₹1,12,984 crore

(ii) Modified DCF Method 1 — CF-Adjusted, Baseline WACC

Compute expected FCFF per year as probability-weighted average of Bull, Base, Bear scenario FCFFs.

Year	Bull (g=15%)	Base (g=6%)	Bear (g=-8%)	Expected FCFF	PV @ 12%
1	9,200	8,480	7,360	8,472	7,564
2	10,580	8,989	6,771	9,023	7,193
3	12,167	9,528	6,230	9,660	6,876
4	13,992	10,100	5,731	10,394	6,605
5	16,091	10,706	5,273	11,235	6,375
Sum of explicit PV					**34,613**

Expected growth rate (weighted): 30% × 15% + 50% × 6% + 20% × (−8%) = 5.90%

Terminal FCFF = ₹11,235 × 1.04 = ₹11,684 crore

Terminal Value = ₹11,684 / (0.12 − 0.04) = ₹1,46,051 crore

PV of TV = ₹1,46,051 × 0.5674 = ₹82,873 crore

Modified DCF (CF-adjusted only) EV = ₹34,613 + ₹82,873 = ₹1,17,486 crore

Note: EV is HIGHER than vanilla DCF because the Bull scenario's 15% growth pulls the expected value up MORE than the Bear scenario's −8% pulls it down. This reflects the asymmetric probabilities (30% bull vs 20% bear) rather than any true benefit.

(iii) Full Modified DCF — CF-Adjusted AND WACC-Adjusted

Apply the distress-adjusted WACC of 14% to the same expected FCFFs.

Year	Expected FCFF (₹cr)	PV Factor @ 14%	PV (₹cr)
1	8,472	0.8772	7,432
2	9,023	0.7695	6,943
3	9,660	0.6750	6,522
4	10,394	0.5921	6,155
5	11,235	0.5194	5,832
Sum of explicit PV			**32,883**

Terminal Value = ₹11,684 / (0.14 − 0.04) = ₹1,16,844 crore

PV of TV = ₹1,16,844 × 0.5194 = ₹60,683 crore

Full Modified DCF EV = ₹32,883 + ₹60,683 = ₹93,567 crore

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(iv) Comparison and Recommendation

Method	EV (₹ crore)	% vs Vanilla
Vanilla DCF	1,12,984	—
Modified DCF (CF-adjusted only)	1,17,486	+4.0%
Full Modified DCF (CF + WACC-adjusted)	93,567	−17.2%

Key Insights:

(i) Method 2 (CF-adjusted only) gives a HIGHER valuation than vanilla — because probability weighting favours the bull case (30% at +15%) over the bear (20% at −8%)

(ii) Method 3 (with WACC adjustment) gives a LOWER valuation, roughly 17% compression from vanilla, reflecting genuine distress risk pricing

(iii) The 21% swing between Method 2 and Method 3 illustrates that CASH FLOW adjustments alone are INSUFFICIENT for cyclical/distressed businesses — you must also adjust the discount rate

(iv) The WACC adjustment (200 bps) captures the fact that in the bear scenario, JSW Steel could face refinancing risk, covenant breaches, and higher borrowing costs — which the base 12% WACC does not reflect

(v) The 17% compression from vanilla ($1.13L cr) to full modified DCF ($94k cr) is REALISTIC for cyclical stocks — the market often prices cyclicals at 15-25% discount to their vanilla DCF for this reason

Recommendation for Investment Committee:

- Adopt the FULL MODIFIED DCF (₹93,567 crore) as the anchor valuation
- Present the vanilla DCF (₹1,12,984 crore) as an UPSIDE scenario that assumes the current commodity strength persists
- Prepare a downside case using bear scenario only, which would suggest ₹55-60k crore — the FLOOR valuation
- Any capital raise should target a valuation in the ₹90-95k crore range — defensible against sophisticated investors

Question 9 — DCF + Distress Value Hybrid — Probability-Weighted Two-State Valuation

Case Study — Prime Real Estate Finance Ltd (PREFL)

Prime Real Estate Finance Ltd is a listed mid-sized NBFC specializing in developer loans and Loan Against Property (LAP). Following the 2018-19 IL&FS crisis and 2023 RBI tightening on developer exposure, PREFL trades at 0.3x book value with a stressed loan book. The company's Chairperson, Anita Malhotra, has appointed Motilal Oswal Investment Banking to advise on strategic alternatives — including potential sale to a stronger financial services group. The IB team, led by Rohit Pandey, needs to prepare a defensible equity valuation that reflects both the going concern upside and the real distress risk.

PREFL Financial Snapshot (FY26):

Item	Value
FCFF (FY26)	₹250 crore
Growth (going concern case, Years 1-5)	8% per annum
Terminal growth	3%
WACC (elevated for stressed NBFC)	16%
Net Debt	₹1,500 crore
Loan Book (Gross)	₹4,200 crore
Investment Portfolio	₹400 crore
Real Estate Property (Offices)	₹100 crore
Annual Probability of Distress (from CDS spreads)	10%

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Item	Value
Projection Horizon	5 years

Distress Sale Value Assumptions:

- Loan book realizable at 55% of book (bank-style haircut on developer NPLs)
- Investment portfolio realizable at 85% of book
- Real estate at book value
- Additional recovery ₹250 cr from real estate collateral takeover on defaulted loans

Required:

(i) Compute the GOING CONCERN DCF Equity Value.

(ii) Compute the DISTRESS SALE Equity Value.

(iii) Compute the CUMULATIVE probability of distress over the 5-year projection horizon.

(iv) Apply the HYBRID DCF-DISTRESS formula to derive equity value.

(v) Run sensitivity of the hybrid equity value across annual default probabilities of 3% to 20%, and comment on which probability the buyer is likely to argue for.

Solution

(i) Going Concern DCF Equity Value

Year	FCFF (₹cr)	PV Factor @ 16%	PV (₹cr)
1	270.00	0.8621	232.76
2	291.60	0.7432	216.71
3	314.93	0.6407	201.76
4	340.12	0.5523	187.85
5	367.33	0.4761	174.87
Sum of explicit PV			**1,013.96**

Terminal FCFF = ₹367.33 × 1.03 = ₹378.35 crore

Terminal Value = ₹378.35 / (0.16 − 0.03) = ₹2,910.39 crore

PV of TV = ₹2,910.39 × 0.4761 = ₹1,385.68 crore

Going Concern Enterprise Value = ₹1,013.96 + ₹1,385.68 = ₹2,399.64 crore

Less: Net Debt of ₹1,500 crore

Going Concern EQUITY VALUE = ₹2,399.64 − ₹1,500 = ₹899.64 crore

(ii) Distress Sale Equity Value

Asset	Book (₹ cr)	Realization %	Distress Value (₹ cr)
Loan Book (Gross)	4,200	55%	2,310.00
Investment Portfolio	400	85%	340.00
Real Estate Property (Offices)	100	100%	100.00
Additional Real Estate Collateral	n/a	n/a	250.00
TOTAL DISTRESS EV			**3,000.00**

Less: Net Debt of ₹1,500 crore

Distress Sale EQUITY VALUE = ₹3,000 − ₹1,500 = ₹1,500 crore

Note: The distress equity value (₹1,500 cr) is HIGHER than the going-concern equity value (₹900 cr). This is because the market is DEEPLY discounting NBFC cash flows, but the underlying assets (loan collateral, investment portfolio) still

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have substantial realizable value. This pattern is typical of stressed NBFCs — the accounting/prudential book value exceeds the market value of the equity because the market builds in future defaults not yet crystallized on the books.

(iii) Cumulative Distress Probability

Annual probability of distress = 10%

Probability of survival for one year = 90%

Probability of survival for 5 years = 0.90^5 = 0.5905 = 59.05%

Cumulative probability of distress over 5 years = 1 − 0.5905 = 40.95%

(iv) Hybrid DCF-Distress Equity Value

Applying the ICAI formula:

V_equity = DCF Equity × (1 − P_distress) + Distress Equity × P_distress

= ₹899.64 × (1 − 0.4095) + ₹1,500 × 0.4095

= ₹899.64 × 0.5905 + ₹1,500 × 0.4095

= ₹531.23 + ₹614.27

= ₹1,145.50 crore

The hybrid value falls BETWEEN the going-concern (₹900 cr) and distress (₹1,500 cr) values.

(v) Sensitivity to Annual Default Probability

Annual P_distress	Cumulative P (5-yr)	Hybrid Equity Value (₹ cr)
3%	14.13%	984.45
5%	22.62%	1,035.46
8%	34.09%	1,104.32
10% (base)	40.95%	1,145.50
15%	55.63%	1,233.62
20%	67.23%	1,303.28

Interpretation:

(i) Because distress equity value (₹1,500 cr) is HIGHER than going-concern equity value (₹900 cr), the hybrid value INCREASES with higher default probability — a counter-intuitive but mathematically correct result

(ii) This suggests the market's implicit view is that the loan book is worth MORE dead than alive — i.e., the equity holders would be better off liquidating than continuing to bleed

(iii) A strategic buyer like HDFC Bank looking at PREFL as a going concern will rationally pay only up to ₹900 crore (the going-concern DCF value). They see PREFL as a lending platform to integrate. Meanwhile, a distressed-asset PE fund (Apollo, Cerberus, Baring PE India Special Situations) sees the ₹1,500 crore liquidation upside and could rationally pay up to ~₹1,400 crore (leaving a small margin for their execution risk). The type of buyer matters more than the default probability argument.

(iv) For the SELLER (Chairperson Anita Malhotra):

The seller's OPTIMAL strategy is NOT to negotiate the hybrid formula's inputs — it's to choose the RIGHT BUYER TYPE. Three tiers of outcome:

BEST: Initiate voluntary run-off / liquidation → capture full ₹1,500 crore for existing shareholders

SECOND-BEST: Sell to a distressed-asset PE fund → get ₹1,200-1,400 crore

WORST: Sell to a strategic going-concern buyer at ~₹900 crore, leaving ₹600 crore of value on the table (v) The 10% base case gives ₹1,146 crore as the anchor value; negotiation range with 5% premium on either side gives ₹1,090 to ₹1,200 crore

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(v) This is a classic example of NEGATIVE OPTIONALITY — the option to liquidate has real value, and the hybrid framework surfaces it explicitly

Recommendation to Chairperson Malhotra:

- Pitch the sale at ₹1,150-1,200 crore equity value using the 10% base case as anchor
- The buyer will argue for higher distress probability; be prepared to defend the 10% figure using CDS spreads and rating agency data
- Emphasize the going-concern value as a floor — even if the buyer disputes distress probability, the ₹900 crore going-concern value is defensible
- If the buyer refuses to go above ₹900 crore, consider RUN-OFF LIQUIDATION as an alternative — the ₹1,500 crore distress value implies existing shareholders could do BETTER by winding down the company

Question 10 — Tough Multi-Method Valuation — Comprehensive M&A Target Analysis (May 26 Style)

Case Study — Acquisition of MedTech Innovations Ltd

Dr. Lal PathLabs, India's leading listed diagnostics chain, is considering the acquisition of MedTech Innovations Ltd — a fast-growing unlisted diagnostics chain with 220 collection centers across South India. Kirti Menon, Head of Corporate Development at Dr. Lal, has been asked by CEO Om Prakash Manchanda to prepare a comprehensive valuation using all five standard methods. The transaction would be Dr. Lal's largest ever acquisition and requires Board approval.

MedTech Innovations Financial Snapshot (FY26):

Item	Value
Revenue	₹800 crore
EBITDA	₹200 crore (25% margin)
PAT	₹100 crore
FCFF (FY26)	₹120 crore
Invested Capital	₹1,200 crore
NOPAT	₹120 crore
Listed status	Unlisted
DLOM (Discount for Lack of Marketability)	25%

Assumptions for FCFF DCF (Two-Stage):

- Years 1-3: High growth 15% (continues current trajectory)
- Years 4-6: Stable growth 8% (scale slowdown)
- Terminal growth (Year 7 onwards): 5%
- WACC: 13.5% (unlisted target premium over listed peers)

Peer Comparables — Listed Diagnostics Chains:

Peer	EV/EBITDA	Growth
Dr Lal PathLabs	32x	15%
Metropolis Healthcare	26x	12%
Vijaya Diagnostics	24x	14%
Thyrocare Technologies	18x	10%
Peer average	**25x**	**13%**

Precedent Transaction Multiples (Recent M&A Deals):

- Metropolis acquires Hi-Tech Diagnostics (2024): 30x EV/EBITDA
- Dr Lal acquires Suburban Labs (2023): 34x EV/EBITDA
- Agilus acquires Genesis Labs (2024): 28x EV/EBITDA

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- Apollo Diagnostics acquires AMPATH (2025): 32x EV/EBITDA
- Precedent average: 31x EV/EBITDA (control premium already embedded)

LBO Assumptions:

- Debt/Equity mix at acquisition: 70:30
- Cost of debt: 10%
- Hold period: 5 years
- Target IRR: 20%
- Exit multiple: 22x EBITDA
- Debt paydown assumption: 50% of original debt by exit

Required:

(i) Compute Enterprise Value under FCFF DCF (two-stage).

(ii) Compute Enterprise Value under Comparable Companies method (with DLOM).

(iii) Compute Enterprise Value under Precedent Transactions method (with DLOM).

(iv) Compute the maximum Enterprise Value a financial (LBO) buyer could pay.

(v) Reconcile all four methods into a WEIGHTED FAIR VALUE and recommend the acquisition price range for Dr. Lal Board approval.

Solution

(i) FCFF DCF — Two-Stage

Year	Growth	FCFF (₹cr)	PV Factor @ 13.5%	PV (₹cr)
1	15%	138.00	0.8811	121.59
2	15%	158.70	0.7764	123.19
3	15%	182.50	0.6841	124.82
4	8%	197.11	0.6027	118.77
5	8%	212.87	0.5310	113.02
6	8%	229.90	0.4679	107.54
Sum of explicit PV				**708.93**

Terminal FCFF (Year 7) = ₹229.90 × 1.05 = ₹241.40 crore

Terminal Value = ₹241.40 / (0.135 − 0.05) = ₹2,840 crore

PV of TV = ₹2,840 × 0.4679 = ₹1,328.44 crore

FCFF DCF Enterprise Value = ₹708.93 + ₹1,328.44 = ₹2,037 crore

(ii) Comparable Companies Method

Peer average EV/EBITDA: 25x

Raw EV = 25x × ₹200 crore = ₹5,000 crore

Less: DLOM @ 25% (unlisted target): ₹1,250 crore

Adjusted EV (Comparable Companies) = ₹3,750 crore

Note: DLOM captures the fact that MedTech is unlisted — investors demand a 20-30% discount for the lack of a ready secondary market compared to listed peers.

(iii) Precedent Transactions Method

Precedent average EV/EBITDA: 31x (control premium already embedded in these prices)

Raw EV = 31x × ₹200 crore = ₹6,200 crore

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Less: DLOM @ 25% (unlisted target): ₹1,550 crore

Adjusted EV (Precedent Transactions) = ₹4,650 crore

Note: Precedent multiples are typically HIGHER than comparable multiples because they include the CONTROL PREMIUM the acquirer paid for majority control. Applying DLOM on top of this is appropriate for the unlisted status.

(iv) LBO Ability-to-Pay

Exit EBITDA Projection:

Year 5 EBITDA = ₹200 × 1.15^3 × 1.08^2 = ₹354.79 crore

Exit Enterprise Value:

EV at exit = 22x × ₹354.79 = ₹7,805.37 crore

Solving for Purchase EV:

Let purchase EV = X

Debt at purchase = 70% × X | Equity invest = 30% × X

Debt at exit = 50% × Debt at purchase = 35% × X

Equity at exit = Exit EV − Debt at exit = ₹7,805 − 0.35X

For 20% IRR over 5 years: Exit Equity / Equity Invest = 1.2^5 = 2.4883

(₹7,805 − 0.35X) / (0.30 × X) = 2.4883

₹7,805 − 0.35X = 0.7465 × X

₹7,805 = 1.0965 × X

Purchase EV = ₹7,805 / 1.0965 = ₹7,118 crore

A leveraged financial buyer could theoretically pay up to ₹7,118 crore. This is the ABILITY-TO-PAY ceiling, not the negotiated price — a strategic buyer like Dr. Lal cannot rationally pay above the price at which a PE fund would still hit 20% IRR.

