Module 13 · Financial derivatives P14 · 13.1–13.5

SM pp. 479–600 (exercise 601–616). **The biggest module: 16–22 marks every paper** (expected 17.9). **Q6(a) index-futures hedge in all 6 papers** since Dec'23; **Q6(b) options in 5 of 6** (binomial three times), a swap in Jun'26; **MCQs (x) and (xi)** on options / Greeks every paper. FRA and caps never examined but in the MQP, PTP and postal paper.

Paper	Q6(a) futures	Q6(b) options / swap
Jun'23	beta, risk-free route, Nifty contracts, beta after a 4% rise	binomial hedge, call value, expected return
Dec'23	**5-share portfolio: beta, Feb futures fair value, full hedge, cut beta to 0.6**	**binomial (delta) call, put by parity, expected values**
Jun'24	cut beta to 0.91: risk-free securities or futures	call by binomial and risk-neutral methods
Dec'24	= Dec'23 template (beta to 0.5)	long call + long put (strangle) at 3 prices
Jun'25	= Jun'24 template (beta to 0.975)	call from a price distribution
Dec'25	**= Dec'23 template, same rates; one beta missing**	**= Dec'23 template, same e-factors**
Jun'26	contracts with an adjusted beta; P/L both ways	**interest rate swap = SM exercise sum 9 word for word**

HOW IT IS ASKED

- **December Q6(a)**: same table of 5 shares (price × number × beta), cost of capital 10.5% (ln 1.105 = 0.0998 given), Nifty Feb futures at fair value, lot 100 / 200. Four parts — learn the four steps.
- **June Q6(a)**: reduce beta by selling shares and buying risk-free securities, or by selling futures (the risk-free route is in Module 9).
- **Q6(b)**: two-price binomial with the delta method, put by parity, expected values — all e-factors given. Or a strategy table at several prices, or a swap.
- **MCQs**: Greeks (rho of a put, theta per day, vega), straddle, LEAPS, baskets, covered call, bull call spread, contracts to hedge.

A Formula sheet — when to use

Formula	When to use · notes	SM
$\mathbf{F^* = S_0\, e^{rt}}$	Fair (theoretical) futures / forward price; no income. r continuously compounded p.a., t in years. Index futures use the same model.	[SM 490, SM 493]
$\mathbf{F^* = (S_0 - I)\, e^{rt}}$	Known cash dividend: I = PV of the dividend at e^{-rt}.	[SM 491]
$\mathbf{F^* = S_0\, e^{(r-y)t}}$	Known dividend **yield** y (index with continuous dividends).	[SM 492–493]
TFP > actual → buy spot, sell futures; TFP < actual → sell spot, buy futures	Cash-and-carry / reverse arbitrage; value of a long forward f = (F* − K) e^{-rt}.	[SM 490, SM 492]
Portfolio beta = Σ (value weight × beta)	Value = price × number of shares; step 1 of every Q6(a).	[SM 511]
$\mathbf{Contracts = V_P \times (\beta_N - \beta_E) \div V_F}$	Change beta: negative / falling → **sell** futures; rising → **buy**. V_F = index × lot. Full hedge: $\beta_N = 0$, i.e. $V_P \times \beta \div V_F$.	[SM 505, SM 511]
Hedge ratio = $\rho_{SF} \times \sigma_S \div \sigma_F$	Cross hedge (no futures on the stock): contracts = hedge ratio × units to hedge ÷ units per contract.	[SM 506]
Call BEP = X + C · Put BEP = X − P	Pay-off tables at several spot prices; buyer's loss limited to the premium.	[SM 519–520]
Intrinsic value: call max(S − X, 0), put max(X − S, 0); time value = premium − IV	ITM / ATM / OTM questions; Illus. 47 table.	[SM 524, SM 550]
$\mathbf{C + X\, e^{-rt} = P + S}$	Put-call parity, European only: P = C + X e^{-rt} − S.	[SM 539]

