DERIVATIVES ANALYSIS & VALUATIONS → OPTIONS

8 Marks +

Introduction:-

Future Segment Market:-

Contracted Today

Rate is Decided as on today

for the Buy, & selling at some future date

Options:- One side betting

Future: Both side betting.

Option:- [Choice]

Right

Pay Premium as on today

Obligation

Derivatives:-

It derives its value from the value of an Underlying Asset.

Example.

Insurance Contract:-

(Option Contract)

1 year

Customer

CAR Insurance

UA

Insurance Co.

right

Pay Premium on today.

$\boxed{₹10,000}$

Sunk Cost

Obligation

₹5,00,000

Sum Assured

⇒ If the event happens:-

→ Right → Customer

→ Obligation → Insurance Co

⇒ To cover the damages at the time of event happens.

Example.

Bond / Debenture

Risk

Default

Credit Ratings ⇓

IB

Customer → IB

⇓

Invest in Bonds / Deb.

2008

Pay Premium Due on today

CDS

Credit Default Swap

Customer → Right

IB → Obligation

Option Contracts

- **Call option**
  - **Long Call** ⟹ Right to Buy ⟹ Option Buyer ⟹ OP Paid
  - **Short Call** ⟹ Obligation to sell ⟹ Option Seller ⟹ OP Recd.
- **Put option**
  - **Long Put** ⟹ Right to Sell ⟹ Option Buyer ⟹ OP Paid
  - **Short Put** ⟹ Obligation to Buy ⟹ Option Seller ⟹ OP Rec

Right Buy

⇓

Buyer

OP Paid

Long

Right sell

⇓

Seller

⇓

OP Rec

Short

CALL option:-

Example.

UA RIL Share

UA ⇒ Buy.

3 mnths

Mr.A — Expiry Date — Mr.B

Mr.A: right to Buy RIL

right → Buy

Mr.B: right → Sell

X ⇒ 1500

X = Exercise Price = Contract Price = Strike Price

U/A → Buy → Call option

right → Buyer → Long

right → Seller → Short

Right to Buy | Obligation to sell
⇓ | ⇓
Long Call | Short Call
⇓ | ⇓
Who Buy's right | Who sell's right
⇓ | ⇓
OP Paid as on today. | OP Received as on today.

⇒ ₹ 500

Option Premium → Sunk Cost
⇓
Non-Refundable
Non-Adjustable

X = 1500

Mr. A → **Mr. B**

Long Call → Short Call

Right to Buy | Obligation to Sell

OP Paid = 500 | OP Rec = 500

X = 1500

Case I: If on Expiry:-

3 mths

On Expiry

X = 1500

S = 2300

OP = 500

Right to Buy X = 1500

Call Buyer will exercise

⇒ Gross Profit / Pay-off :-

⇒ 2300 − 1500 ⇒ 800

Call → [S − X]

⇒ Net Profit / Net Pay-off :-

⇒ 800 − 500 ⇒ 300 ✓

$\boxed{S - X - OP}$

GP − OP = NP = Net Pay-off

Case II: If on Expiry S = 1300

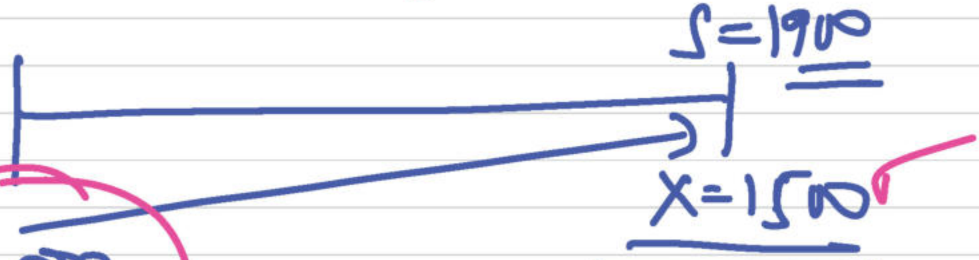
Call Buyer will not exercise

GP | Payoff = 0

Net Profit | Net Pay-off = 0 − 500

= ₹ −500

Case III: If on Expiry S = 1900



OP = 500

Call Buyer will Exercise

$GP = 1900 - 1500 > 0$ Exercise

$S - X$

$\Rightarrow 400$

$NP = 400 - 500 = -100$ ✓

Call Buyer will Exercise.
$(S - X > 0)$

$X = 1500$

Call Buyer will not Exercise
$(S - X < 0)$

⇒ While deciding whether to exercise or not exercise an option, we will never consider the option premium, it is just like a sunk cost.

OP is only considered while Cal. the Net Profit & Loss.