(v) Reconciliation and Recommendation

Method	EV (₹ cr)	Weight	Contribution
FCFF DCF	2,037	30%	611.1
Comparable Companies (DLOM-adj)	3,750	25%	937.5
Precedent Transactions (DLOM-adj)	4,650	25%	1162.5
LBO Ability-to-Pay	7,118	20%	1423.6
WEIGHTED FAIR VALUE		**100%**	**4,135**

Weighting Rationale:

- FCFF DCF (30%): the theoretically anchor method, gets highest weight
- Comparable Companies (25%): important market anchor for public-market benchmark
- Precedent Transactions (25%): reflects control-premium reality but limited data
- LBO (20%): sets the ceiling — Dr. Lal must know a financial buyer could pay up to ₹7,118 cr

Valuation Range and Recommendation:

- Range: ₹2,037 crore (EVA floor) to ₹7,118 crore (LBO ceiling)
- Weighted fair value: ~₹4,135 crore
- Recommended acquisition price range: ₹3,750 to ₹3,600 crore

Board Presentation Recommendation:

(i) Open the bid at ₹2,800 crore (below the weighted fair value, allowing room to negotiate up)

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(ii) Maximum walk-away price: ₹3,600 crore (slightly above weighted fair value, protecting against overpayment)

(iii) If competing bidder emerges (e.g., Metropolis or Agilus), consider going to ₹4,200 crore — the precedent-transactions value with control premium — but not higher

(iv) AVOID paying the LBO ceiling of ₹7,118 crore — that price rewards financial engineering, not strategic value

(v) Structure the deal with earn-outs tied to Year 3 EBITDA achieving ₹300 crore — if MedTech continues its growth trajectory, additional consideration is justified; if it stalls, Dr. Lal is protected

Question 11 — Modified DCF for a Distressed Company

Case Study — Coastal Textiles Ltd

Coastal Textiles Ltd is a mid-cap integrated textile manufacturer based in Surat, exporting to Middle East and North Africa markets. Following the 2024 collapse of Egyptian textile importers and a sharp cotton price spike, the company has faced 18 months of margin compression and covenant breaches on its ₹1,000 crore borrowings from IDBI Bank, Union Bank and Yes Bank. Vinita Rane, CFO, has been asked by the Board's Audit Committee to reassess the enterprise valuation using the ICAI SM's Modified DCF methodology, to inform strategic decisions on asset sales, capital raise, or possible sale of the business.

Financial Data:

Item	Value
FCFF (FY26)	₹200 crore
Explicit growth (Years 1-5)	5% per annum
Terminal growth	3% per annum
Risk-free rate	7.00%
Market risk premium	6.00%
Tax rate	25%
Unlevered β (business risk of textile mfg)	0.85

Capital Structure — Pre-Stress (18 Months Ago):

- Debt (market value): ₹800 crore
- Equity (market value): ₹1,600 crore
- D/E ratio: 0.50
- Cost of debt (Kd): 11% (investment-grade rated)

Capital Structure — Current (Stressed):

- Debt (market value): ₹1,000 crore (increased due to further drawdowns)
- Equity (market value): ₹800 crore (fallen due to stress)
- D/E ratio: 1.25
- Cost of debt (Kd): 15% (400 bps default premium over prior 11%)
- Annual probability of distress: 12%

Required:

1. Compute the VANILLA DCF value using pre-stress capital structure and no distress probability adjustment.

2. Recompute the WACC using: (a) updated D/E ratio, (b) same unlevered beta, (c) updated levered beta, (d) updated cost of equity, (e) updated cost of debt at 15%.

3. Apply the ICAI SM formula $E[CF_t] = CF_t \times (1 - \text{Cumulative } P_{distress_t})$ to project adjusted expected cash flows over 5 years.

4. Compute the MODIFIED DCF enterprise value using updated WACC and adjusted cash flows.

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Solution

(i) Vanilla DCF — Pre-Stress Capital Structure

Compute Pre-Stress WACC:

Levered β = Unlevered β × [1 + (1 − t) × D/E]

= 0.85 × [1 + 0.75 × 0.50]

= 0.85 × 1.375 = 1.1687

Ke (pre-stress) = 7% + 1.1687 × 6% = 14.01%

Kd after tax = 11% × (1 − 0.25) = 8.25%

Weight of equity = 1,600 / 2,400 = 66.67%

Weight of debt = 800 / 2,400 = 33.33%

Vanilla WACC = 66.67% × 14.01% + 33.33% × 8.25% = 9.34% + 2.75% = 12.09%

Vanilla DCF Cash Flow Projections and PV:

Note: FY26 FCFF is ₹200 crore (base year). Year 1 = FY27 with 5% growth applied → ₹210 crore.

Year	FCFF (₹ cr)	PV Factor @ 12.09%	PV (₹ cr)
1	210.00	0.8921	187.35
2	220.50	0.7959	175.50
3	231.53	0.7101	164.40
4	243.10	0.6335	154.00
5	255.26	0.5652	144.26
Sum of explicit PV			**825.51**

Terminal FCFF (Year 6) = ₹255.26 × 1.03 = ₹262.91 crore

Terminal Value = ₹262.91 / (0.1209 − 0.03) = ₹2,892.34 crore

PV of TV = ₹2,892.34 × 0.5652 = ₹1,634.62 crore

VANILLA DCF EV = ₹825.51 + ₹1,634.62 = ₹2,460.12 crore

(ii) Updated WACC — Applying ICAI SM Sec 9.1 Adjustments

Update the Levered Cost of Equity:

Same unlevered β = 0.85 (business risk unchanged — textile manufacturing hasn't gotten riskier at the business level)

Updated D/E = 1,000 / 800 = 1.25

Updated Levered β = 0.85 × [1 + 0.75 × 1.25]

= 0.85 × [1 + 0.9375]

= 0.85 × 1.9375 = 1.6469

Updated Ke = 7% + 1.6469 × 6% = 7% + 9.88% = 16.88%

Update the Cost of Debt:

Kd increased from 11% to 15% (400 bps default premium reflecting deteriorated credit)

Updated Kd after tax = 15% × (1 − 0.25) = 11.25%

Update the Weights:

Weight of equity = 800 / 1,800 = 44.44%

Weight of debt = 1,000 / 1,800 = 55.56%

Updated WACC:

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Updated WACC = 44.44% × 16.88% + 55.56% × 11.25%

= 7.50% + 6.25% = 13.75%

Note: The updated WACC of 13.75% is HIGHER than the vanilla WACC of 12.09% despite the debt weight increasing (which normally lowers WACC). This is because both the increased default risk premium on debt AND the elevated levered beta on equity more than offset the debt-weight benefit.

(iii) Cash Flow Adjustment per ICAI SM Formula

Cumulative Survival Probabilities (Annual P_distress = 12%):

Year	Annual Survival	Cumulative Survival
1	88%	88.00%
2	88%	77.44%
3	88%	68.15%
4	88%	59.97%
5	88%	52.77%

Applying ICAI SM formula E[CF_t] = CF_t × (1 − Cumulative P_distress_t):

Year	Baseline FCFF	Cumulative Survival	Adjusted E[CF]
1	210.00	88.00%	184.80
2	220.50	77.44%	170.76
3	231.53	68.15%	157.78
4	243.10	59.97%	145.79
5	255.26	52.77%	134.71

(iv) Modified DCF Computation

Discount Adjusted Expected CFs at Updated WACC 13.75%:

Year	Adjusted CF (₹ cr)	PV Factor @ 13.75%	PV (₹ cr)
1	184.80	0.8791	162.46
2	170.76	0.7728	131.97
3	157.78	0.6794	107.20
4	145.79	0.5971	87.08
5	134.71	0.5250	70.73
Sum of explicit PV			**559.44**

Terminal FCFF (survival-adjusted) = ₹134.71 × 1.03 = ₹138.75 crore

Terminal Value = ₹138.75 / (0.1375 − 0.03) = ₹1,290.68 crore

PV of TV = ₹1,290.68 × 0.5250 = ₹677.74 crore

MODIFIED DCF EV = ₹559.44 + ₹677.74 = ₹1,237.18 crore

(v) Comparison and Interpretation

Method	EV (₹ cr)	Change
Vanilla DCF (pre-stress WACC, no distress adj)	2,460.12	—
Modified DCF (updated WACC + distress adj)	1,237.18	−49.71%
Value Gap	1,222.94	—

Key Insights:

1. The Modified DCF cuts value nearly in half compared to the naïve vanilla DCF — a 49.7% reduction driven by TWO compounding effects

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2. First effect: higher WACC (13.75% vs 12.09%) reduces PV of each future cash flow

3. Second effect: cumulative distress probability drops the projected cash flows themselves (Y5 cash flow multiplied by only 52.77% survival probability)

4. The two effects are NOT strictly additive — they interact multiplicatively (higher WACC compounds the discount on already-reduced cash flows)

5. This ~50% valuation compression is realistic for genuinely stressed companies and explains why distressed debt investors often bid at 40-50% of face value even when EBITDA looks reasonable

Recommendation for Board of Coastal Textiles:

- The intrinsic enterprise value is closer to ₹1,237 crore, not the ₹2,460 crore that vanilla DCF would suggest
- Any strategic sale of the business at above ₹1,300-1,400 crore should be seriously considered — that captures the intrinsic value plus a modest control premium
- Debt restructuring conversations with IDBI/Union/Yes should reference the ₹1,237 crore figure, not the misleading ₹2,460 crore vanilla estimate
- If the company can execute a successful turnaround (reduce annual distress probability from 12% to 6%), the Modified DCF would rise materially — creating a clear turnaround value proposition to present to shareholders

Question 12 — Adjusted Present Value (APV) with Bankruptcy Cost

Case Study — Bharat Iron & Steel Ltd

Bharat Iron & Steel Ltd (BISL) is a mid-tier integrated steel producer with plants in Bhilai and Rourkela. Following the 2024-25 correction in Chinese steel exports flooding Asian markets, BISL has faced sustained margin pressure and is now carrying elevated debt of ₹3,000 crore. Ranjit Aggarwal, Finance Director, is presenting to the Board a valuation analysis using the ICAI SM's APV framework — the objective is to identify whether the current capital structure is optimal, and to inform decisions on partial debt paydown or continued leverage.

Financial Data:

Item	Value
FCFF (FY26)	₹500 crore
Explicit growth (Years 1-5)	6% per annum
Terminal growth (Year 6 onwards)	3% per annum
Unlevered Cost of Equity (Ke_u)	13.00%
Total Debt Outstanding	₹3,000 crore
Cost of Debt (Kd)	11.00%
Tax Rate	25%
Annual Probability of Distress	8%
Distress Sale Value (as % of Unlevered Value)	60%

Required:

1. STEP 1 — Compute the UNLEVERED FIRM VALUE by discounting FCFF at the unlevered cost of equity of 13%.
2. STEP 2 — Compute the PV of Tax Benefits from Debt, assuming perpetual constant debt.
3. STEP 3 — Estimate the Distress Sale Value at 60% of the Unlevered Firm Value.
4. STEP 4 — Compute the Expected Bankruptcy Cost using the ICAI SM formula.
5. STEP 5 — Compute the APV = Unlevered Value + PV(Tax Benefits) − Expected Bankruptcy Cost.

Solution

(i) Step 1 — Unlevered Firm Value

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Discount all FCFF at the unlevered cost of equity of 13% (representing operational risk without any financing benefit).

Note: FY26 FCFF is ₹500 crore (base year). Year 1 = FY27 with 6% growth applied → ₹530 crore.

Year	FCFF (₹ cr)	PV Factor @ 13%	PV (₹ cr)
1	530.00	0.8850	469.03
2	561.80	0.7831	439.97
3	595.51	0.6931	412.72
4	631.24	0.6133	387.15
5	669.11	0.5428	363.17
Sum of explicit PV			**2,072.03**

Terminal FCFF (Year 6) = ₹669.11 × 1.03 = ₹689.19 crore

Terminal Value = ₹689.19 / (0.13 − 0.03) = ₹6,891.86 crore

PV of TV = ₹6,891.86 × 0.5428 = ₹3,740.63 crore

UNLEVERED FIRM VALUE = ₹2,072.03 + ₹3,740.63 = ₹5,812.66 crore

(ii) Step 2 — PV of Tax Benefits from Debt

Under the standard APV assumption of perpetual constant debt, the PV of tax shields simplifies to:

PV of Tax Shields = Debt × Tax Rate

Annual interest expense = ₹3,000 × 11% = ₹330 crore

Annual tax shield = ₹330 × 25% = ₹82.5 crore

Under perpetual constant debt, discounting the annual shield at Kd:

PV of Tax Shields = ₹82.5 / 0.11 = ₹750 crore

Equivalently: PV of Tax Shields = D × T = ₹3,000 × 0.25 = ₹750 crore

PV OF TAX BENEFITS = ₹750 crore

(iii) Step 3 — Distress Sale Value

Per ICAI SM guidance, distress sale value is estimated as a percentage of the unlevered firm value (or book value). For BISL, we apply 60% based on:

- Steel plants typically realize 55-65% of going-concern value in distress sale
- Equipment has liquid secondary market but capacity utilization drops
- Land and mining rights hold most of their value; captive power plants command premium

Distress Sale Value = 60% × Unlevered Firm Value

Distress Sale Value = 0.60 × ₹5,812.66 = ₹3,487.60 crore

(iv) Step 4 — Expected Bankruptcy Cost

Applying the ICAI SM Section 9.3 formula:

Expected Bankruptcy Cost = (Unlevered Value − Distress Sale Value) × Probability of Distress

The 'gap' between Unlevered Value and Distress Sale Value represents the value that is DESTROYED if the firm enters bankruptcy. This is the cost the firm bears whenever bankruptcy occurs.

Cumulative Probability of Distress over 5-Year Horizon:

Annual survival probability = 1 − 8% = 92%

Cumulative survival over 5 years = 0.92^5 = 0.6591

Cumulative probability of distress = 1 − 0.6591 = 34.09%

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Expected Bankruptcy Cost Computation:

Value at risk if bankruptcy occurs = ₹5,812.66 − ₹3,487.60 = ₹2,325.06 crore

Expected Bankruptcy Cost = ₹2,325.06 × 34.09% = ₹792.66 crore

EXPECTED BANKRUPTCY COST = ₹792.66 crore

(v) Step 5 — APV Computation

Assembling all components per ICAI SM Section 9.3 formula:

Firm Value = Unlevered Value + PV(Tax Benefits) − Expected Bankruptcy Cost

Component	Value (₹ cr)
Unlevered Firm Value	5,812.66
ADD: PV of Tax Benefits of Debt	+750.00
LESS: Expected Bankruptcy Cost	(792.66)
ADJUSTED PRESENT VALUE (APV)	**5,770.00**

Critical Insight — Tax Shield and Bankruptcy Cost Almost Perfectly Offset:

At the current 8% annual distress probability, the ₹750 crore benefit from tax shields is almost entirely offset by the ₹793 crore expected bankruptcy cost — leaving a small NET DESTRUCTION of ₹43 crore. The APV of ₹5,770 crore is essentially the SAME as the Unlevered Firm Value of ₹5,813 crore. This means the debt-financing decision is CURRENTLY DESTROYING SMALL VALUE for BISL — the firm has taken on financial risk in exchange for tax benefits that are more than consumed by bankruptcy costs.

Recommendation to BISL Board:

1. The current capital structure is DESTROYING modest value — ₹43 crore of net destruction relative to unlevered baseline
2. IMMEDIATE ACTION: Any incremental deterioration in operating conditions (raising annual distress probability above 8%) will cause leverage to destroy meaningful value — at 12% distress, ₹348 crore of destruction occurs
3. OPTIMAL STRATEGY: Reduce debt from ₹3,000 crore to ₹2,000 crore through partial equity infusion or asset sales
4. At ₹2,000 crore debt: tax shields fall to ₹500 crore, but distress probability could drop to 5% (per credit rating agencies' rules of thumb), giving APV = ₹5,813 + ₹500 − ₹350 (approximate) = ₹5,963 crore — a ₹193 crore uplift from current APV with substantially lower financial risk
5. COMMUNICATION TO SHAREHOLDERS: The Board can present this as VALUE-CREATING deleveraging — actual creation of ₹193 crore of shareholder value coupled with material reduction of tail risk
6. COMMUNICATION TO LENDERS: Partial debt paydown will improve BISL's credit spreads by 100-150 bps, further improving APV by reducing Kd

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CHAPTER 14 — MERGERS, ACQUISITIONS AND CORPORATE RESTRUCTURING

Question 1 — Advanced Swap Ratio with Multi-Method Reconciliation

Case Study — HDFC Bank Ltd Acquires IDFC First Bank Ltd (Hypothetical)

In a hypothetical consolidation scenario, HDFC Bank is evaluating the acquisition of IDFC First Bank. The Board's Merger Committee, chaired by Atanu Chakraborty (Non-Executive Chairman), has appointed Motilal Oswal Investment Banking and Kotak Investment Banking as joint financial advisers. The acquisition would rank as the third-largest banking merger in Indian history (after HDFC-HDFC Bank and SBI-associate banks integration).

Standalone Financial Metrics:

Metric	HDFC Bank (Acquirer)	IDFC First Bank (Target)
Number of shares outstanding	750 crore	660 crore
EPS (FY26)	₹92.00	₹4.50
Current Market Price (CMP)	₹1,650	₹85
Book Value per share	₹620	₹45
DPS (FY26)	₹19	Nil
Intrinsic value per share (analyst DCF)	₹1,850	₹95

Required:

(i) Compute the swap ratio under FOUR methods: Market Price, EPS, Book Value, Intrinsic Value.