$\Delta = (C_u - C_d) \div (S_u - S_d)$; C = Δ × ($S_0$ − PV of the lower price)	Binomial, **delta method** (the December Q6(b)), when $C_d = 0$.	[SM 563]
$p = (f - d) \div (u - d)$, $f = e^{rt}$; C = $[C_u\, p + C_d(1 - p)] \div f$	Binomial, risk-neutral method; $u = S_u/S_0$, $d = S_d/S_0$; two-stage: work back node by node.	[SM 541–542]
$C = S\, N(d_1) - X\, e^{-rt}\, N(d_2)$; $d_2 = d_1 - \sigma\sqrt{t}$	Black-Scholes (N values are given in the question).	[SM 543]
Swap gain = |fixed diff − floating diff| − commission	Quality spread; strong party borrows where its advantage is bigger and swaps.	[SM 580]
FRA payoff = N × (ref − fixed) × α ÷ (1 + ref × α)	Settled at the start of the period, so discounted; α = days ÷ 360.	[SM 586]

B Index-futures hedging · Q6(a) 13.2

- **Forward**: private, customised, settled at maturity. **Futures**: exchange-traded, standardised, **marked to market** daily — re-priced at the settlement price, gains and losses settled each day. [SM 487]
- **Basis** = futures price − spot price. [SM 487]
- **Initial margin** deposited to open; **maintenance margin** the minimum balance; a call brings it back to the initial level = **variation margin**. [SM 488]
- **Hedge with stocks held**: equal and opposite futures position; a 100% hedge with beta 1.5 makes a 10% market fall net nil. [SM 503]
- **Money in the account** (stocks not yet chosen) → **buy** index futures to ride a rally. [SM 503–504]
- **Modify systematic risk**: V × original β ± futures position = V × desired β. Selling futures reduces beta. [SM 504]
- Cross hedge carries **basis risk**; choose the index with the highest correlation, then the beta nearer 1. [SM 506, SM 510]

1 · Portfolio beta
value = price × shares; β = Σ value × β ÷ Σ value (back-solve a missing beta)

↓

2 · Fair value of the futures
r = ln(1 + rate); $F = S\, e^{rt}$, t = days ÷ 365

↓

3 · Full hedge
contracts to SELL = V × β ÷ (F × lot)

↓

4 · Change beta
V × (β − β*) ÷ (F × lot): sell to cut, buy to raise; round to whole contracts

The answer layout ICMAI uses: a table Security · Price · Shares · Value · Beta · Value × Beta, then one line per part.

PROBLEMS BOX · INDEX-FUTURES HEDGE (Q6(a) — RECOMPUTED BY SCRIPT m13_patterns.py)

WORKED PATTERN · SM ILLUSTRATION 19 (STOCK INDEX FUTURES)

Stock	Value ₹ lakh	Beta	Weighted
1 · 2 lakh × ₹800	1,600	1.1	0.34
2 · 4 lakh × ₹600	2,400	1.2	0.55
3 · 6 lakh × ₹200	1,200	1.3	0.30
Portfolio	**5,200**		**1.19**

- One contract = spot 2700 × 100 = ₹2,70,000.
- Cut beta to 0.8: **sell** 5,200 lakh × (1.19 − 0.8) ÷ ₹2,70,000 = **751 contracts**.
- Raise beta to 1.5: **buy** 5,200 lakh × (1.50 − 1.19) ÷ ₹2,70,000 = **597 contracts**. [SM 510–511]
- Illus. 15: ₹100 crore, β 1.2 → 0.8, futures 5500 × 100: (0.8 − 1.2) × 100 crores ÷ 550000 = **−727** (sell). [SM 504–505]

FAIR VALUE — SM ILLUSTRATIONS 3–5

- Illus. 4: dividend ₹1.50 in 4 months, r 10%: I = 1.4508; F = (38 − 1.4508) × $e^{0.10 \times 6/12}$ = **₹38.4231**. Illus. 5: 25 × $e^{(0.10 - 0.04) \times 6/12}$ = **₹25.76**. [SM 491–492]