S = Underlying Asset Price

X = Exercise Price / Strike Price

Crux

Call option:

If $S - X > 0$ Exercise

$S - X < 0$ Not Exercise

$S - X = 0$ Not Exercise

Q. IV If on Expiry $S = 1500$

$X = 1500$

$S = 1500$

Call Buyer will not Exercise

$GP = 0$

$NP = 0 - 500 = -500$

$$\boxed{NP = S - X - OP \text{ or } GP - OP}$$

Option Buyer

Mr. A

$\boxed{BEP = ?}$

Option Seller

Mr. B

Max. Profit ⇒ ?

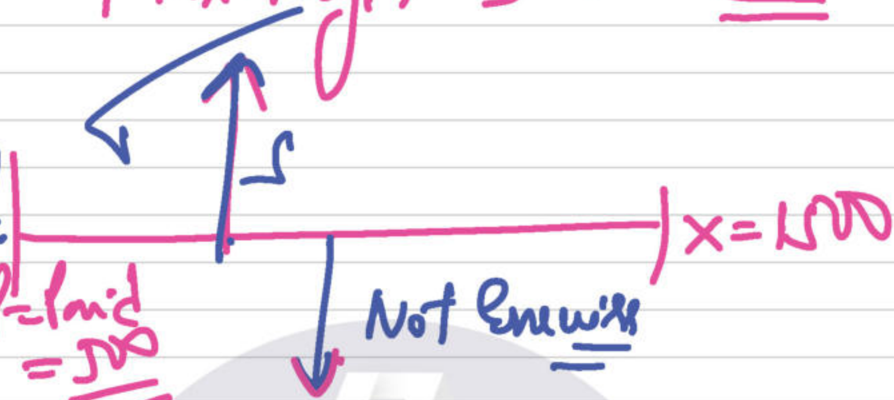
Max. Loss ⇒ ?

Max. Profit = ?

Max. Loss = ?

Mr A:- Max. Profit ⇒ Unlimited

Long Call



Max. Loss ⇒ Option Premium paid i.e. ₹500

Mr. B

Short Call

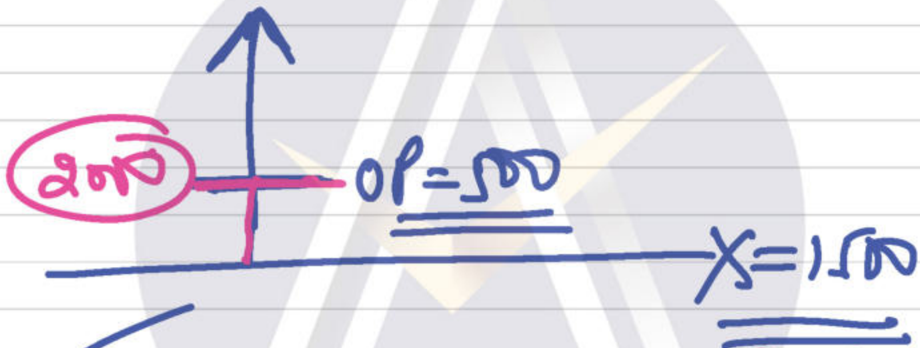
Maximum Profit = OP Received

Maximum Loss ⇒ Unlimited

Zero-Sum Game

BEP:- (Break-even Point)