(ii) Compute the WEIGHTED AVERAGE swap ratio using weights 30% (Market), 20% (EPS), 15% (Book Value), 35% (Intrinsic).

(iii) Compute the post-merger EPS (before any synergies) at the weighted swap ratio and comment on dilution.

(iv) Derive the BREAK-EVEN swap ratio at which post-merger EPS equals HDFC's standalone EPS.

(v) Identify the NEGOTIATION ZONE and recommend HDFC's opening offer, walk-away point, and expected outcome.

Solution

(i) Swap Ratio — Four Methods

Formula: SR = Target Value per Share / Acquirer Value per Share

Method	Target Value	Acquirer Value	Swap Ratio
Market Price	₹85	₹1,650	85/1,650 = 0.0515
EPS	₹4.50	₹92.00	4.50/92 = 0.0489
Book Value	₹45	₹620	45/620 = 0.0726
Intrinsic (DCF)	₹95	₹1,850	95/1,850 = 0.0514

Observations Across Methods:

- EPS-based ratio (0.0489) is LOWEST — reflects HDFC's superior profitability per share
- Book Value ratio (0.0726) is HIGHEST — reflects IDFC First's larger book relative to its earnings capacity
- Market and Intrinsic ratios (~0.0515) cluster together — the market has largely priced in DCF fundamentals
- The 48% spread between highest (BV) and lowest (EPS) is the negotiation space

(ii) Weighted Average Swap Ratio

Method	Weight	Swap Ratio	Weighted
Market Price	30%	0.0515	0.01546
EPS	20%	0.0489	0.00978

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Method	Weight	Swap Ratio	Weighted
Book Value	15%	0.0726	0.01089
Intrinsic	35%	0.0514	0.01798
Weighted Average	**100%**		**0.0541**

Weighted Swap Ratio = 0.0541 (approximately 1 HDFC share for every 18.48 IDFC shares)

Weighting Rationale:

- Intrinsic Value (35%) — highest weight; reflects fundamental future cash flow generation
- Market Price (30%) — high weight; reflects current investor consensus
- EPS (20%) — moderate weight; captures immediate profitability but not future potential
- Book Value (15%) — lowest weight; banking book values distorted by NPA classification and provision policies
- Dividend method excluded — target IDFC First has zero DPS

(iii) Post-Merger EPS Impact

New Shares Issued to IDFC Shareholders:

New shares = 660 crore × 0.0541 = 35.70 crore HDFC shares

Post-Merger Share Structure:

Shareholder Group	Shares (₹ cr)	% Holding
Existing HDFC shareholders	750.00	95.46%
Ex-IDFC First shareholders	35.70	4.54%
Total post-merger shares	**785.70**	**100.00%**

Combined PAT (Pre-Synergy):

HDFC PAT = 92 × 750 = ₹69,000 crore

IDFC First PAT = 4.5 × 660 = ₹2,970 crore

Combined PAT = ₹71,970 crore

Combined EPS:

EPS = ₹71,970 crore / 785.70 crore shares = ₹91.60

HDFC standalone EPS: ₹92.00

Change: DILUTIVE by ₹0.40 (–0.44%)

The 0.44% dilution is minor and easily recoverable through modest synergies. Cost synergies of ~₹350 crore (post-tax) would restore break-even; this is achievable through branch consolidation, technology integration and treasury operations centralization.

(iv) Break-Even Swap Ratio (EPS-Neutral)

For post-merger EPS = HDFC's standalone EPS of ₹92:

Combined PAT / (HDFC shares + New shares issued) = ₹92

₹71,970 / (750 + 660 × SR) = 92

750 + 660 × SR = ₹71,970 / 92 = 782.28

660 × SR = 32.28

Break-even SR = 32.28 / 660 = 0.0489

Note: The break-even SR (0.0489) equals the EPS-based method result — this is not coincidence. When there are no synergies, the EPS-based swap ratio exactly preserves the acquirer's EPS.

(v) Negotiation Zone and Recommendation

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Negotiation Boundaries:

Anchor	Swap Ratio	Interpretation
HDFC's floor (Break-even EPS)	0.0489	Below this, deal is accretive but IDFC will reject
Weighted fair value	0.0541	Balanced view across methods
Market Price (IDFC's ask)	0.0515	IDFC shareholders' expectation
Book Value (IDFC's aggressive ask)	0.0726	IDFC will pitch this if fundamentals story fails

Practical Negotiation Zone: 0.0489 to 0.0515

- Below 0.0489: HDFC accretive but IDFC will reject as unfair
- Above 0.0515: IDFC market price paid — no negotiation gains for HDFC
- The weighted SR of 0.0541 is ABOVE the market ratio — reflects that DCF/intrinsic supports a higher price than market currently pays

Board Recommendation:

(i) OPENING OFFER: 0.0500 — slightly above break-even, provides psychological anchor

(ii) TARGET NEGOTIATED PRICE: 0.0510 to 0.0515 — accepts market's implied ratio, minor dilution acceptable if synergies materialize

(iii) WALK-AWAY: 0.0530 — beyond this, EPS dilution exceeds 1% without offsetting strategic value

(iv) CONTINGENT CONSIDERATION: consider structuring an earn-out where 0.0005 additional swap ratio is issued if IDFC First achieves ₹5,000 crore PAT in FY28 (protects HDFC against underperformance)

(v) DEAL RATIONALE FOR SHAREHOLDERS: emphasize the ₹350 crore of achievable cost synergies (2× the maximum expected dilution) rather than the swap ratio itself

Question 2 — Synergy Valuation with Phased Integration Timeline

Case Study — Tata Air India + Vistara Merger

The Tata Group's merger of Air India and Vistara, formally completed in November 2024, is the largest airline consolidation in Indian aviation history. Campbell Wilson, CEO of the merged Air India, is presenting the post-merger synergy realization plan to the Tata Sons Board, chaired by N. Chandrasekaran. The Board wants a rigorous PV-of-synergies analysis with realistic ramp-up assumptions, integration costs, and a clear framework for how synergy value is shared between Air India (as majority owner) and Vistara-Singapore Airlines (as merged-in party).

Operational Synergies at Steady State (Year 4+):

Category	Peak Annual (₹ cr)	Rationale
Route rationalization	200	Eliminate overlap on Delhi-Mumbai, Bangalore-Delhi
Fleet & MRO consolidation	350	Shared aircraft maintenance, unified spares inventory
Ground handling scale	150	Combined airport operations at 30 stations
Frequent flyer program merger	100	Club Vistara + Flying Returns merged loyalty
HR / overhead reduction	180	Duplicate corporate functions eliminated
Fuel procurement synergy	120	Combined fuel volume for lower per-litre pricing
Cross-selling premium routes	300	Vistara's business class inventory sold on AI network
Total Operational Peak	**1,400**	

Financial Synergies at Steady State (Year 2+):

- Debt refinancing at Air India's investment-grade rating (vs Vistara's lower rating): ₹180 crore savings per year
- Extra tax shield from higher depreciation on merged fleet: ₹60 crore per year
- Total Financial Peak: ₹240 crore per year

Integration Costs (Front-Loaded):

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Year	Integration Cost (₹ cr)	Nature
1	800	IT integration, aircraft repainting, brand transition
2	400	Continued IT, contract renegotiations, redundancies
3	150	Training, cultural integration
4	50	Residual harmonization
5+	0	Fully integrated

Ramp-Up Curves:

- Operational synergies: Year 1 30% | Year 2 60% | Year 3 85% | Year 4+ 100%
- Financial synergies: Year 1 50% | Year 2+ 100% (refinancing ramps faster)

Discount Framework:

- Post-tax cash flows (tax rate 25%)
- Discount rate: 11% (Tata Sons blended WACC)
- Terminal value: perpetuity of steady-state synergies

Required:

(i) Build a 6-year synergy cash flow schedule showing operational synergies (ramp-adjusted), financial synergies (ramp-adjusted), and integration costs.

(ii) Compute the PRESENT VALUE of synergies (explicit 6-year period + perpetuity terminal value).

(iii) Determine the fair share of synergy value that accrues to Air India (60% given majority control) versus Vistara/Singapore Airlines (40% as merged-in party).

(iv) Given Vistara's standalone value of ₹15,000 crore, recommend the fair offer price and the walk-away ceiling that Tata Sons should not exceed.

Solution

(i) 6-Year Synergy Cash Flow Schedule

Year	Ops Synergy (₹cr)	Fin Synergy (₹cr)	Integration Cost (₹cr)	Net Pre-tax (₹cr)	After-tax (₹cr)	PV @ 11% (₹cr)
1	420	120	(800)	(260)	(195.00)	(175.68)
2	840	240	(400)	680	510.00	413.93
3	1,190	240	(150)	1,280	960.00	701.94
4	1,400	240	(50)	1,590	1,192.50	785.54
5	1,400	240	0	1,640	1,230.00	729.95
6	1,400	240	0	1,640	1,230.00	657.61
Sum of Explicit PV						**3,113.29**

Sample Calculation for Year 1:

Operational synergy at 30% ramp: ₹1,400 × 30% = ₹420 crore

Financial synergy at 50% ramp: ₹240 × 50% = ₹120 crore

Integration cost: ₹800 crore

Net pre-tax: ₹420 + ₹120 − ₹800 = ₹(260) crore

After-tax (net loss × 0.75): ₹(195) crore

PV @ 11%: ₹(195) / 1.11 = ₹(175.68) crore

(ii) Terminal Value and Total PV

Steady-state synergy (Year 7 onwards) = ₹1,400 + ₹240 = ₹1,640 crore pre-tax

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After-tax steady-state = ₹1,640 × 0.75 = ₹1,230 crore per year

Terminal value = ₹1,230 / 0.11 = ₹11,181.82 crore (perpetuity)

PV of TV = ₹11,181.82 / $(1.11)^6$ = ₹5,978.26 crore

TOTAL PV OF SYNERGIES = ₹3,113.29 + ₹5,978.26 = ₹9,091.54 crore ≈ ₹9,092 crore

Structural Observations:

(i) Year 1 shows NEGATIVE synergy value — integration costs exceed early synergy realization. This is realistic and honest

(ii) Break-even year: Year 2 (when net after-tax synergies turn positive)

(iii) Steady state achieved from Year 4 — 4-year integration horizon is typical for airline mergers

(iv) Terminal value (₹5,978 cr) contributes 66% of total PV — reflects the perpetual nature of scale advantages

(v) If Board had used undiscounted peak synergy × 10-year horizon (naïve approach): ₹1,640 × 10 = ₹16,400 crore — 80% overstatement vs realistic ₹9,092 crore

(iii) Synergy Value Sharing

Under the Air India / Singapore Airlines merger agreement, Tata Sons emerges with 74.9% of the merged Air India (retaining control), while Singapore Airlines gets 25.1%. Synergy value is shared based on ownership + negotiation leverage.

Party	Share of Synergy Value	₹ crore
Air India (Tata Sons)	60%	5,454.93
Vistara (Singapore Airlines share)	40%	3,636.62
Total PV of Synergies	**100%**	**9,091.54**

Rationale for 60/40 split (rather than 75/25 ownership): Vistara's Singapore Airlines partnership brings the premium brand, business-class competency, and international operating standards that are the SOURCE of many synergies. Compensating Singapore Airlines above their ownership percentage reflects this contribution.

(iv) Fair Offer and Walk-Away Ceiling

Valuation Framework:

Component	Value (₹ cr)
Vistara standalone equity value	15,000
ADD: Vistara's share of synergy value (40%)	3,637
FAIR OFFER for Vistara equity	**18,637**
MAXIMUM (if Air India transfers 100% of synergies)	24,092

Recommendation to Tata Sons Board:

(i) FAIR OFFER: ₹18,637 crore for Vistara's equity — this recognizes Singapore Airlines' contribution to the synergy pool while retaining ₹5,455 crore of value for Air India shareholders

(ii) OPENING NEGOTIATION: Anchor around ₹17,000 crore (5% below fair) to preserve room for concessions

(iii) WALK-AWAY CEILING: ₹22,000 crore — beyond this, Air India transfers substantially all synergy value and gets no reward for taking merger execution risk

(iv) STRUCTURAL PROTECTIONS: Include an earn-out where an additional ₹1,000-2,000 crore is paid if actual Year-3 operational synergies exceed ₹1,000 crore (protects Tata Sons if synergies underperform)

(v) DISCLOSE RAMP CURVE: The Board memo should explicitly show that synergies destroy value in Year 1 — investors and rating agencies must understand this is a 4-year story, not immediate accretion

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Question 3 — Bain Capital LBO of MedPlus Health Services — Full FCFE Cash Flow Walk, Realistic Amortization, Mezzanine Retirement

Case Study — Bain Capital Acquires MedPlus Health Services

Bain Capital India is evaluating a take-private of MedPlus Health Services Ltd, a Hyderabad-headquartered pharmacy retail chain operating 4,500+ stores across South India, listed on BSE/NSE. Following consolidation in the Indian pharmacy retail sector, MedPlus's management-controlled promoter group has offered to work with Bain on a delisting-and-scale strategy. Rajath Sunder Rajan, Managing Director at Bain, is finalising the LBO structure for Investment Committee approval.

Transaction Structure:

Item	Value
Purchase Enterprise Value	₹5,000 crore
Senior Debt (Kotak Mahindra + Axis Bank consortium @ 11%)	₹3,000 crore
Mezzanine Debt (Bain Credit Partners @ 15%)	₹500 crore
Sponsor Equity (Bain Capital)	₹1,500 crore
Hold Period	5 years
Tax Rate	25%
Senior Mandatory Amortization (5% of original balance)	₹150 crore per year
Cash Sweep Priority	Mezzanine first (retire before exit); residual to Senior
Working Capital Change	Assumed nil (steady-state pharmacy retail)

Operating Projections (₹ crore):

Bain's 100-day operating plan (store rationalization, private label expansion, procurement consolidation) is expected to accelerate EBITDA growth relative to the pre-LBO base of ₹700 crore.

Metric	Y1	Y2	Y3	Y4	Y5
EBITDA	750	820	890	960	1,030
EBITDA Growth YoY	—	9.3%	8.5%	7.9%	7.3%
Capex (18% of EBITDA)	135.0	147.6	160.2	172.8	185.4
D&A (assumed = Capex, steady state)	135.0	147.6	160.2	172.8	185.4

Exit Assumption:

- Exit at end of Year 5 via strategic sale or IPO
- Base case exit multiple: 8.5x Y5 EBITDA
- Buyer expected to be clean-balance-sheet acquirer (Apollo Pharmacy or Reliance Retail) who requires mezzanine fully retired before flip

Required:

1. Build the EXPLICIT YEAR-BY-YEAR FCFE CASH FLOW WALK from EBITDA down to Cash Available for Discretionary Sweep. Clearly show each line item.

2. Model the DEBT PAYDOWN SCHEDULE showing senior mandatory amortization, sweep allocation to mezzanine, and resulting closing balances year-over-year.

3. Compute the CLOSING TOTAL DEBT at end of Year 5.

4. Compute the EXIT ENTERPRISE VALUE using 8.5x Y5 EBITDA.

5. Compute EXIT EQUITY VALUE to Bain, MOM, and IRR over the 5-year hold.

6. Perform sensitivity analysis of MOM and IRR across exit multiples of 7.0x, 7.5x, 8.0x, 8.5x (base), 9.0x, and 9.5x.

7. Recommend to Investment Committee whether to proceed, and identify key operating levers Bain must execute on.

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Solution

(i) Explicit FCFE Cash Flow Walk

For each year, we compute cash available for discretionary sweep using the FCFE formula. Key assumption: D&A = Capex (steady state — reasonable for mature pharmacy retail where Bain's capex program maintains store network without meaningful expansion beyond base).

Interest computed on OPENING debt balance for each year:

Year	Sr Opening	Sr Int @ 11%	Mz Opening	Mz Int @ 15%	Total Int
Y1	3,000.00	330.00	500.00	75.00	405.00
Y2	2,850.00	313.50	492.50	73.88	387.38
Y3	2,700.00	297.00	428.73	64.31	361.31
Y4	2,550.00	280.50	302.36	45.35	325.85
Y5	2,400.00	264.00	106.35	15.95	279.95

Year-by-Year FCFE Walk (₹ crore):

Line Item	Y1	Y2	Y3	Y4	Y5
EBITDA	750.00	820.00	890.00	960.00	1,030.00
Less: Total Cash Interest	(405.00)	(387.38)	(361.31)	(325.85)	(279.95)
EBIT (= EBITDA − D&A)	615.00	672.40	729.80	787.20	844.60
PBT (= EBIT − Interest)	210.00	285.02	368.49	461.35	564.65
Less: Cash Tax @ 25%	(52.50)	(71.26)	(92.12)	(115.34)	(141.16)
PAT	157.50	213.77	276.37	346.01	423.49
Add back: D&A	135.00	147.60	160.20	172.80	185.40
Less: Capex	(135.00)	(147.60)	(160.20)	(172.80)	(185.40)
Less: ΔWC (nil)	0.00	0.00	0.00	0.00	0.00
FCFE (before debt amort)	**157.50**	**213.77**	**276.37**	**346.01**	**423.49**
Less: Mandatory Senior Amort	(150.00)	(150.00)	(150.00)	(150.00)	(150.00)
Cash Available for Discretionary Sweep	**7.50**	**63.77**	**126.37**	**196.01**	**273.49**

Cumulative Cash Sweep Over 5 Years:

₹7.50 + ₹63.77 + ₹126.37 + ₹196.01 + ₹273.49 = ₹667.14 crore

This cumulative sweep of ₹667 crore comfortably retires the ₹500 crore mezzanine with a ₹167 crore residual applied to senior.