DEC'23 Q6(a) DEVAL — THE DECEMBER TEMPLATE (OUR WORKING)

- Values: A 17,46,500 · B 33,63,500 · C 47,48,160 · D 73,47,000 · E 16,49,700 = **₹1,88,54,860**; Σ value × β = ₹1,60,09,114 → **β = 0.8491**.
- r = ln(1.105) = 0.0998; 1 Jan → end Feb = 58 days: 0.0998 × 58/365 = 0.015858 → F = 5900 × 1.01598 = **5,994.28**.
- Full hedge: 1,60,09,114 ÷ (5,994.28 × 200) = 13.35 → **sell 13 contracts**.
- Beta to 0.6: 1,88,54,860 × (0.8491 − 0.6) ÷ 11,98,856 = 3.92 → **sell 4 contracts**.

DEC'25 Q6(a) HICKS — THE TWIST (OUR WORKING)

- Portfolio β 0.859 given, β of BZ missing: (0.859 × 1,63,29,800 − Σ known value × β) ÷ 16,71,000 = **1.1534**.
- F = 13000 × 1.01598 = **13,207.74**; full hedge 0.859 × 1,63,29,800 ÷ (13,207.74 × 100) = 10.62 → **11**; at β 1.263: 15.62 → **16** (our reading of part (iv)).

PRACTISE THESE (MOST LIKELY FIRST)

D23, D24, D25 Q6(a) (December template) · J24, J25 Q6(a) and J23 Q6(a) (risk-free route) · J26 Q6(a) · MQP Q6(a), Q1(ix) (cross hedge 1.5) · PTP Q6(a), Q1(ix) · postal Q4(b)(i) · SM Illus. 15, 19, 20, 21, 22 (beta matrix), 16–17 (cross

⚠ SM SLIP · ILLUSTRATION 3

The SM writes $70 \times e^{0.06 \times 3/12} = 70 \times 1.0202 = ₹71.41$. $0.06 \times 3/12 = 0.015$ and $e^{0.015} = 1.0151$, so **F* = ₹71.06**; 1.0202 is $e^{0.02}$. [SM 491]

hedge), 3–6, 9–12 (pricing) · SM exercise sums 1–2, MCQs 20, 27, 28 · **ICMAI Practice Workbook Ch8 illus. 8, 9, 11, 12, 13, 14, 16** · MCQ bank Q128, Q131, Q133, Q135, Q136, Q160, Q162, Q165, Q170, Q172.

C Options · Q6(b) and MCQs (x)–(xi) 13.3

Position	Max loss	Max gain	BEP
Long call	premium	unlimited	X + C
Short call	unlimited	premium	X + C
Long put	premium	substantial	X − P
Short put	substantial	premium	X − P

Illus. 25–28: X ₹3,500, premium ₹50 → call BEP **₹3,550**, put BEP **₹3,450**. [SM 520–524]

Strategy	Made of	View
Covered call	long stock + short call	neutral / mildly bullish
Protective put	long stock + long put	insure a holding
Bull call spread	buy lower-strike call + sell higher-strike call	moderately bullish
Bear put spread	buy higher-strike put + sell lower-strike put	moderately bearish
Long straddle	buy call + put, **same** strike and expiry	big move either way
Long strangle	buy OTM put + OTM call; BEPs: call strike + net premium, put strike − net premium	very high volatility
Strap / strip	2 calls + 1 put / 2 puts + 1 call	bullish / bearish on volatility

[SM 528–539]

- **Greeks**: **delta** = change in option price ÷ change in stock price (call positive, put negative; = shares per option for a riskless hedge); **gamma** = rate of change of delta; **vega** = sensitivity to volatility; **theta** = sensitivity to time to expiry (time decay); **rho** = sensitivity to the interest rate. [SM 544–545]
- MCQ facts: value up 1.75 / 1.8 when rates fall 1% = **rho of a put** (J23, D24); theta −0.02 → option loses 0.02 a day (J26); options up to 3 years = **LEAPS** (D25); options on portfolios = **baskets** (J26). (past MCQs)
- **Bounds**: European call max S, min max(0, $S - X e^{-rt}$); American put max X, min max(0, X − S). [SM 525]
- Put-call parity is **not applicable to American options**. [SM 539]
- Black-Scholes assumptions: no dividend, efficient market, no costs or taxes, constant known r, log-normal returns, European exercise. [SM 543]