No Profit No loss situation



If S = 2000 On Expiry

S = 2000

S − X

2000 − 1500 > 0 Exercise

G/L = 500   NP = 500 − 500

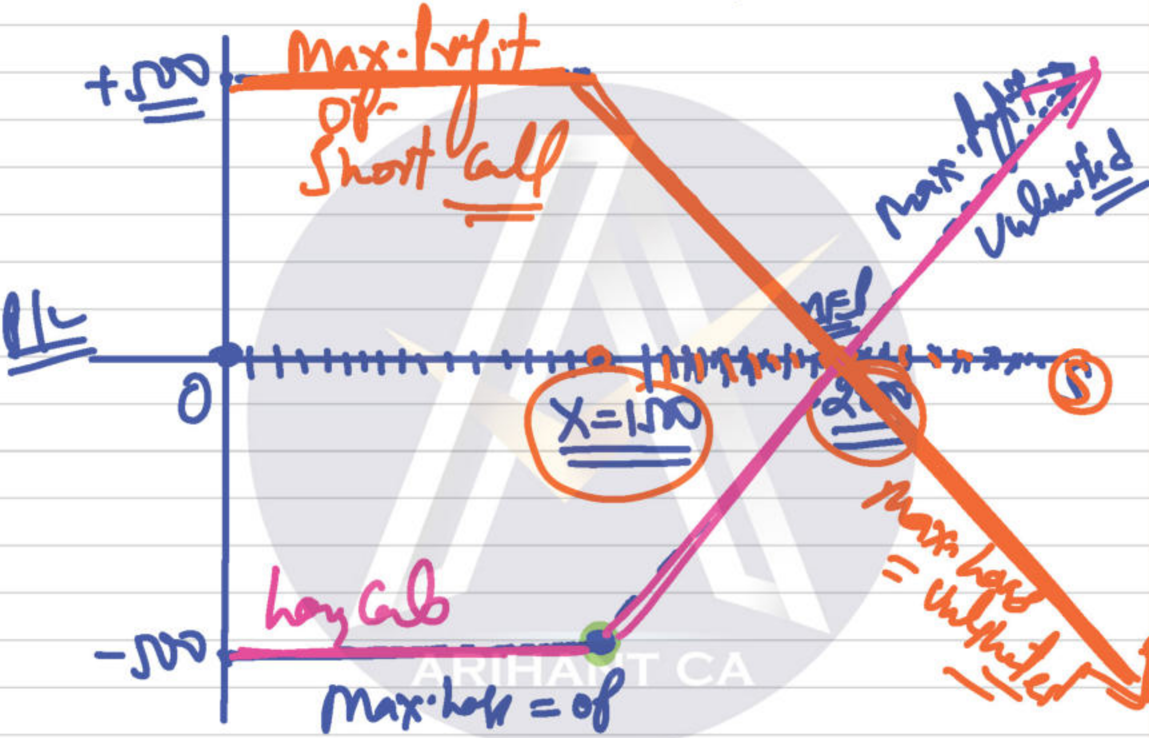
= 0

X = 1500 + 500 (OP)

Call BEP $\Rightarrow X + OP$

$\Rightarrow 1500 + 500$

$= 2000$ ✓



Put option:-

Example.

UA → TCS → Sell

X → @ 5000

3 mths

Mr A

Mr. B

Option → Buyer.

right → Buy.

right to sell

⇓

Who buys right

⇓

right to sell

⇓

Long Position

Option → Seller

right → Sell

Obligation to Buy

⇓

who sells right

⇓

Obligation to Buy.

⇓

Short Position

Long Put — OP Paid

Short Put — OP Received

Case I:

On Expiry

X = 5000

S = 4000

OP Paid = 700

Right to sell @ 5000

Obligation to Buy at X = 5000

Put Buyer will Exercise

G/L = 5000 − 4000 > 0

$X - S$

$GP = 1000$

$NP = 1000 - 700 = \underline{300}$

Case:

$\boxed{X - S}$

Put Buyer will not Exercise

$X = 5000$

Put Buyer will Exercise

Case II: If on Expiry $S = 7000$

$X - S$

$5000 - 7000 < 0$ — Put Buyer will Not Exercise

$GP = 0$

$NP = 0 - 700 = \underline{-700}$

Gn III: If on Expiry S = 4500

OP = 700 ⟶ X = 5000, S = 4500

Put Buyer will Exercise

$X - S$

$5000 - 4500 > 0$ Exercise

$GP = 500$ $\quad NP = 500 - 700$

$= -200$

If	$X - S > 0$	Exercise
	$X - S < 0$	Not Exercise
	$X - S = 0$	Not Exercise

Case IV:

$X = 5000$

$S = 5000$

$X - S = 0$

$5000 - 5000 = 0$

Put Buyer will not Exercise

$GP = 0$ $NP = 0 - 700$

$= -700$

BEP = ?

Mr. A

Max. Profit ⇒ ? X − OP.

Max. Loss ⇒ ? OP = 700

Mr. B

Max. Profit = OP

Max. Loss = X − OP

Max. Profit ⇒ X = 5000, S = 0

S = 0

X – S

5000 – 0 ⇒ $\underline{5000}$ – 700

NP

Max. Profit ⇒ X – OP

= $\underline{4300}$

NP

Case: $\boxed{X - OP}$ = Max. Profit

Zero-Sum Game

AEP:-

X = 5000

700 = OP

5000 – 700 = 4300

Proof.