Cross-Check via FCFF (Illustrative — NOT used for LBO sweep):

If we mistakenly computed FCFF instead of FCFE for the Y1 sweep:

FCFF Y1 = PAT + Interest × (1 − t) + D&A − Capex = ₹157.50 + ₹405 × 0.75 + ₹135 − ₹135 = ₹461.25 crore

If we used FCFF as "sweep", we would overstate cash available by ₹303.75 crore — precisely equal to Interest × (1 − t). This is because FCFF ADDS BACK the after-tax interest that FCFE correctly leaves out. Using FCFF for LBO sweep would suggest the LBO can pay off ALL debt by Year 2 — a fantasy that ignores the fact that interest has actually been paid to lenders.

(ii) Debt Paydown Schedule

Sweep Priority: MEZZANINE first (to ensure clean balance sheet before exit); residual to SENIOR after mezz fully retired.

Senior Debt Paydown:

Year	Opening	Mandatory Amort	Sweep	Closing
Y1	3,000.00	150.00	0.00	2,850.00

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Year	Opening	Mandatory Amort	Sweep	Closing
Y2	2,850.00	150.00	0.00	2,700.00
Y3	2,700.00	150.00	0.00	2,550.00
Y4	2,550.00	150.00	0.00	2,400.00
Y5	2,400.00	150.00	167.13	2,082.87
Total Paydown		**750.00**	**167.13**	**₹917.13 cr**

Mezzanine Debt Paydown:

Year	Opening	Sweep Applied	Closing
Y1	500.00	7.50	492.50
Y2	492.50	63.77	428.73
Y3	428.73	126.37	302.36
Y4	302.36	196.01	106.35
Y5	106.35	106.35	0.00 (FULLY RETIRED)

The mezzanine sweep math ties: ₹7.50 + ₹63.77 + ₹126.37 + ₹196.01 + ₹106.35 = ₹500.00 crore = original mezz balance. In Year 5, only ₹106.35 crore of the ₹273.49 crore available sweep is needed to retire the residual mezz; the remaining ₹167.13 crore flows to senior.

(iii) Closing Total Debt at Exit

Closing Senior Debt: ₹2,082.87 crore

Closing Mezzanine Debt: ₹0 crore (fully retired in Y5)

CLOSING TOTAL DEBT = ₹2,082.87 crore

Total debt paydown during hold: ₹3,500 − ₹2,082.87 = ₹1,417.13 crore (40.5% deleveraging). This is a strong deleveraging story for the exit narrative — a clean balance sheet with no expensive mezzanine appeals to strategic acquirers who cannot inherit 15% coupon debt.

(iv) Exit Enterprise Value

Y5 EBITDA = ₹1,030 crore

Exit Multiple = 8.5x (in line with recent pharmacy retail comparables — Apollo Pharmacy trades at 12x forward; strategic acquirer haircut of ~30% for control premium already paid at LBO close)

EXIT ENTERPRISE VALUE = ₹1,030 × 8.5 = ₹8,755 crore

(v) Exit Equity Value, MOM and IRR

Component	Value (₹ cr)
Exit Enterprise Value	8,755.00
Less: Closing Senior Debt	(2,082.87)
Less: Closing Mezzanine Debt	(0.00)
EXIT EQUITY TO BAIN	**6,672.13**
Entry Equity	1,500.00
MOM (Money-on-Money Multiple)	**4.45x**
IRR (5-year hold)	**34.78%**

Math Verification:

MOM = ₹6,672.13 / ₹1,500 = 4.448x

IRR = 4.448^(1/5) − 1 = 1.3478 − 1 = 34.78%

Return Attribution:

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Value Driver	Contribution (₹ cr)	% of Total Value Creation
EBITDA Growth (₹750 → ₹1,030 at entry multiple 6.67x)	1,867	36.1%
Multiple Expansion (6.67x → 8.5x on ₹1,030 Y5 EBITDA)	1,885	36.5%
Deleveraging (₹1,417 cr debt paydown)	1,417	27.4%
Total Value Created for Sponsor	**5,169**	**100.0%**

(vi) Sensitivity Analysis — Exit Multiple

Exit Multiple	Exit EV (₹ cr)	Exit Equity (₹ cr)	MOM	IRR
7.0x (bear)	7,210	5,127	3.42x	27.87%
7.5x	7,725	5,642	3.76x	30.34%
8.0x	8,240	6,157	4.10x	32.63%
8.5x (BASE)	8,755	6,672	4.45x	34.78%
9.0x	9,270	7,187	4.79x	36.80%
9.5x (bull)	9,785	7,702	5.13x	38.71%

Sensitivity Observations:

- Base case delivers 34.78% IRR — comfortably above Bain's 25% underwriting hurdle
- Even at bear-case 7.0x exit multiple (multiple compression scenario), IRR remains 27.87% — above hurdle
- Every 0.5x of multiple expansion adds ~200 bps to IRR — highlights the importance of exit market timing
- Downside protection is strong: debt paydown of ₹1,417 crore over 5 years insulates equity even if EBITDA underperforms

(vii) Investment Committee Recommendation

RECOMMENDATION: PROCEED with the LBO at proposed structure.

Key Rationale:

1. STRONG BASE CASE RETURNS: 34.78% IRR / 4.45x MOM comfortably above Bain's 25% hurdle rate

2. ROBUST DOWNSIDE PROTECTION: Even at 7.0x exit multiple (bear case), IRR remains 27.87% — above hurdle

3. CLEAN EXIT NARRATIVE: 40.5% deleveraging with full mezzanine retirement creates highly attractive asset for strategic acquirer (Apollo, Reliance Retail)

4. BALANCED VALUE CREATION: One-third each from EBITDA growth, multiple expansion, and deleveraging — reduces reliance on any single lever

5. SECTOR TAILWINDS: Indian pharmacy retail consolidation continues; MedPlus's South India density provides strategic scarcity value at exit

Key Operating Levers Bain Must Execute:

Lever	Target Impact	Owner
Store rationalization (close bottom 8% underperformers)	+₹40-50 cr EBITDA over 24 months	COO within 100 days
Private label expansion (from 12% to 25% of revenue)	+₹80-100 cr EBITDA over 36 months	CMO with Bain operating partner
Procurement consolidation (leverage volume vs Apollo)	+₹30-40 cr EBITDA over 18 months	CFO + Bain Capital Sourcing Group
Digital-first re-platforming (PharmEasy playbook)	Enable ₹300 cr online GMV by Y3	CTO with Bain Digital team
Working capital efficiency (DSO from 45 to 30 days)	₹80-100 cr one-time cash release	CFO within 12 months

Key Risks to Monitor:

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- Multiple compression risk: If pharmacy retail multiples derate to 7x by Y5, IRR falls to 27.87% (still above hurdle, but tighter)
- Amazon Pharmacy / Flipkart HealthPlus expansion could pressure EBITDA growth in Tier-1 markets
- Interest rate risk: Senior debt is floating-rate — Bain should negotiate a fixed-rate swap for at least 60% of senior notional
- Mezz retirement timing: If Y5 EBITDA misses ₹1,030 target by more than 5%, mezz retirement will slip to Y6, creating exit complications

Post-Deal Governance:

- Bain to nominate 3 Board seats (out of 7); MedPlus promoter retains 1 seat plus Chairman Emeritus role
- Independent operating partner (Bain nominee) to run 100-day plan
- Quarterly Investment Committee review during Y1-Y2; semi-annual thereafter

Question 4 — Reverse Merger — Unlisted Company Going Public via Listed Shell

Case Study — TechEdu Innovations Ltd Reverse Merger with Legacy Cements Ltd

TechEdu Innovations, a fast-growing unlisted education technology company backed by Peak XV Partners and Elevation Capital, is looking to achieve listed status without the delay of a traditional IPO. Its founder, Akshay Mundra, has identified Legacy Cements Ltd — a small listed cement company on BSE SME with a dying core business but a clean regulatory record and listed status — as the ideal reverse-merger vehicle. The deal has been structured by Motilal Oswal Investment Banking as legal and financial adviser.

Standalone Valuations:

Item	Legacy Cements (Shell)	TechEdu Innovations (Target)
Number of shares	5 crore	12 crore
Current market price	₹40	Unlisted
Market cap / Series C pre-money	₹200 crore	₹3,500 crore
Book value	₹180 crore	₹350 crore
FY26 PAT	₹8 crore	₹100 crore
Business	Cement (declining)	EdTech (growing)

Structural Assumptions:

- Post-merger, TechEdu shareholders should own 94.59% of combined entity (matching relative valuation ₹3,500 / (₹3,500 + ₹200))
- Combined entity to trade at 45x P/E (blended EdTech + listing premium; TechEdu's Series C already at 35x)
- Merger to qualify as tax-neutral under Section 2(1B) of Income Tax Act (all conditions met)
- Post-merger corporate name to change to 'TechEdu Innovations Ltd' with fresh ISIN

Required:

(i) Compute the number of new shares Legacy Cements must issue to TechEdu's shareholders, and derive the SWAP RATIO.

(ii) Verify the post-merger shareholding pattern and identify the effective 'reverse' nature of the transaction.

(iii) Compute combined PAT and combined EPS post-merger.

(iv) Compute the post-merger market capitalization and share price at the implied 45x P/E multiple.

(v) Quantify value creation (or destruction) for BOTH Legacy shareholders AND TechEdu shareholders.

(vi) Comment on the tax implications and identify regulatory approvals required.

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Solution

(i) New Shares Issued and Swap Ratio

Target Ownership Structure:

TechEdu shareholders should own 94.59% of combined entity

Legacy shareholders will retain 5.41%

Solving for New Shares:

Let X = new shares issued to TechEdu shareholders

X / (5 + X) = 94.59%

X = 0.9459 × (5 + X)

X = 4.7297 + 0.9459X

0.0541X = 4.7297

X = 87.50 crore new Legacy shares issued to TechEdu shareholders

Swap Ratio Computation:

Swap Ratio = New shares issued / Existing TechEdu shares

= 87.50 / 12

= 7.2917 : 1

Interpretation: Each TechEdu shareholder receives 7.2917 shares of Legacy for every 1 TechEdu share held.

(ii) Post-Merger Shareholding Pattern

Shareholder Group	Shares (crore)	Ownership %
Existing Legacy Cements shareholders	5.00	5.41%
Ex-TechEdu shareholders (new)	87.50	94.59%
Total post-merger shares	**92.50**	**100.00%**

Why This IS a Reverse Merger:

- Legally, Legacy Cements has absorbed TechEdu (Legacy is the surviving entity)
- Economically, TechEdu's shareholders now control 94.59% of the merged entity
- The merged entity will be renamed TechEdu Innovations Ltd — Legacy Cements ceases as a brand
- Post-merger, TechEdu's founders (Akshay Mundra and co-founders) will control the Board
- Regulatory hurdle: 94.59% jump above 25% triggers open offer under SEBI SAST Regulations — will need SEBI relaxation via Regulation 10 (statutory approval)

(iii) Combined PAT and EPS

Legacy PAT: ₹8 crore

TechEdu PAT: ₹100 crore

Combined PAT = ₹108 crore

Combined shares outstanding: 92.50 crore

Combined EPS = ₹108 / 92.50 = ₹1.17

Note: The EPS appears low because 92.50 crore shares dilute the earnings. This is normal for reverse mergers where a large volume of new shares are issued. What matters is the applied P/E multiple in the next step.

(iv) Post-Merger Market Capitalization and Share Price

Applied P/E: 45x (TechEdu's implied Series C P/E was 35x; the market pays a 10x premium for LISTING + ownership dispersion + trading liquidity)

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Post-Merger Market Cap = ₹108 crore × 45 = ₹4,860 crore

Post-Merger Share Price = ₹4,860 / 92.50 = ₹52.54

(v) Value Creation Analysis

For Legacy Cements Shareholders:

Metric	Pre-Merger	Post-Merger
Shares held	5 crore	5 crore (unchanged)
Share price	₹40	₹52.54
Value of holding	₹200 crore	₹262.71 crore
Change	—	+₹62.71 crore (+31.35%)

For TechEdu Shareholders:

Metric	Pre-Merger	Post-Merger
Equity value (Series C pre-money)	₹3,500 crore	—
Shares received	—	87.50 crore (of Legacy)
Share price post-merger	—	₹52.54
Value of holding	₹3,500 crore	₹4,597 crore
Change	—	+₹1,097 crore (+31.35%)

Symmetric Value Creation of 31.35% for Both Parties:

(i) Value creation source: P/E RE-RATING from 35x (TechEdu's Series C implied) to 45x (post-listing blended)

(ii) This 10-turn P/E expansion reflects three tangible benefits: (a) listing liquidity discount removal, (b) broader retail ownership base, (c) sell-side analyst coverage

(iii) Legacy shareholders gain because they exchange a dying cement business for a stake in a growing EdTech listing

(iv) TechEdu shareholders gain because they achieve listed status without IPO costs (~₹150 crore saved) and 18-24 months earlier than a fresh IPO would have allowed

(v) The transaction demonstrates the WIN-WIN nature of well-structured reverse mergers

(vi) Tax Implications and Regulatory Approvals

Tax Position:

- Merger structured under Section 2(1B) of the Income Tax Act — all conditions for tax-neutral merger met (transfer of all assets & liabilities, minimum 75% shareholders of merged entity becoming shareholders of merged company, etc.)
- Capital gains tax exemption under Section 47(vi) for TechEdu shareholders — swap of TechEdu shares for Legacy shares is NOT a taxable event
- Cost of acquisition and period of holding of the original TechEdu shares carry forward to the new Legacy shares under Sections 49(2) and 2(42A)
- Legacy's accumulated business losses can be carried forward and set off against TechEdu's income under Section 72A (subject to conditions being met — Legacy was in the business of manufacturing for at least 3 years, continuity of 3/4th of book assets, etc.)

Regulatory Approvals Required:

- NATIONAL COMPANY LAW TRIBUNAL (NCLT) approval — scheme of amalgamation under Sections 230-232 of Companies Act 2013
- STOCK EXCHANGE approval — BSE (SME segment) needs to approve the scheme under LODR Regulation 37
- SEBI exemption — from open offer under SAST Regulation 10 (the ownership transfer exceeds 25%)

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- SHAREHOLDER approvals — 3/4th majority of both companies' shareholders and creditors under Section 230(6)
- INCOME TAX assessment — advance ruling recommended for the Section 72A carry-forward if it's a material amount
- CCI (COMPETITION COMMISSION) — likely no notification required since the companies are in unrelated sectors and below de minimis thresholds

Question 5 — Form of Consideration Decision — Cash vs Stock vs Mixed

Case Study — Bharti Airtel Acquires Tata Play

Bharti Airtel Ltd is considering the acquisition of Tata Play Ltd (India's largest DTH broadcaster) from Tata Sons and Walt Disney Company. Shashwat Sharma (CEO) and Vittal Gogte (CFO) have been asked by Chairman Sunil Bharti Mittal to evaluate three structures. The strategic logic is compelling — Tata Play's 21 million DTH subscribers augment Airtel's telecom+broadband ecosystem, unlocking cross-sell opportunities and creating a 'quad-play' (mobile + broadband + DTH + streaming) bundle. But which form of consideration best serves Airtel's shareholders?

Bharti Airtel Financial Snapshot:

Metric	Value
Shares outstanding	570 crore
FY26 PAT (standalone consolidated)	₹8,500 crore
EPS	₹14.91
Current Market Price (CMP)	₹1,450
Book value per share	₹350
Cash on balance sheet	₹6,000 crore
Remaining debt capacity (up to 2.5x EBITDA)	₹15,000 crore

Deal Parameters:

- Tata Play acquisition value: ₹12,000 crore (agreed valuation)
- Tata Play post-acquisition PAT contribution to Airtel: ₹800 crore
- Cost of new debt (if used): 9%
- Tax rate: 25%

Three Structures Under Evaluation:

- STRUCTURE A: 100% Cash (funded by new debt of ₹12,000 crore)
- STRUCTURE B: 100% Stock (new shares issued at CMP ₹1,450)
- STRUCTURE C: 60% Cash + 40% Stock (blended structure)

Required:

(i) Compute the EPS impact of Structure A (100% Cash / Debt-Funded).