Binomial · delta method

pay-offs at the two prices: $C_u = S_u - X$, $C_d = 0$

↓

$\Delta = (C_u - C_d) \div (S_u - S_d)$

↓

PV of $S_d = S_d \times e^{-rt}$; $C = \Delta \times (S_0 - PV)$

↓

Put = $C + X e^{-rt} - S_0$; expected values with the given probabilities

PROBLEMS BOX · OPTION VALUE (Q6(b) — RECOMPUTED BY SCRIPT)

WORKED PATTERN · SM ILLUSTRATION 57 (ABC LTD) — THE DELTA METHOD

- S ₹110; in 3 months ₹100 or ₹150; X ₹120; r 12% continuous.
- Pay-offs: lapse at 100 (nil), exercise at 150 (₹30). Option delta = (₹30 − 0) ÷ (₹150 − ₹100) = **0.60**.
- Invest at risk-free = PV of ₹100 = ₹100 ÷ $e^{0.12 \times 0.25}$ = ₹100 ÷ 1.0305 = **₹97.04**.
- Call = 0.60 × (₹110 − ₹97.04) = **₹7.78**; put = ₹7.78 + ₹116.45 − ₹110 = **₹14.23**. [SM 562–563]

RISK-NEUTRAL METHOD · SM ILLUSTRATION 41

S ₹50, ± 20% in 3 months, X ₹50, 8%: f = 1.02, p = (1.02 − 0.80) ÷ (1.2 − 0.8) = 0.55 → call = 10 × 0.55 ÷ 1.02 = **₹5.39**, put = 10 × 0.45 ÷ 1.02 = **₹4.41**. [SM 541]

PARITY · SM ILLUSTRATION 40

DEC'25 Q6(b) HONT — THE DECEMBER TEMPLATE (OUR WORKING)

- S ₹648 → ₹680 (60%) or ₹616 (40%); X ₹640; 6% continuous; 3 months ($e^{-0.015}$ = 0.985112).
- Pay-offs ₹40 / nil → Δ = 40 ÷ 64 = **0.625**; PV of 616 = 616 × 0.985112 = 606.83.
- Call = 0.625 × (648 − 606.83) = **₹25.73**; put = 25.73 + 640 × 0.985112 − 648 = **₹8.20**.
- Expected price in 3 months = 680 × 0.6 + 616 × 0.4 = **₹654.40**; expected option value at expiry = 40 × 0.6 = **₹24**.

PRACTISE THESE (MOST LIKELY FIRST)

D23, D25 Q6(b) (delta + parity) · J24 Q6(b) (both methods) · J23 Q6(b) · J25 Q6(b) · D24 Q6(b) (strangle) · PTP Q6(b), Q8(b), Q1(xi) · MQP Q1(x) · postal Q1(ii) · SM Illus. 57, 58, 41, 42, 40, 23–39 (pay-offs, strategies), 43 (Black-Scholes), 47, 50, 51 (tables) · SM exercise sums 4, 5, 6, 8 (binomial

S ₹500, call ₹12, X ₹550, 3 months, 8%: P = 12 + 539.11 − 500 = **₹51.11**. [SM 540]

₹21.522), 10 (strategy names), MCQs 6–12, 19–26, 29 · **ICMAI Practice Workbook Ch8 illus. 1–7, 10, 15, 17, 18** · MCQ bank Q126, Q127, Q129, Q130, Q134, Q138, Q139, Q163, Q164, Q166–Q169, Q189.