If S = 4300 on Expiry

X − S

5000 − 4300 > 0 Exercise

GP = 700 NP = 700 − 700

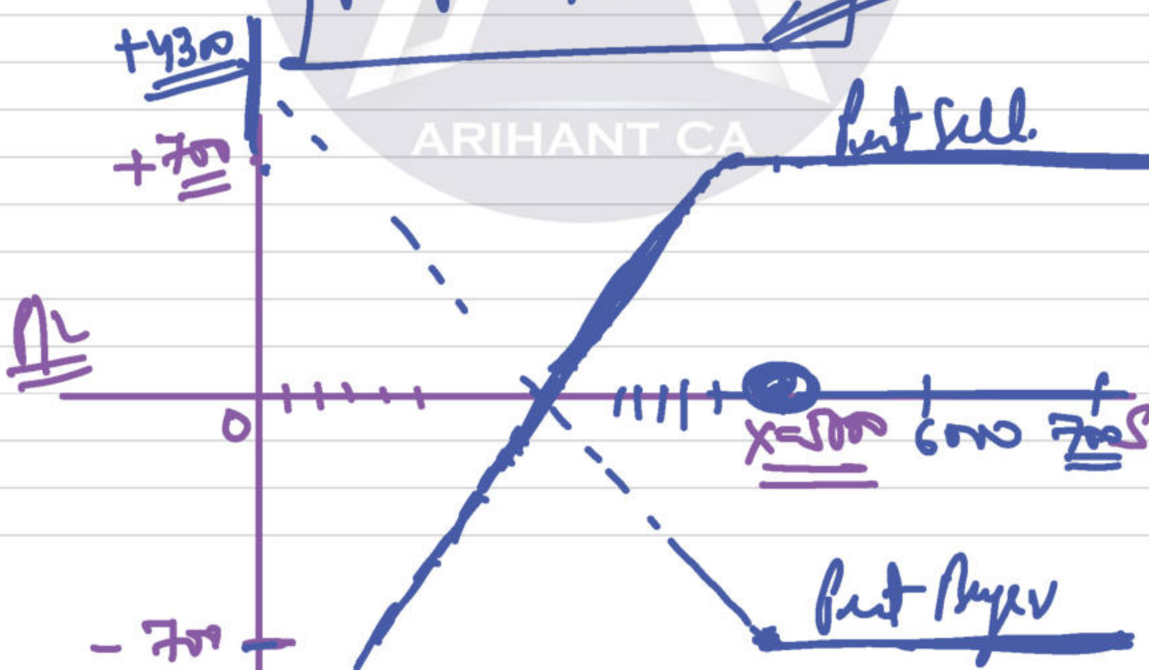
= 0

(No Profit No Loss)

BEP

Conclusion

$\boxed{BEP = X - OP}$



-4300

Q.1A

$X = 220$

OP = Call = 6

Put = 5

$S = 200 - 240$

1) Long Call :- $[S - X]$

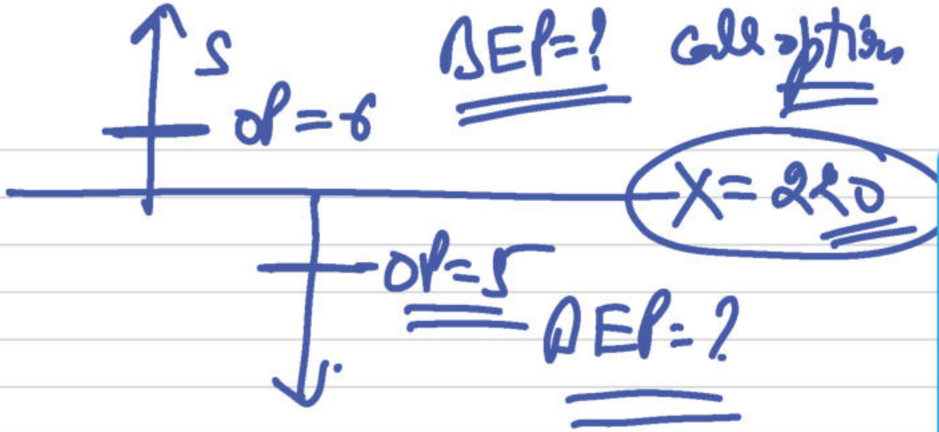
S − X			GP	NP = GP − OP (Net Pay off)
200 − 220	< 0	Not Exercise	0	0 − 6 = −
210 − 220	< 0	Not Exercise	0	0 − 6 = −
220 − 220	= 0	Not Exercise	0	0 − 6 = −
230 − 220	> 0	Exercise	10	10 − 6 = 4
240 − 220	> 0	Exercise	20	20 − 6 = 14

2) Long Put $X - S$ $\vdash \longrightarrow$ $220 = X$

G/-OP

$X - S$		GP	Net Pay-off
$220 - 200 > 0$	Exercise	20	$20 - 5 = 15$
$220 - 210 > 0$	Exercise	10	$10 - 5 = 5$
$220 - 220 = 0$	Not Exercise	0	$0 - 5 = -5$
$220 - 230 < 0$	Not Exercise	0	$0 - 5 = -5$
$220 - 240 < 0$	Not Exercise	0	$0 - 5 = -5$

(b)



1) Call option :-

BEP = X + OP

= 220 + 6 = 226

If Actual Price on Expiry > ₹226 then the Call option will be gainfully exercised.