(ii) Compute the EPS impact and share dilution of Structure B (100% Stock).

(iii) Compute the EPS impact, debt increase, and dilution of Structure C (60% Cash + 40% Stock).

(iv) Present a comparative summary and recommend the structure that best serves Airtel's shareholders, given the strategic context.

Solution

(i) Structure A: 100% Cash (Debt-Funded)

New debt raised: ₹12,000 crore

Interest cost @ 9%: ₹1,080 crore per year

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Tax shield @ 25%: ₹270 crore

After-tax interest impact: ₹810 crore

Post-Merger PAT Calculation:

Bharti standalone PAT: ₹8,500 crore

Tata Play PAT contribution: ₹800 crore

Less: After-tax interest on new debt: ₹810 crore

Post-Merger PAT = ₹8,490 crore

Shares outstanding (unchanged): 570 crore

Post-Merger EPS = ₹8,490 / 570 = ₹14.89

Change vs standalone EPS ₹14.91: –0.12% (marginally dilutive)

Debt-to-EBITDA impact: Airtel's Debt/EBITDA rises by ~0.8x. Combined with existing debt, the leverage would remain within investment grade rating band but headroom reduces sharply.

(ii) Structure B: 100% Stock

New shares to be issued: ₹12,000 crore / ₹1,450 per share = 8.28 crore shares

Total post-merger shares: 570 + 8.28 = 578.28 crore

Post-Merger PAT (no interest impact):

Bharti PAT: ₹8,500 crore

Tata Play PAT contribution: ₹800 crore

Combined PAT = ₹9,300 crore

Post-Merger EPS = ₹9,300 / 578.28 = ₹16.08

Change vs standalone EPS ₹14.91: +7.85% (accretive)

Ownership Dilution:

Tata Sons / Disney (as sellers) receive 8.28 crore shares

Their post-merger holding: 8.28 / 578.28 = 1.43%

Existing Bharti shareholders' dilution: 1.43%

Note: The apparent 7.85% EPS accretion is misleading — it reflects the fact that Tata Play's PAT contribution (₹800 crore) is high relative to the incremental shares issued (8.28 crore). But this 'accretion' comes at the cost of PERMANENT dilution to existing shareholders.

(iii) Structure C: 60% Cash + 40% Stock

Cash portion: ₹12,000 × 60% = ₹7,200 crore (debt-funded)

Stock portion: ₹12,000 × 40% = ₹4,800 crore

Debt Impact:

New debt: ₹7,200 crore

Interest @ 9%: ₹648 crore

After-tax interest: ₹648 × 0.75 = ₹486 crore

Stock Impact:

New shares issued: ₹4,800 / ₹1,450 = 3.31 crore

Total post-merger shares: 570 + 3.31 = 573.31 crore

Post-Merger PAT:

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Bharti PAT: ₹8,500 + Tata Play ₹800 − After-tax interest ₹486 = ₹8,814 crore

Post-Merger EPS = ₹8,814 / 573.31 = ₹15.37

Change vs standalone EPS ₹14.91: +3.10% (moderately accretive)

Ownership Dilution: 3.31 / 573.31 = 0.58%

(iv) Comparative Summary and Recommendation

Metric	A: 100% Cash	B: 100% Stock	C: 60/40 Mixed
Post-Merger EPS	₹14.89	₹16.08	₹15.37
EPS change vs standalone	−0.12%	+7.85%	+3.10%
New Debt (₹ crore)	12,000	0	7,200
New Shares issued (crore)	0	8.28	3.31
Dilution to existing shareholders	0.00%	1.43%	0.58%
Tax on target shareholders (immediate)	Yes (capital gains)	No (Sec 47 exempt)	60% taxed

Recommendation to Airtel Board: STRUCTURE C (60% Cash + 40% Stock)

Rationale:

(i) STRUCTURE A is unattractive because it exhausts Airtel's debt capacity for one acquisition, leaving no headroom for future strategic moves; the marginal EPS dilution (0.12%) is minor but the strategic flexibility loss is significant

(ii) STRUCTURE B looks EPS-accretive (+7.85%) but the accretion is optical — Tata Sons / Disney end up holding 1.43% of Airtel, becoming a permanent minority shareholder with Board rights potentially; also signals that Airtel management thinks Airtel stock is overvalued

(iii) STRUCTURE C balances the trade-offs: modest EPS accretion (+3.10%), manageable debt increase (₹7,200 crore vs ₹15,000 crore capacity), minimal dilution (0.58%), and gives Tata Sons a stake that maintains their commitment to the merged entity's success

(iv) The 40% stock component also ensures Tata Sons has SKIN IN THE GAME — if Tata Play synergies underperform, Tata Sons' 0.58% ownership stake in Airtel takes the pain, aligning incentives

(v) The 60% cash component provides upfront value certainty to Tata Sons / Disney (they wanted to monetize) while preserving Airtel's balance sheet capacity for future acquisitions

Key Structural Recommendations for the Board:

- Structure the 40% stock component with a 3-year lock-in for Tata Sons / Disney — prevents immediate dumping in secondary market
- Include an earn-out mechanism where an additional ₹500-1,000 crore of stock is issued if Tata Play achieves 25 million subscribers by FY29 (aligns with growth objective)
- Negotiate for a Board seat for Tata Sons (representing the ex-Tata Play stake) — brings continuity and reduces integration risk
- Structure the debt financing as a 5-year term loan at fixed 9% (lock in current rates before RBI hikes); use ₹4,000 crore of Airtel's ₹6,000 crore cash to partially fund cash portion, further reducing borrowing to ₹5,200 crore

Question 6 — Corporate Demerger under Section 2(19AA) — Piramal Enterprises Spinning Off Piramal Pharma

Case Study — Piramal Enterprises Ltd Demerging Piramal Pharma Ltd

Piramal Enterprises Ltd (PEL) is a diversified holding company with two distinct businesses: (a) Financial Services — a fast-growing NBFC-HFC platform with ₹65,000 crore AUM and (b) Pharma — a mid-tier CDMO and consumer healthcare business exporting to 100+ countries. The Board, chaired by Ajay Piramal, has approved a Composite

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Scheme of Arrangement to demerge the Pharma business into a separately-listed entity, Piramal Pharma Ltd (PPL). Ranjit Iyer, Chief Strategy Officer, is presenting the transaction structure and value analysis to the Board's Audit Committee ahead of NCLT filing.

Pre-Demerger Financial Snapshot (PEL Consolidated):

Item	Value
Total Shares Outstanding	24 crore
Current Market Price (CMP)	₹1,000 per share
Market Capitalization	₹24,000 crore
Blended EPS	₹80 per share
Total PAT	₹1,920 crore

Business Segment Breakdown:

Segment	Revenue (₹ cr)	EBITDA (₹ cr)	PAT (₹ cr)
Financial Services (Retail + Wholesale)	8,000	N/A (NBFC — use P/BV)	1,400
Pharma (CDMO + India Consumer + Complex Hospital Generics)	5,500	850	520
Total	**13,500**	**—**	**1,920**

Additional Data:

- Book Value of Financial Services segment: ₹18,000 crore
- Peer P/BV for NBFC-HFC (Bajaj Finance, LIC Housing, PFC): 1.2-1.8x, midpoint 1.5x
- Peer EV/EBITDA for CDMO-plus-consumer pharma (Divi's, Laurus, Syngene): 12-18x, midpoint 15x
- Proposed Demerger Ratio: 4 shares of PPL for every 1 share of PEL held

Required:

1. Compute the SUM-OF-PARTS (SOTP) fair value of PEL pre-demerger using segment-appropriate multiples, and identify the conglomerate discount currently embedded in the stock price.

2. Determine the post-demerger share structure: (a) shares of Piramal Pharma to be issued, (b) post-demerger shareholding of a shareholder who held 100 PEL shares pre-demerger.

3. Compute post-demerger financial metrics for both entities: (a) residual PEL (Financial Services only) EPS and fair value per share, (b) Piramal Pharma EPS and fair value per share.

4. Quantify the total value unlock to PEL shareholders. Express the unlock in ₹ per pre-demerger share and as % gain vs current CMP.

5. Verify compliance with all FIVE conditions of Section 2(19AA) of the Income Tax Act.

6. Analyze the tax implications under Sections 47(vib), 47(vid), 49(2C) and 72A(4) — specifically the treatment for (a) the demerged company PEL, (b) the resulting company PPL, and (c) the shareholders receiving PPL shares.

7. Map the approval pathway: NCLT, SEBI, Stock Exchanges, and any other regulatory clearances required.

Solution

(i) Sum-of-Parts Fair Value and Conglomerate Discount

Financial Services Segment (Residual PEL):

Fair Value = Book Value × Target P/BV = ₹18,000 crore × 1.5 = ₹27,000 crore

Per PEL share (24 cr shares): ₹27,000 / 24 = ₹1,125 per share

Pharma Segment (Piramal Pharma):

Enterprise Value = EBITDA × EV/EBITDA multiple = ₹850 crore × 15 = ₹12,750 crore

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(Assuming immaterial net debt in pharma segment; EV ≈ Equity Value)

Per PPL share (96 cr shares — see part ii): ₹12,750 / 96 = ₹132.81 per share

SOTP Value per PEL Shareholder (holding 1 PEL share):

Component	Value (₹)
1 share of residual PEL (Financial Services)	1,125.00
4 shares of Piramal Pharma (@ ₹132.81 each)	531.24
TOTAL SOTP VALUE PER PEL SHARE	**1,656.24**
Pre-demerger CMP	1,000.00
CONGLOMERATE DISCOUNT / VALUE UNLOCK	**656.24 (65.62%)**

The 65.62% conglomerate discount is high but not unusual for a holding company with two fundamentally different business models. Historical precedents: Reliance Industries traded at 30-40% conglomerate discount pre-Jio spinoff; Grasim Industries traded at 25-35% discount before Aditya Birla Capital listing; ITC currently trades at estimated 20-30% discount vs SOTP fair value including ITC Hotels.

(ii) Post-Demerger Share Structure

Piramal Pharma Shares to be Issued:

Demerger Ratio: 4 shares of PPL per 1 share of PEL held

Total PPL shares to be issued = 24 crore × 4 = 96 crore shares

Shareholder Position (holding 100 PEL shares pre-demerger):

Position	PEL Shares	PPL Shares
Pre-Demerger	100	—
Post-Demerger	100 (unchanged — residual PEL)	400 (100 × 4)

Note: Section 2(19AA) requires mirror shareholding — every shareholder of demerged company receives proportionate shares of the resulting company, with no dilution or cross-cash consideration. The 4:1 ratio here is determined by relative fair values; it does NOT change the shareholder's economic interest.

(iii) Post-Demerger Financial Metrics

Residual PEL (Financial Services Only):

Metric	Value
Shares Outstanding	24 crore (unchanged)
PAT (Financial Services segment)	₹1,400 crore
EPS	₹58.33 per share (1,400 / 24)
Fair Value per Share (P/BV 1.5x)	₹1,125
P/E at Fair Value	19.29x (1,125 / 58.33)

Piramal Pharma Ltd (New Listed Entity):

Metric	Value
Shares Outstanding	96 crore (24 × 4)
PAT	₹520 crore
EPS	₹5.42 per share (520 / 96)
Fair Value per Share (EV/EBITDA 15x)	₹132.81
Implied P/E at Fair Value	24.51x (132.81 / 5.42)

Observation: The higher P/E multiple on PPL (24.5x) versus residual PEL (19.3x) reflects the different growth-quality profiles that the market can now price separately. This differentiated multiple is the mechanical driver of the ₹656 per share value unlock.

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(iv) Total Value Unlock Quantification

Metric	₹ per PEL Share	₹ Crore (24 cr shares)
Pre-Demerger CMP	1,000.00	24,000
Post-Demerger SOTP Fair Value	1,656.24	39,749
VALUE UNLOCK	656.24	15,749
Unlock as % of pre-demerger CMP	65.62%	65.62%

Ajay Piramal's stake (~46% economic ownership through Piramal family entities) will see paper wealth increase by ₹7,244 crore purely from removal of conglomerate discount — the strongest possible alignment argument for Board approval.

(v) Section 2(19AA) Compliance Check

Section 2(19AA) of the Income Tax Act, 1961 defines 'demerger' and prescribes FIVE cumulative conditions for tax-neutral treatment. All must be satisfied:

S.No.	Section 2(19AA) Condition	Compliance Status
1	All property of the undertaking is transferred to resulting company by demerged company	✓ All pharma-related property (plants, IP, brands, receivables, inventories, investments) transferred to PPL
2	All liabilities of the undertaking are transferred to resulting company	✓ All pharma-related liabilities (working capital loans, ECBs specific to pharma, trade payables) transferred to PPL
3	Transfer is at book value (no revaluation for tax purposes)	✓ Assets and liabilities transferred at book values as per audited financials; revaluation reserves not created
4	Consideration in shares of resulting company issued to shareholders of demerged company on proportionate basis	✓ 4 PPL shares issued per 1 PEL share to all PEL shareholders proportionately; no cash element
5	Shareholders holding at least 75% of the value of shares in demerged company become shareholders of resulting company by virtue of the demerger	✓ 100% of PEL shareholders receive PPL shares (well above 75% threshold)

CONCLUSION: All five conditions of Section 2(19AA) are satisfied. The demerger qualifies for tax-neutral treatment.

(vi) Tax Implications

(a) Tax Treatment for the Demerged Company (PEL):

- Section 47(vib): Transfer of capital assets from PEL to PPL under the demerger scheme is NOT a 'transfer' for the purposes of capital gains tax. Hence, no capital gains tax liability arises in PEL's hands on the transfer of pharma business assets.

(b) Tax Treatment for the Resulting Company (PPL):

- PPL takes assets at PEL's book values (Section 43(6) etc.) — no step-up in tax base
- Section 72A(4): Unabsorbed losses and depreciation of pharma undertaking (₹450 crore accumulated tax losses estimated) are transferred to PPL and can be carried forward and set off against PPL's future taxable profits for the balance period (8 years for losses; unlimited for depreciation)

(c) Tax Treatment for the Shareholders:

- Section 47(vid): Receipt of PPL shares by PEL shareholders under the demerger is NOT a transfer for capital gains tax — no tax liability at the time of receipt
- Section 49(2C): Cost of acquisition of new PPL shares is derived using the formula: Cost of acquisition × (Net Book Value of assets transferred to PPL / Net Worth of PEL immediately before demerger)
- Section 49(2D): Cost of acquisition of original PEL shares is reduced by the same amount allocated to PPL shares

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- Period of holding of PPL shares includes the period of holding of PEL shares (for long-term / short-term classification)

Illustrative Cost Split Calculation (for shareholder with cost ₹800 per PEL share):

Assume Net Book Value of pharma transferred = ₹4,500 cr; PEL Net Worth pre-demerger = ₹22,500 cr

Split ratio = 4,500 / 22,500 = 20% allocated to PPL, 80% remains with PEL

Cost of 4 PPL shares (per 1 PEL) = ₹800 × 20% = ₹160 → ₹40 per PPL share

Revised cost of 1 residual PEL share = ₹800 × 80% = ₹640

(vii) Regulatory Approval Pathway

Approval / Filing	Authority	Timeline (indicative)
Scheme of Arrangement (Sections 230-232 of Companies Act, 2013)	NCLT Mumbai Bench	6-9 months from filing to sanction
No-Objection Certificate (SAST implications)	SEBI	Concurrent with NCLT process
In-principle listing approval for PPL shares	BSE and NSE	45-60 days
ROC filings under Companies Act	MCA / ROC Mumbai	Post NCLT order
Class-wise shareholder approval (at least 75% by value)	PEL Equity Shareholders (through court-convened meeting)	During NCLT process
Creditor approval (at least 75% by value)	Secured and Unsecured Creditors (through court-convened meetings)	During NCLT process
CCI notification (if combination thresholds triggered)	Competition Commission of India	Not applicable — this is intra-group restructuring, not combination
Income Tax approval (advance ruling optional)	Assessing Officer / Advance Ruling Authority	6-12 months if AAR route taken

Board Recommendation:

- The demerger unlocks ₹15,749 crore (65.6% of current market cap) with no tax leakage under Section 2(19AA)
- Both resulting entities will attract dedicated institutional coverage: PEL will be a pure-play NBFC-HFC comparable to Bajaj Finance / Sundaram Finance; PPL will be a pure-play pharma CDMO-plus-consumer comparable to Divi's / Piramal Consumer
- Timing is favorable: NBFC valuations at 15-year highs; specialty pharma multiples recovering from 2022-23 correction
- Approve the Composite Scheme; file with NCLT within 30 days; target listing of PPL within 12 months

Question 7 — Cross-Border APV Valuation — TCS Acquisition of Cognitive Analytics Inc (US Target)

Case Study — TCS Acquires Cognitive Analytics Inc

Tata Consultancy Services Ltd is evaluating the acquisition of Cognitive Analytics Inc, a Boston-headquartered mid-cap AI and data analytics firm serving Fortune 500 clients across BFSI and pharma verticals. The target has been identified as strategic to TCS's Analytics and AI service line expansion in North America. K. Krithivasan, CEO, and Samir Seksaria, CFO, have engaged Morgan Stanley to structure a $500 million acquisition, financed 60% through ECB (External Commercial Borrowing) in USD and 40% through TCS's own INR reserves converted at spot rate.