D Swaps, FRA, caps and floors 13.4 · 13.5

Interest rate swap — steps
differences: fixed rates, floating rates → net (quality spread)

↓

less the bank's commission → net gain; split in the given ratio

↓

the party with the bigger edge in fixed borrows **fixed**, the other **floating**; they swap

↓

effective rate = own loan ∓ differential ∓ share of gain (+ commission); check against the direct-borrowing rate

- Plain vanilla swap = fixed for floating (J23 MCQ). Swaps are private agreements (MQP MCQ). (past MCQs)
- **FRA**: forward rate > LIBOR → the buyer pays the difference; forward rate < LIBOR → the seller pays. The principal is notional. [SM 586]
- **Cap** = call options on interest rates (pays when rates rise above the strike); **floor** = put options on rates; **collar** = buy a cap + sell a floor. [SM 593]

PROBLEMS BOX · SWAP / FRA / CAP (RECOMPUTED BY SCRIPT)

WORKED PATTERN · SM ILLUSTRATION 69 (PQR / DEF)

- Floating diff 0.5% · fixed diff 1.4% · net 0.9% − bank 0.5% = 0.4% → 0.2% each.
- PQR borrows fixed 12.0%, collects 11.9% − LIBOR from DEF and 0.2% gain → **LIBOR − 0.1%**. DEF borrows LIBOR + 0.6% and pays the rest. [SM 580–581]

SM EXERCISE SUM 9 = JUN'26 Q6(b) (OUR WORKING)

- X 7.5% / L + 25 bp; Y 8.45% / L + 37 bp; commission 0.2% borne by Y; split 60 : 40.
- 0.95 − 0.12 = 0.83% − 0.20 = **0.63%** → X 0.378%, Y 0.252%.
- X borrows fixed 7.5%, collects 7.25% − L from Y → **L − 0.128%**; Y: L + 0.37 + 7.25 − L + 0.378 + 0.2 = **8.198%** (v 8.45%).
- Savings on US$ 50 million: X **$1,89,000**, Y **$1,26,000** a year.

FRA · SM ILLUSTRATION 71 · CAP · ILLUSTRATION 75

3 × 6 FRA on $3,00,00,000 at 5.5%; settles at 4.875% for 92 days → payoff **$47,326.39** to the seller. [SM 586]

Cap 9% on ₹400 million at 0.65% = ₹26,00,000; rates at 10% → cap pays ₹40,00,000; floors to sell to pay for it: ₹37,68,11,594. [SM 593–594]

PRACTISE THESE

J26 Q6(b) · MQP Q6(b) · postal Q8, Q4(b)(ii), Q5(a), Q5(b) · PTP Q1(x) (cap pay-off) · SM Illus. 65–70, 71–75, solved case 1 · SM exercise sums 3, 7, **9** · **WB Ch8 illus. 19** · MCQ bank Q132, Q140, Q192.

R Revision sheet and traps

Item	Rule	SM
Fair value	$S e^{rt}$; dividend: $(S - I) e^{rt}$; yield: $S e^{(r-y)t}$	[SM 493]
Contracts	$V \times (\beta^* - \beta) \div$ (index × lot)	[SM 505]
Parity	$C + X e^{-rt} = P + S$	[SM 539]
Risk-neutral p	$(f - d) \div (u - d)$, $f = e^{rt}$	[SM 541]
Delta	change in option ÷ change in stock	[SM 544]
BEP	call X + C; put X − P	[SM 519–520]

TRAPS

- Use the **continuous** rate: ln(1 + annual rate) when the question gives ln values — not the simple rate.
- Days: count from the trade date to the expiry month-end as the question says; the e-factor given tells you which count ICMAI used.
- Contracts must be whole: state "sell 13 (13.35)"; say **sell** or **buy**.
- The full hedge uses value × **beta**, not the value alone.
- Delta method needs $C_d = 0$; if both pay off, use the risk-neutral formula.
- Swap: commission borne by one party is added only to that party's cost.

MEMORY HOOK

"Beta, Fair, Full, Fix" — the four steps of every December Q6(a). **"Delta, PV-low, Call, Parity"** — the four of Q6(b).