Deal Structure:

Item	Value
Purchase Price (Enterprise Value)	$500 million
USD/INR Spot Rate at Signing	₹84.00
Purchase Price in INR	$500M × ₹84 ÷ 10 = ₹4,200 crore
USD ECB (60%)	$300 million = ₹2,520 crore

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Item	Value
INR Equity from TCS Reserves (40%)	$200 million equivalent = ₹1,680 crore
ECB Interest Rate (Kd USD)	6.50%
ECB Tenor	Perpetual (rolled)

Target Financials (USD million):

Item	Value
FCFF (Y0 base year — CY26)	$40 million
Explicit growth (Y1-Y5)	8% per annum
Terminal growth (Y6 onwards)	3% per annum
US corporate tax rate	21%
US 10-year Treasury (risk-free rate)	4.50%
US equity market risk premium	5.50%
Target unlevered β (analytics services sector)	1.20
Distress sale value (as % of unlevered value)	65%
Annual probability of distress	5%

Required:

1. STEP 1 — Compute the target's UNLEVERED FIRM VALUE in USD by discounting FCFF at the unlevered cost of equity.
2. STEP 2 — Compute the PV of Tax Benefits from the $300M USD ECB (assuming perpetual constant debt at US 21% tax rate).
3. STEP 3 — Compute the Expected Bankruptcy Cost using distress sale value 65% and 5% annual distress probability.
4. STEP 4 — Compute the ADJUSTED PRESENT VALUE (APV) in USD.
5. STEP 5 — Translate APV to INR at spot rate; compute NPV in INR vs purchase price of ₹4,200 crore.
6. STEP 6 — Perform FX sensitivity: recompute INR NPV assuming exit-period USD/INR of ₹80, ₹84 (spot), ₹88, ₹92, ₹96. Comment on the natural hedge from USD financing.
7. STEP 7 — Recommend to TCS Investment Committee whether to proceed with the acquisition and the ECB financing.

Solution

(i) Step 1 — Unlevered Firm Value in USD

Compute Unlevered Cost of Equity (USD):

Ke_u = US Risk-Free + β_unlevered × US Market Risk Premium

= 4.50% + 1.20 × 5.50% = 4.50% + 6.60% = 11.10%

USD FCFF Projections and Discounting:

Note: Y0 FCFF is $40M (base year — CY26). Year 1 = CY27 with 8% growth applied → $43.20M.

Year	FCFF ($M)	PV Factor @ 11.10%	PV ($M)
1	43.20	0.9001	38.88
2	46.66	0.8102	37.80
3	50.39	0.7292	36.74
4	54.42	0.6564	35.72
5	58.77	0.5908	34.72
Sum explicit PV			**183.87**

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Terminal FCFF (Y6) = $58.77M × 1.03 = $60.54M

Terminal Value = $60.54M / (0.111 − 0.03) = $747.36M

PV of TV = $747.36M × 0.5908 = $441.53M

UNLEVERED FIRM VALUE (USD) = $183.87M + $441.53M = $625.40M

(ii) Step 2 — PV of Tax Benefits from USD ECB

Under APV framework, tax shields are valued at their own generating currency and tax jurisdiction. Since the ECB is USD-denominated and interest is deductible against US taxable profits of the target (Cognitive Analytics Inc) at US corporate tax rate of 21%:

Annual interest expense = $300M × 6.50% = $19.50M

Annual tax shield = $19.50M × 21% = $4.095M

Under perpetual constant debt assumption:

PV of Tax Shields = Annual Shield / Kd = $4.095M / 0.065 = $63.00M

Equivalently: PV Tax Shields = D × T = $300M × 21% = $63.00M

PV OF TAX BENEFITS (USD) = $63.00 million

(iii) Step 3 — Expected Bankruptcy Cost

Distress Sale Value:

Analytics firms have moderate liquidation value — key assets are (a) client contracts, which have transfer restrictions, (b) intellectual property, which sells at 40-60% of book, (c) trained talent, which does not transfer. Distress sale historically realizes 60-70% of going-concern value in software/analytics sector.

Distress Sale Value = 65% × $625.40M = $406.51M

Cumulative Probability of Distress (5-year horizon):

Annual survival = 1 − 5% = 95%

Cumulative survival (5 years) = 0.95^5 = 0.7738

Cumulative distress probability = 1 − 0.7738 = 22.62%

Expected Bankruptcy Cost:

Value at risk if bankruptcy occurs = $625.40M − $406.51M = $218.89M

Expected BC = $218.89M × 22.62% = $49.52M

EXPECTED BANKRUPTCY COST (USD) = $49.52 million

(iv) Step 4 — APV in USD

Component	Value ($M)
Unlevered Firm Value	625.40
ADD: PV of Tax Benefits (USD debt, US tax)	+63.00
LESS: Expected Bankruptcy Cost	(49.52)
ADJUSTED PRESENT VALUE (APV)	**638.88**
LESS: Purchase Price (EV)	(500.00)
NPV (USD)	**138.88**

Deal creates $138.88 million of value for TCS in USD terms.

(v) Step 5 — INR Translation and NPV (CORRECTED)

Applying the conversion convention: INR Crore = USD Million × ₹84 ÷ 10

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Item	$M	Computation	₹ Crore
APV (USD)	638.88	$638.88M × 84 ÷ 10	5,366.59
Purchase Price	500.00	$500M × 84 ÷ 10	4,200.00
NPV	**138.88**	**$138.88M × 84 ÷ 10**	**1,166.59**

The deal creates ₹1,166.59 crore of INR value at spot FX.

Contextual scale: TCS's market cap of ~₹13,00,000 crore means this deal alone is ~0.09% accretive at close — a genuine bolt-on acquisition. The deal is justified on strategic (capability accretion, US enterprise footprint) rather than financial-materiality grounds. Series of such bolt-ons compound into meaningful capability gains over 3-5 years.

(vi) Step 6 — FX Sensitivity Analysis (CORRECTED)

Since APV is USD-denominated and translates to INR at exit FX rates, INR NPV is sensitive to USD/INR path. Purchase price is locked at ₹4,200 crore at spot ₹84 (the INR equivalent of the $500M contractually committed at close).

Exit USD/INR	APV (INR cr)	Purchase Price (INR cr)	NPV (INR cr)	Comment
₹80 (INR apprec.)	5,111.04	4,200.00	911.04	INR strengthens → lower INR value of USD earnings
₹84 (spot/base)	5,366.59	4,200.00	1,166.59	Base case
₹88 (moderate depr.)	5,622.14	4,200.00	1,422.14	Natural FX tailwind
₹92 (significant depr.)	5,877.70	4,200.00	1,677.70	Strong FX tailwind
₹96 (extreme depr.)	6,133.25	4,200.00	1,933.25	USD earnings translate to much higher INR

Natural Hedge from USD Financing Structure:

The 60% USD debt component ($300M / ₹2,520 crore) creates a partial natural hedge — debt service is in USD, matching USD FCF, so the deal's financial fragility is insulated from INR depreciation. INR appreciation reduces INR NPV but simultaneously reduces the INR burden of USD debt service — offsetting effects. Only the 40% INR equity contribution ($200M / ₹1,680 crore) carries pure FX exposure.

If TCS had funded 100% with INR debt at say 9%, the FX sensitivity would be far more adverse: any INR depreciation would raise the INR value of foreign earnings but leave interest cost unchanged, potentially over-hedging the equity holder to FX in a way that raises volatility rather than reduces it.

(vii) Step 7 — Investment Committee Recommendation

RECOMMENDATION: PROCEED with acquisition and 60% USD ECB financing.

Key Rationale:

8. POSITIVE STANDALONE NPV: $138.88M USD / ₹1,166.59 crore INR — a 27.8% NPV yield on purchase price ($138.88M / $500M)
9. STRATEGIC FIT: Cognitive Analytics's US enterprise client base and AI/ML capability accelerates TCS's Growth & Transformation service line by 2-3 years vs organic buildout
10. NATURAL HEDGE: USD ECB financing matched to USD cash flows minimizes FX-driven cash flow volatility
11. TAX EFFICIENCY: US 21% tax shield on ECB interest generates $63M PV — more valuable than an equivalent INR debt structure because ECB is deductible against US taxable profits at close proximity
12. DOWNSIDE PROTECTION: Even if INR appreciates to ₹80, INR NPV of ₹911 crore remains healthy positive
13. UPSIDE OPTIONALITY: If INR depreciates to ₹96 over 5 years (RBI's forward-implied path), INR NPV expands to ₹1,933 crore — a 66% upside from base case
14. BOLT-ON SCALE: 0.09% of TCS market cap — appropriate for a capability acquisition, not a bet-the-company move

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Key Execution Considerations:

- Hedge ECB principal (not interest) via cross-currency swaps for the first 3 years to limit FX volatility on ₹2,520 crore debt during integration phase
- Structure ECB with LIBOR-successor benchmark (SOFR + spread) and negotiate 6-month prepayment option
- Confirm India-US DTAA benefits on Withholding Tax at 15% on dividend repatriation from Cognitive Analytics to TCS (vs 30% US domestic WHT)
- Model GILTI (Global Intangible Low-Taxed Income) implications for US subsidiary structure; consider Check-the-Box election
- Retention: Structure a $50M management retention pool over 4 years (10% of purchase price) to lock in key AI/ML talent

Question 8 — Reverse Working M&A — L&T Acquiring Kalpataru Infrastructure with EPS Growth Mandate (Jan 2026 Paper Style)

Case Study — L&T Acquiring Kalpataru Infrastructure Ltd

Larsen & Toubro Ltd is evaluating the acquisition of Kalpataru Infrastructure Ltd, a mid-cap Indian infrastructure EPC player specializing in power transmission and railway electrification. R. Shankar Raman, CFO, has been mandated by the Board to structure the transaction such that Combined EPS post-merger grows by at least 3% over standalone L&T EPS in Year 1 itself (before synergies materialize meaningfully). Additionally, the Board wants preservation of L&T's blue-chip 32x+ P/E multiple. Sundeep Batra, Head of Corporate Development, is presenting the reverse-worked analysis.

Financial Data:

Metric	L&T (Acquirer)	Kalpataru (Target)
Shares Outstanding (crore)	137.5	24
EPS (₹)	98	32
Current Market Price (₹)	3,650	625
Market Capitalization (₹ crore)	5,01,875	15,000
PAT (₹ crore)	13,475	768
Market P/E (x)	37.24	19.53

Board Mandate:

- Combined EPS post-merger must grow by ≥ 3% over standalone L&T EPS in Year 1 (i.e., minimum combined EPS ₹100.94)
- Combined P/E must not fall below 32x (i.e., combined mcap divided by combined earnings ≥ 32)
- Assume no revenue or cost synergies in Year 1 (conservative)
- Deal to be fully stock-financed (no cash / debt component)

Required:

1. STEP 1 — Compute the MARKET SWAP RATIO based on relative CMPs, and compare with the maximum acceptable swap ratio under the Board's EPS constraint (assuming zero synergies).

2. STEP 2 — At the market swap ratio, back-derive the MINIMUM ANNUAL SYNERGY (₹ crore of after-tax PAT contribution) required to satisfy the Board's 3% EPS growth mandate.

3. STEP 3 — Analyze the P/E preservation constraint: at what combined EPS would L&T's 32x P/E be preserved at its CMP of ₹3,650? Quantify the synergy required at market swap ratio to hit this second constraint.

4. STEP 4 — Given that L&T's Corporate Development team has projected ₹200 crore of realizable annual synergies, recompute the maximum acceptable swap ratio. Compare with market SR and comment.

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5. STEP 5 — Recommend the negotiation strategy: what swap ratio should L&T offer, and what fallback positions should the negotiation team hold?

Solution

(i) Step 1 — Market SR vs Maximum Acceptable SR (No Synergy)

Market Swap Ratio:

SR_market = Target CMP / Acquirer CMP = ₹625 / ₹3,650 = 0.1712

i.e., 17.12 L&T shares for every 100 Kalpataru shares (or 1 L&T share per 5.84 Kalpataru shares)

Board Constraint — Minimum Combined EPS:

Target minimum combined EPS = ₹98 × 1.03 = ₹100.94

Maximum Acceptable Swap Ratio (No Synergy):

Let SR = swap ratio (new L&T shares per Kalpataru share)

Total shares post-merger = 137.5 + 24 × SR

Combined PAT (no synergy) = ₹13,475 + ₹768 = ₹14,243 crore

Combined EPS = ₹14,243 / (137.5 + 24 × SR) ≥ ₹100.94

Solve:

137.5 + 24 × SR ≤ ₹14,243 / ₹100.94 = 141.10

24 × SR ≤ 3.60

SR_max = 3.60 / 24 = 0.1502

Item	Value
Market Swap Ratio	0.1712
Maximum Acceptable SR (no synergy)	0.1502
Gap	**Market SR EXCEEDS max by 0.0210**

Interpretation:

At market swap ratio (0.1712), L&T issues 24 × 0.1712 = 4.11 crore new shares. Total post-merger shares = 141.61 crore. Combined EPS = ₹14,243 / 141.61 = ₹100.58, which is only 2.63% higher than ₹98 — BELOW the 3% mandate. The Board's constraint would be violated at market SR.

(ii) Step 2 — Minimum Synergy at Market SR

At market SR of 0.1712, total post-merger shares = 141.61 crore. To meet the ₹100.94 EPS target:

Required combined PAT = 141.61 × ₹100.94 = ₹14,294.07 crore

Standalone combined PAT = ₹14,243 crore

MINIMUM SYNERGY REQUIRED = ₹14,294.07 – ₹14,243 = ₹51.07 crore per year

This is a modest synergy expectation — typical infrastructure EPC deals generate 3-5% of combined revenue as cost synergies (₹450-750 crore on combined ~₹1,50,000 cr revenue), well above the ₹51 crore threshold. The market SR is therefore ACCEPTABLE if even modest synergies materialize.

(iii) Step 3 — P/E Preservation Constraint

Compute Combined EPS Required for P/E ≥ 32x at CMP ₹3,650:

Combined EPS × 32 ≥ ₹3,650

Combined EPS ≥ ₹3,650 / 32 = ₹114.06

This is a MUCH TIGHTER constraint than the 3% EPS growth mandate (₹100.94). The market currently prices L&T at 37.24x — if post-merger EPS only rose to ₹100.94, the price of ₹3,650 would imply a P/E of 36.16x, still above 32x. The

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32x floor is therefore not a binding constraint at the EPS growth threshold — it's an aspirational quality preservation target.

Synergy Required for P/E 32x Preservation (at Market SR):

Required combined PAT = 141.61 × ₹114.06 = ₹16,151 crore

Standalone combined PAT = ₹14,243 crore

SYNERGY REQUIRED = ₹16,151 − ₹14,243 = ₹1,908 crore per year

This is a much higher bar — ₹1,908 crore of annual synergy is aggressive but achievable if L&T can (a) cross-sell railway electrification into its power T&D pipeline, (b) rationalize duplicate central procurement, and (c) extract 3-4% cost of goods sold savings on combined ₹65,000 crore procurement base. Realistic time horizon: 3-4 years to reach ₹1,900 cr steady-state synergy, not Year 1.

(iv) Step 4 — Maximum Acceptable SR with ₹200 Cr Synergy

Assume L&T Corporate Development projects ₹200 crore realizable Year 1 synergy:

Combined PAT with synergy = ₹14,243 + ₹200 = ₹14,443 crore

Maximum total shares for EPS ≥ ₹100.94:

137.5 + 24 × SR ≤ ₹14,443 / ₹100.94 = 143.09

24 × SR ≤ 5.59

SR_max (with synergy) = 5.59 / 24 = 0.2327

Scenario	Max Acceptable SR	vs Market SR (0.1712)
No synergy	0.1502	Market SR exceeds max by 0.0210 (12.3% too high)
₹51 cr synergy (breakeven)	0.1712	Just matches market SR
₹200 cr synergy (realistic)	0.2327	36% headroom above market SR
₹500 cr synergy (stretch)	0.3163	84% headroom above market SR

Interpretation:

With ₹200 crore annual synergy — a modest and achievable target — L&T has 36% headroom above the market swap ratio. This means L&T can pay a PREMIUM to market of up to ~36% (offering swap ratio of 0.2327 instead of 0.1712) while still meeting the 3% EPS growth mandate. In dollar terms: L&T can offer up to ~₹850 per Kalpataru share (vs CMP ₹625, a 36% premium) — which is exactly the range of typical control premiums in Indian midcap M&A.

(v) Step 5 — Recommendation and Negotiation Strategy

Recommended Opening Offer:

Offer at SR 0.2000 — implies price of ₹730 per Kalpataru share (16.8% premium to CMP ₹625)

- Rationale: represents a fair control premium while retaining margin for synergy under-delivery
- At SR 0.2000 with ₹200 cr synergy: Combined EPS = ₹14,443 / (137.5 + 4.8) = ₹101.60 → 3.67% growth
- Comfortably above 3% mandate

Fallback Positions (in order of concession):

Position	SR	Kalpataru Price Equivalent	Premium to CMP
Opening Offer	0.2000	₹730	16.8%
First Concession	0.2100	₹766	22.6%
Second Concession	0.2200	₹803	28.5%
Maximum Acceptable (with ₹200 cr synergy)	0.2327	₹849	35.9%

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Position	SR	Kalpataru Price Equivalent	Premium to CMP
Walk-Away Line	0.2400	₹876	40.2% — would breach 3% EPS mandate

Key Negotiation Levers:

1. SYNERGY VERIFICATION: Insist on independent due diligence of synergy potential before final SR — Kalpataru's Board should share procurement, capacity utilization, and cross-selling data
2. EARN-OUT PROTECTION: For SR above 0.2100, structure with earn-out — 15% of consideration in escrow, released after Year 2 conditional on Kalpataru's Y1 EBITDA meeting projected baseline
3. ANTI-DILUTION: Insist on a lock-in for Kalpataru promoter's L&T shares for 3 years, preventing overhang risk on L&T stock price
4. REGULATORY SAFEGUARDS: SEBI SAST triggers open offer at higher of 26 weeks VWAP or price offered — factor this into effective premium
5. BOARD REPRESENTATION: Kalpataru promoter to get 1 non-executive Director seat as goodwill measure

Board-Level Communication Message:

"The deal comfortably meets our 3% EPS growth mandate at a swap ratio of 0.2000, representing a 16.8% control premium — well within Indian M&A norms of 15-25%. We retain negotiation flexibility up to 35.9% premium if Kalpataru's Board pushes back, before hitting our walk-away line. Preservation of our 32x P/E multiple requires meaningful synergy realization over 3-4 years — our Corporate Development team is confident of ₹200 crore Year 1 synergies scaling to ₹1,900+ crore by Year 4, based on precedent transactions in the infrastructure EPC space."

Question 9 — Post-Merger EPS with Leveraged Financing — Sun Pharma Acquiring Merrion Pharma Inc

Case Study — Sun Pharma Acquiring Merrion Pharma Inc

Sun Pharmaceutical Industries Ltd is finalizing the acquisition of Merrion Pharma Inc, a Massachusetts-based specialty pharmaceutical company with a portfolio of complex generics in gastroenterology and oncology. The $500 million transaction has been approved by both Boards in principle. Abhay Gandhi, CEO North America, and C.S. Muralidharan, CFO, are evaluating three financing structures for Board recommendation.

Deal and Target Data:

Item	Value
Purchase Price (all-cash / cash-equivalent)	$500 million
USD/INR Spot	₹84.00
Purchase Price in INR	$500M × ₹84 ÷ 10 = ₹4,200 crore
Merrion Pharma PAT (annualized post-close, INR)	₹210 crore
Implied Acquisition P/E	₹4,200 / ₹210 = 20.00x (in line with US specialty pharma norms)
ECB Cost of Debt (Kd USD)	7.00%
Sun Pharma Tax Rate	25%

Sun Pharma Standalone Metrics:

Metric	Value
Shares Outstanding	240 crore
EPS (FY26)	₹35
Current Market Price (CMP)	₹1,650
Market P/E	47.14x
PAT (FY26)	₹8,400 crore

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Metric	Value
Combined EBITDA (post-merger estimate)	₹14,000 crore

Three Financing Structures Under Evaluation:

- Option 1: 100% USD ECB Debt at 7.00% (₹4,200 crore of ECB)
- Option 2: 100% Equity Issuance at CMP ₹1,650 (raise ₹4,200 crore via QIP)
- Option 3: 50/50 Mixed (₹2,100 crore debt + ₹2,100 crore equity)

Required:

1. Compute post-merger EPS under each of the three financing structures. Identify which options are accretive and which are dilutive vs standalone Sun Pharma EPS of ₹35.
2. Compute the BREAK-EVEN SUN PHARMA SHARE PRICE at which the 100% Equity option would produce identical EPS as the 100% Debt option. Convert this to break-even P/E multiple.
3. Compute the BREAK-EVEN COST OF DEBT at which the 100% Debt option would produce identical EPS as the 100% Equity option.
4. Analyze interest coverage post-merger under the 100% Debt structure. Comment on cash flow adequacy.
5. Recommend the optimal financing structure to the Board, with rationale grounded in EPS impact, balance sheet risk, and strategic flexibility.

Solution

(i) Post-Merger EPS Under Each Financing Option

Option 1: 100% USD ECB Debt at 7.00%

Debt Raised: ₹4,200 crore | Interest: ₹4,200 × 7% = ₹294 crore

After-tax Interest: ₹294 × (1 − 0.25) = ₹220.50 crore

Combined PAT: Sun Pharma PAT + Merrion PAT − After-tax Interest

Combined PAT: ₹8,400 + ₹210 − ₹220.50 = ₹8,389.50 crore

Total Shares: 240 crore (unchanged)

EPS Option 1 = ₹8,389.50 / 240 = ₹34.96 (Δ vs standalone: −0.13%) — marginally dilutive

Option 2: 100% Equity Issuance at CMP ₹1,650

Equity Raised: ₹4,200 crore | New Shares: ₹4,200 / ₹1,650 = 2.5455 crore

Total Shares Post: 240 + 2.5455 = 242.5455 crore

Combined PAT: ₹8,400 + ₹210 = ₹8,610 crore (no interest cost)

EPS Option 2 = ₹8,610 / 242.5455 = ₹35.50 (Δ vs standalone: +1.42%) — ACCRETIVE

Option 3: 50/50 Mixed

Debt Raised: ₹2,100 crore | Interest: ₹2,100 × 7% = ₹147 crore

After-tax Interest: ₹147 × (1 − 0.25) = ₹110.25 crore

Equity Raised: ₹2,100 crore | New Shares: ₹2,100 / ₹1,650 = 1.2727 crore

Total Shares Post: 240 + 1.2727 = 241.2727 crore

Combined PAT: ₹8,400 + ₹210 − ₹110.25 = ₹8,499.75 crore

EPS Option 3 = ₹8,499.75 / 241.2727 = ₹35.23 (Δ vs standalone: +0.65%) — mildly accretive

EPS Impact Summary:

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Option	Combined PAT (₹ cr)	Shares (cr)	EPS (₹)	% Δ vs ₹35
Option 1: 100% Debt @ 7%	8,389.50	240.00	34.96	−0.13%
Option 2: 100% Equity @ CMP	8,610.00	242.55	35.50	+1.42%
Option 3: 50/50 Mixed	8,499.75	241.27	35.23	+0.65%
Sun Pharma Standalone	8,400.00	240.00	35.00	—

Analytical Finding:

At Sun Pharma's current P/E of 47.14x, EQUITY financing is more accretive than debt — though the magnitude is small because the deal is a bolt-on (₹4,200 cr on ₹8,400 cr standalone PAT = 5% incremental PAT contribution). The economic logic: Sun Pharma's earnings yield (1/47.14 = 2.12%) is lower than the after-tax cost of debt (7% × 0.75 = 5.25%), but the target's PAT yield on purchase price (₹210 / ₹4,200 = 5.00%) is comparable to after-tax debt cost — making debt only marginally dilutive rather than sharply so. Equity issuance at a very high P/E remains the more accretive choice.

(ii) Break-Even Sun Pharma Share Price

Find the share price at which Option 2 (100% Equity) produces the same EPS as Option 1 (100% Debt @ 7%).

Set up equation: Combined PAT (Option 2) / Total Shares (Option 2) = EPS Option 1

(₹8,400 + ₹210) / (240 + ₹4,200/P) = ₹34.96

Where P = break-even share price

Solving algebraically:

₹8,610 × P / (240P + ₹4,200) = ₹34.96

₹8,610 × P = ₹34.96 × (240P + ₹4,200)

₹8,610 × P = 8,390.4P + 146,832

₹219.6 × P = 146,832

P_break-even = ₹665.83 per share

Break-even P/E = ₹665.83 / ₹35 = 19.02x

Metric	Value
Break-Even Sun Pharma Share Price (equity = debt EPS)	₹665.83
Break-Even Sun Pharma P/E	19.02x
Current Sun Pharma CMP	₹1,650
Current Sun Pharma P/E	47.14x
Buffer	**CMP is 148% above break-even price → strong preference for equity**

Interpretation:

For debt financing to become more accretive than equity, Sun Pharma's share price would need to fall from ₹1,650 to ₹665.83 — a 60% decline. This would only happen in a severe pharma sector de-rating or a Sun Pharma-specific crisis. Under any normal market condition, equity financing dominates at Sun Pharma's current premium valuation, though the magnitude of accretion difference is modest at this deal size.

(iii) Break-Even Cost of Debt

Find the Kd at which Option 1 (100% Debt) produces the same EPS as Option 2 (100% Equity).

Setup: Sun Pharma standalone shares × EPS Option 2 = Combined PAT under Debt

240 × ₹35.50 = ₹8,400 + ₹210 − ₹4,200 × Kd × (1 − 0.25)

₹8,520 = ₹8,610 − ₹4,200 × Kd × 0.75

₹4,200 × Kd × 0.75 = ₹90

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Kd_break-even = ₹90 / (₹4,200 × 0.75) = 2.87%

Metric	Value
Break-Even Cost of Debt (debt = equity EPS)	2.87%
Current ECB Cost of Debt	7.00%
Gap	**Current Kd is 413 bps ABOVE break-even → equity preferred**

Interpretation:

For debt to become as accretive as equity, ECB rates would need to drop below 2.87% — a near-zero-real-rate scenario impossible in the current US Fed regime. Robust preference for equity financing.

(iv) Interest Coverage Post-Merger (100% Debt Option)

Combined EBITDA (post-merger): ₹14,000 crore

New Interest Cost: ₹294 crore (100% debt option)

Interest Coverage Ratio = ₹14,000 / ₹294 = 47.62x

This is an EXCEPTIONALLY strong interest coverage — well above investment-grade thresholds (typically ≥3.5x for BBB/BBB+). The reason: the deal is a bolt-on relative to Sun Pharma's earnings power; ₹4,200 cr of debt against ₹14,000 cr EBITDA is easily serviced. Rating agencies would NOT downgrade Sun Pharma for this transaction — the AAA-equivalent rating is preserved.

Debt-to-EBITDA Post-Merger:

Debt/EBITDA = ₹4,200 / ₹14,000 = 0.30x (very comfortable — well below sector norms)

This changes the recommendation calculus:

With such strong coverage metrics and only −0.13% EPS impact from the 100% debt option, the balance-sheet-risk argument against debt is weak. The decision now hinges more on strategic optionality (preserving debt capacity for larger future deals) than on immediate financial risk.

(v) Recommendation to Board

RECOMMENDATION: 100% Equity Financing via QIP at CMP ₹1,650 (marginal preference)

Rationale:

6. MOST ACCRETIVE: +1.42% EPS uplift Y1 (₹35.50 vs ₹35 standalone) — the only structure that is meaningfully accretive without synergies
7. USE OF PREMIUM VALUATION: Sun Pharma's 47.14x P/E is significantly higher than pharma peers (Cipla 28x, Dr Reddy's 22x). Using this premium currency to acquire is textbook value creation — 'issuing highly-priced paper to buy cheaper cash flows'
8. PRESERVES BALANCE SHEET FLEXIBILITY: Zero incremental debt, keeps rating optionality for future larger US deals (specialty biosimilars, oncology assets in $2-5B range) where balance sheet capacity would be critical
9. MINIMAL DILUTION: 2.55 cr new shares represent only 1.06% dilution — well below the 5% threshold that typically raises institutional-investor concerns
10. STRONG DOWNSIDE: Even if Sun Pharma P/E derates from 47x to 25x, the equity choice remains materially better than debt at current 7% ECB rate

Alternative Case for 100% Debt Financing:

- EPS dilution is trivial (−0.13%) — not economically meaningful
- Interest coverage of 47.62x is exceptional; no rating risk
- Debt/EBITDA of 0.30x leaves ample capacity for follow-on deals

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- Avoids the 30-45 day QIP execution overhang risk
- If Muralidharan expects Sun Pharma stock to appreciate 15-20% over the next 12 months (pre-QIP announcement), debt today + buyback in 18 months could be superior

Considerations for Board Discussion:

- MODEST SCALE: ₹4,200 cr deal is ~0.6% of Sun Pharma's ~₹6,80,000 cr market cap — genuine bolt-on. All three options produce economically similar outcomes; the choice is more about signaling than material value
- PROMOTER DILUTION: At only 1.06% dilution, Dilip Shanghvi's family stake moves from ~55% to ~54.4% — negligible
- QIP EXECUTION: 2.55 cr shares is very small relative to average daily trading volume of ~20 cr shares — easy to execute with top-5 institutional accounts
- STRATEGIC MESSAGING: Debt-funded deals signal 'we can service leverage' to rating agencies and future targets; equity-funded deals signal 'our currency is precious'. Given Sun Pharma's 47x P/E, the equity-currency message is well-aligned
- TIMING: Execute in a favorable window (post-Q4 results, before US pharma election-year policy uncertainty in Nov 2026)

Preferred Structure: Option 2 (100% Equity via QIP) — with Option 1 (100% Debt) as a closely-second alternative if Board prefers to preserve equity currency for a larger deal.

Question 10 — Multi-Layered M&A with Reverse-Weight Solve — Bharat Cement Ltd Acquiring Rajasthan Cement Corp

Case Study — Bharat Cement Ltd (BCL) Acquiring Rajasthan Cement Corp (RCC)

Bharat Cement Ltd is India's third-largest cement producer with 55 MTPA capacity across South, West and Central India. Rajasthan Cement Corp is a mid-cap Northern India-focused player with 18 MTPA capacity, controlled family assets, and stagnant growth. The acquisition would give BCL PAN-India footprint and Northern India capacity to match UltraTech and Ambuja. Yashvardhan Chatwal, CFO of BCL, is presenting the transaction to the Board of Directors.

Financial Data — Both Companies:

Metric	BCL (Acquirer)	RCC (Target)
Shares Outstanding (crore)	350	80
EPS (₹)	55	18
Current Market Price (₹)	720	210
Book Value per Share (₹)	210	95
Dividend per Share (₹)	8	3
Intrinsic Value per Share (₹) — DCF	800	245
PAT (₹ crore)	19,250	1,440
Market Capitalization (₹ crore)	2,52,000	16,800
Debt (₹ crore)	8,000	3,500

Independent Valuer Report:

SBI Capital Markets has been appointed as the independent valuer for the merger. After its own detailed valuation exercise (comparable transactions, standalone DCF of both entities, synergy value assessment, and precedent premium analysis), SBI Capital Markets has recommended a FAIR SWAP RATIO of **0.3284** as the anchor for negotiation.

Board Policy on Method Weights:

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BCL's Board Investment Committee has laid down two policy constraints on how weights across the four traditional methods should be distributed, based on its philosophy that market-based and earnings-based signals are the primary drivers of value in listed-company M&A:

1. MARKET + EPS weights combined must equal 60% (Board policy — market price and earnings are the dominant signals)
2. BV weight must be exactly 15% (Board policy — book value plays a limited role for going-concern acquisitions)
3. The remaining weight goes to Intrinsic Value method (i.e., Intrinsic weight = 1 − 60% − 15% = 25%)

Synergy Projections (for Layers 2 onwards):

Item	Value
Revenue Synergy Y1 (cross-region freight, price uplift)	₹500 crore
Revenue Synergy growth	5% per annum
Cost Synergy Y1 (procurement, logistics, corporate)	₹800 crore
Cost Synergy growth	3% per annum
Integration Costs Y1	₹300 crore
Integration Costs Y2	₹150 crore
Integration Costs Y3-Y5	Nil
Discount Rate (WACC of combined entity)	11%
Terminal Growth	3%
Tax Rate	25%

Required:

1. Compute the four METHOD-LEVEL SWAP RATIOS (Market, EPS, BV, Intrinsic).
2. REVERSE-SOLVE for the FOUR WEIGHTS across the four methods, using the fair SR of 0.3284 and the Board policy constraints. Show the algebraic setup and solution.
3. VERIFY the discovered weights by recomputing the weighted SR and confirming it equals 0.3284.
4. Compute the FEASIBILITY BAND of fair SRs under the Board policy constraints. What is the lowest and highest fair SR that can be justified?
5. Value the TOTAL SYNERGY over 5-year explicit + terminal value at WACC 11%.
6. Compute the FAIR OFFER VALUE (M Cap + PV of Synergy) to RCC assuming 50/50 synergy sharing.
7. Compute post-merger EPS under THREE structures (Weighted SR stock, Fair-value SR stock, 50/50 cash-stock assuming Kd pre tax @ 10%).
8. Provide FINAL RECOMMENDATION to Board.

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Solution

(i) Method-Level Swap Ratios

Method	Formula	Computation	SR
Market Price	RCC CMP / BCL CMP	210 / 720	0.2917
EPS	RCC EPS / BCL EPS	18 / 55	0.3273
Book Value	RCC BV / BCL BV	95 / 210	0.4524
Intrinsic Value	RCC IV / BCL IV	245 / 800	0.3063

(ii) Reverse-Solve for the Four Weights

Setup — Variables and Constraints:

Let w_M, w_EPS, w_BV, w_I be the four weights.

We have 4 unknowns and need 4 independent equations:

1. Sum-to-100% constraint: w_M + w_EPS + w_BV + w_I = 1
2. Board Policy #1: w_M + w_EPS = 0.60
3. Board Policy #2: w_BV = 0.15
4. Fair SR equation: 0.2917 × w_M + 0.3273 × w_EPS + 0.4524 × w_BV + 0.3063 × w_I = 0.3284

Step 1 — Derive w_I from Constraints (1), (2) and (3):

w_I = 1 − (w_M + w_EPS) − w_BV = 1 − 0.60 − 0.15 = 0.25 = **25%**

Step 2 — Compute Fixed Contribution from w_BV and w_I to Weighted SR:

Fixed contribution = 0.4524 × 0.15 + 0.3063 × 0.25 = 0.0679 + 0.0766 = **0.1444**

Step 3 — Compute Required Contribution from Market + EPS:

Required from Market + EPS = 0.3284 − 0.1444 = **0.1840**

Step 4 — Substitute w_M = 0.60 − w_EPS into Required Contribution:

$0.2917\times(0.60-w_EPS)+0.3273\times w_EPS = 0.1840$
$0.2917\times(0.60-0.2917)\times w_EPS+0.3273\times w_EPS = 0.1840$
$0.1750+(0.3273-0.2917)\times w_EPS = 0.1840$
$0.1750+0.0356\times w_EPS = 0.1840$
$0.0356 \times w_EPS = 0.0090$

Step 5 — Solve:

w_EPS = 0.0090 / 0.0356 = **0.2513** ≈ **25%**

w_M = 0.60 − 0.2513 = **0.3487 ≈ 35%**

DISCOVERED WEIGHTS:

Method	**Discovered Weight**	**Source**
Market Price	34.87% (≈ 35%)	Solved from Fair SR equation
EPS	25.13% (≈ 25%)	Solved from Fair SR equation
Book Value	15.00%	Board policy (given)
Intrinsic Value	25.00%	Derived from sum-to-1
TOTAL	**100.00%**	

(iii) Verification

Recompute Weighted SR with discovered weights:

Method	**Weight**	**SR**	**Contribution**
Market Price	34.87%	0.2917	0.1017
EPS	25.13%	0.3273	0.0822
Book Value	15.00%	0.4524	0.0679
Intrinsic Value	25.00%	0.3063	0.0766
WEIGHTED SWAP RATIO	**100.00%**		**0.3284**
Target Fair SR (SBI Cap)			0.3284
Difference			**0.0000 ✓**

Verified. The discovered weights reproduce SBI Capital Markets' fair SR exactly.

(iv) Feasibility Band of Fair SR

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Maximum Feasible SR (all 60% in EPS):

SR_max = 0.60 × 0.3273 + 0.15 × 0.4524 + 0.25 × 0.3063 = 0.1964 + 0.0679 + 0.0766 = **0.3409**

Feasibility Band: 0.3195 ≤ Fair SR ≤ 0.3409

SBI Capital Markets's fair SR of 0.3284 sits comfortably within this band, ~42% of the way up from the floor. If SBI had instead recommended a fair SR of 0.35, no combination of weights within the Board policy could reconcile — the Board would need to relax either the 60% Market+EPS cap or the 15% BV floor.

(v) Synergy Valuation

Year-by-Year Synergy Cash Flow (₹ crore):

Year	Rev Syn	Cost Syn	Integ Cost	Pre-tax	After-Tax (×0.75)	PV @ 11%
Y1	500.00	800.00	300	1,000.00	750.00	675.68
Y2	525.00	824.00	150	1,199.00	899.25	729.85
Y3	551.25	848.72	0	1,399.97	1,049.98	767.73
Y4	578.81	874.18	0	1,452.99	1,089.75	717.85
Y5	607.75	900.41	0	1,508.16	1,131.12	671.26
Sum PV Y1-Y5						**3,562.38**

- Terminal Value FCF (Y6) = ₹1,131.12 × 1.03 = ₹1,165.06 crore
- Terminal Value = ₹1,165.06 / (0.11 − 0.03) = ₹14,563.17 crore
- PV of TV = ₹14,563.17 × 0.5935 = ₹8,642.53 crore

TOTAL SYNERGY VALUE = ₹3,562.38 + ₹8,642.53 = ₹12,204.91 crore

(vi) Fair Offer with 50/50 Synergy Sharing

- RCC Standalone Market Value = 80 cr × ₹210 = ₹16,800 crore
- BCL retains: ₹12,204.91 / 2 = ₹6,102.45 crore
- RCC receives: ₹6,102.45 crore

Fair Offer = ₹16,800 + ₹6,102.45 = ₹22,902.45 crore

- Fair SR (synergy-loaded) = ₹22,902.45 / (80 cr × ₹720) = **0.3976**
- Premium over Market SR (0.2917): **36.32%**

Two Fair SRs — Reconciliation:

SR Concept	Value	Meaning
Weighted SR (discovered)	0.3284	Fair value if RCC had zero synergy — pure standalone comparable value
Fair Offer SR (with synergy)	0.3976	Fair value including 50% of synergy shared with RCC
Gap	0.0692	Represents 50% of synergy value → forms the negotiation range

(vii) Post-Merger EPS Under Three Structures

Combined PAT (with Y1 after-tax synergy ₹750 cr):
₹19,250 + ₹1,440 + ₹750 = ₹21,440 crore

Structure A: 100% Stock at Weighted SR 0.3284 (Standalone Fair)

- New shares = 80 × 0.3284 = 26.27 cr; Total = 376.27 cr
- **EPS = ₹21,440 / 376.27 = ₹56.98 (+3.60% vs ₹55)**

Structure B: 100% Stock at Fair Offer SR 0.3976

- New shares = 80 × 0.3976 = 31.81 cr; Total = 381.81 cr
- **EPS = ₹21,440 / 381.81 = ₹56.15 (+2.10% vs ₹55)**

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Structure C: 50/50 Cash-Stock at Fair Offer, Debt at 10%

- Cash ₹11,451 cr @ 10% → AT interest ₹859 cr
- Stock ₹11,451 cr → 15.90 cr new shares; Total = 365.90 cr
- Combined PAT (less interest) = ₹21,440 − ₹859 = ₹20,581 cr
- **EPS = ₹20,581 / 365.90 = ₹56.25 (+2.27% vs ₹55)**

Structure	Shares (cr)	EPS (₹)	% Δ vs ₹55
A: Stock at Weighted SR 0.3284	376.27	56.98	+3.60%
B: Stock at Fair SR 0.3976	381.81	56.15	+2.10%
C: 50/50 Cash-Stock at Fair Offer	365.90	56.25	+2.27%
Standalone BCL	350.00	55.00	—

(viii) Final Recommendation to Board

RECOMMENDATION: PROCEED with STRUCTURE B — 100% Stock at Fair Offer SR 0.3976

Rationale:

1. SBI Capital Markets's Fair SR of 0.3284 (standalone, no synergy) is anchor-validated by the discovered weight structure (35/25/15/25) which is defensible on Board policy grounds
2. Fair Offer SR of 0.3976 incorporates 50% synergy sharing — reasonable market-standard split for friendly deals
3. 100% stock preserves Section 2(1B) tax neutrality for all shareholders
4. +2.10% Y1 EPS accretion with Y1 synergies — accretive from Day 1
5. Zero incremental debt — preserves BCL's AA+ rating and balance sheet capacity

Key Risks:

- Weight Sensitivity: If SBI Cap revisits fair SR to 0.335, the implied weights flip to EPS-heavy — Board should mandate SBI Cap conclude within 30 days to lock the fair SR anchor
- Synergy Realization: Below 50% realization, BCL breaks even; between 50%-100%, BCL captures ₹0-6,102 crore net
- CCI Remedy Risk: Combined 73 MTPA capacity may attract 3-5 MTPA divestiture requirement in Northern India
- Fairness Opinion: Independent Merchant Banker's fairness opinion must be secured before NCLT filing — ensure at least two banker consultations to cross-validate SBI Cap's fair SR

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CHAPTER 15 — STARTUP FINANCE

Question 1 — Multi-Stage Dilution and Founder Value

Case

Anaya Sharma founds GlowUp Naturals and issues herself 10,00,000 equity shares at inception, representing 100% ownership. The company raises capital across three rounds as follows:

Round	Investor	Amount Raised	Terms
Angel	Anish Trivedi	₹50 lakh	20% equity stake
Seed VC	Blume Ventures	₹5 crore	Pre-money ₹20 crore
Series A	Nexus Venture Partners	₹30 crore	Pre-money ₹100 crore

Required:

1. Compute post-money valuation, number of new shares issued, and total shares outstanding after each round.
2. Compute Anaya's shareholding percentage after each of the three rounds.
3. Compute Anaya's stake value in rupees immediately after the Series A round.
4. Verify the final founder shareholding using the dilution-factor method.

Solution

(i) Round-by-Round Share Issuance

Round 1 — Angel:

Post-money = ₹50 lakh / 0.20 = ₹2.50 crore

Pre-money = ₹2.50 − ₹0.50 = ₹2.00 crore

Angel shares issued = 10,00,000 × (0.20 / 0.80) = 2,50,000

Total shares after Round 1 = 10,00,000 + 2,50,000 = 12,50,000

Round 2 — Seed VC:

Post-money = ₹20 + ₹5 = ₹25 crore

Seed VC stake = ₹5 / ₹25 = 20%

Seed shares issued = 12,50,000 × (0.20 / 0.80) = 3,12,500

Total shares after Round 2 = 12,50,000 + 3,12,500 = 15,62,500

Round 3 — Series A:

Post-money = ₹100 + ₹30 = ₹130 crore

Series A stake = ₹30 / ₹130 = 23.0769%

Series A shares issued = 15,62,500 × (0.230769 / 0.769231) = 4,68,750

Total shares after Round 3 = 15,62,500 + 4,68,750 = 20,31,250

(ii) Founder Shareholding Progression

After Round	Founder Shares	Total Shares	Founder %
Start	10,00,000	10,00,000	100.00%
Round 1 (Angel)	10,00,000	12,50,000	80.00%
Round 2 (Seed VC)	10,00,000	15,62,500	64.00%
Round 3 (Series A)	10,00,000	20,31,250	49.23%

(iii) Founder Stake Value after Series A

Founder value = 49.23% × ₹130 crore = ₹64.00 crore

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(iv) Dilution-Factor Verification

Founder % final = 100% × (1 − 0.20) × (1 − 0.20) × (1 − 0.230769)

= 100% × 0.80 × 0.80 × 0.769231 = 49.23% ✓

Question 2 — VC Method Valuation and Promoter Buyback

Case

HealthMate Pvt. Ltd. is raising its Series A round. Nexus Venture Partners has agreed to invest ₹25 crore with the following terms:

Parameter	Value
Investment amount	₹25 crore
Required IRR to Nexus	30% per annum
Expected exit horizon	5 years
Projected exit value at Year 5	₹500 crore
Pre-agreed promoter buyback IRR	22% per annum
Buyback trigger	If IPO / third-party sale not materialised by Year 5

Required:

1. Apply the VC Method to compute (a) post-money valuation today, (b) pre-money valuation today, (c) Nexus's ownership stake.
2. Verify the valuation by computing the return multiple and implied IRR Nexus would realise if the Year 5 exit value materialises at ₹500 crore.
3. Compute the promoter buyback obligation at Year 5 at the pre-agreed 22% IRR.
4. Compute the BREAK-EVEN exit value at which Nexus is indifferent between the Year 5 IPO/sale route and invoking the promoter buyback. Comment on the implication.

Solution

(i) VC Method

Post-money (today) = Exit Value / (1 + Required IRR)^n

Discount factor = 1 / $(1.30)^5$ = 1 / 3.7129 = 0.2693

Post-money (today) = ₹500 × 0.2693 = ₹134.66 crore

Pre-money (today) = ₹134.66 − ₹25 = ₹109.66 crore

Nexus's Stake = ₹25 / ₹134.66 = 18.56%

Item	Value (₹ crore)
Post-money (today)	134.66
Pre-money (today)	109.66
Nexus Stake	18.56%

(ii) Return Multiple Verification

Nexus's share of exit = 18.56% × ₹500 = ₹92.82 crore

Multiple = ₹92.82 / ₹25 = 3.71x

Implied IRR = (3.71)^(1/5) − 1 = 1.30 − 1 = 30.00% ✓

(iii) Promoter Buyback Obligation at Year 5

Buyback Amount = Investment × (1 + Buyback IRR)^n

= ₹25 × $(1.22)^5$

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= ₹25 × 2.7027

= ₹67.57 crore

(iv) Break-Even Exit Value

Nexus is indifferent when its share of the exit value equals the buyback amount:

18.56% × Break-even Exit = ₹67.57 crore

Break-even Exit = ₹67.57 / 0.1856 = ₹363.96 crore

Scenario	Nexus Realises	Preferred Route
Exit above ₹363.96 cr	> ₹67.57 cr	IPO / Third-party sale
Exit = ₹363.96 cr	= ₹67.57 cr	Indifferent
Exit below ₹363.96 cr	< ₹67.57 cr	Invoke promoter buyback

Implication: The promoter buyback at 22% IRR acts as a DOWNSIDE PROTECTION FLOOR for Nexus. If the Year 5 exit value falls below ₹363.96 crore, Nexus will invoke the buyback and the founder must deliver ₹67.57 crore in cash. Above this threshold, Nexus prefers the exit route.

Question 3 — Target Multiple Approach to VC Method

Case

Peak XV Partners is evaluating an investment in CloudPulse Technologies Pvt. Ltd. The firm uses the target-return-multiple variant of the VC Method to arrive at its investment valuation.

Parameter	Value
Investment amount	₹20 crore
Target return multiple	10×
Expected exit horizon	7 years
Projected exit value	₹500 crore

Required:

1. Using the TARGET-MULTIPLE approach, compute (a) Peak XV's required share of exit value, (b) ownership stake, (c) post-money valuation today, (d) pre-money valuation today.
2. Compute the IRR implied by a 10x return over 7 years.
3. Verify the valuation using the time-based VC Method with the implied IRR from part (ii).
4. If the exit slips to Year 8 but the target multiple of 10x is retained, compute the new implied IRR. By how many percentage points does Peak XV's IRR erode?
5. If instead Peak XV insists on preserving the IRR from part (ii) over an 8-year horizon (exit value unchanged at ₹500 crore), compute (a) the new required return multiple, (b) the new stake, (c) the new post-money and pre-money valuations.

Solution

(i) Target Multiple Approach

Peak XV's required share of exit = 10 × ₹20 = ₹200 crore

Peak XV's stake = ₹200 / ₹500 = 40.00%

Post-money today = ₹20 / 0.40 = ₹50.00 crore

Pre-money today = ₹50.00 − ₹20 = ₹30.00 crore

(ii) Implied IRR for 10x over 7 years

IRR = 10^(1/7) − 1 = 1.3895 − 1 = 38.95%

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(iii) Verification via Time-Based VC Method

Post-money = ₹500 / $(1 + 0.3895)^7$

= ₹500 / 10.0000

= ₹50.00 crore ✓ (matches Part (i))

(iv) IRR Erosion if Exit Slips to Year 8

New implied IRR = 10^(1/8) − 1 = 1.3335 − 1 = 33.35%

IRR erosion = 38.95% − 33.35% = 5.60 percentage points

(v) Preserving Original IRR over 8-Year Horizon

Required multiple = $(1 + 0.3895)^8$ = 13.8950x

Required share of exit = 13.8950 × ₹20 = ₹277.90 crore

New stake = ₹277.90 / ₹500 = 55.58%

New post-money today = ₹20 / 0.5558 = ₹35.98 crore

New pre-money today = ₹35.98 − ₹20 = ₹15.98 crore

Comparison:

Scenario	Stake	Post-money (₹ cr)	Pre-money (₹ cr)
7-yr exit at 10x (base)	40.00%	50.00	30.00
8-yr exit at same 38.95% IRR	55.58%	35.98	15.98
Change	+15.58 pp	−14.02	−14.02

A one-year slip in exit timing, with IRR preserved, erodes the pre-money valuation by nearly 47% (₹30 → ₹15.98 crore) and increases dilution to the founder by 15.58 percentage points.

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