(ii) For Put option:-

$X = 220$

$OP = ₹5$

$BEP = X - OP$

$\Rightarrow 220 - 5 = \underline{215}$

If Actual Price on Expiry $< ₹215$, then the Put option will be gainfully exercised.

Concept:-

Expiration Date Cash flows:-

Delivery Based Settlement:-

1) **Call option:-**

$X = 60$

Long call

right to Buy @ $X = 60$

(Outflow)

Short Call

Obligation to sell at $X = 60$

(Inflow)

Case I:

$X = 60$

$S = 50$

$(S - X)$

$50 - 60 < 0$

Not Exercise

No Inflow / No outflow

Case II:

OP = Paid as on today

$X = 60$

$S = 70$

$S - X$

$70 - 60 > 0$

Exercise

Call Buyer:	**Call Seller**
Outflow = 60	Inflow = 60

Put option:

$X = 60$

Put Buyer — Put Seller

Right to sell @ $X = 60$ (Inflow)

Obligation to Buy $X = 60$ (Outflow)

On Expiry

$S = 50$

$X = 60$

$X - S$

$60 - 50 > 0$ Exercise

Put Buyer → Sell at $X = 60$ (Inflow)

Put Seller Outflow

Q.1B

X = 60

OP = C = 9

P = 1

(i) Long call (Right to Buy @ X = 60)

S − X		Expiration Date CF's	GP	NP
50 − 60 < 0	Not Exercise	0	0	0 − 9 = −
55 − 60 < 0	Not Exercise	0	0	0 − 9 = −
60 − 60 = 0	Not Exercise	0	0	0 − 9 = −
65 − 60 > 0	Exercise	−60	5	5 − 9 = −
70 − 60 > 0	Exercise	−60	10	10 − 9 =

(ii) Short Call :- Obligation to sell @ X = 60

S − X		Exp. date (E.P.)	GP	NP
50 − 60 < 0	Call Buyer will not Exercise against us	0	0	0+9=+9
55 − 60 < 0		0	0	0+9=+9
60 − 60 = 0		0	0	0+9=+9
65 − 60 > 0	Call Buyer will Exercise against us	+60	−5	−5+9=+4
70 − 60 > 0		+60	−10	−10+9=−

(iii) Long Put → right to sell @ X = 60

X − S		Exp. date (E.S.)	GP	NP
60 − 50 > 0	Exercise	+60	10	10−1=9
60 − 55 > 0	Exercise	+60	5	5−1=4

$60 - 60 = 0$	Not Exercise	0	0	$0-1=-1$
$60 - 65 < 0$	Not Exercise	0	0	$0-1=-1$
$60 - 70 < 0$	Not Exercise	0	0	$0-1=-$

(iv) Short Put :- Obligation to Buy $X = 60$

$X - S$		CF's	CP	NP
$60 - 50 > 0$	Put Buyer will Exercise against us	-60	-10	$-10+1=-9$
$60 - 55 > 0$		-60	-5	$-5+1=-4$
$60 - 60 = 0$	Put Buyer will not Exercise against us	0	0	$0+1=+1$
$60 - 65 < 0$		0	0	$0+1=+1$
$60 - 70 < 0$		0	0	$0+1=+$

Concept: Option Strategies: –

Combination → Net Pay-off

Long Call

Short Call

Long Put

Short Put

Net off

⇒ It is the combination of call & put option.

⇒ We will make different combination based on 4 positions.

Q.1C

Long Call + Long Put

Long Call

$X = 42$

$OP = 2$

Long Put

$X = 40$

$OP = 1$

(i) If $S = 43$ on Expiry i.e. after 3 mths

Long Call

$S - X$

$43 - 42 > 0$

Call Buyer will Exercise

$GP = 1$

$NP = 1 - 2$

$\Rightarrow -1 \times 100$

Long Put

$X - S$

$40 - 43 < 0$

Put Buyer will not Exercise

$GP = 0$

$NP = 0 - 1$

$= -1 \times 100$

$\Rightarrow -100$ | $= -100$

Investor's Position (Net Pay-off) $\Rightarrow -100 - 100$

$= -200$ ✓

(ii) If on Expiry S = 36

Long Call

$S - X$

$36 - 42 < 0$

Call Buyer will not Exercise

$GP = 0$

$NP = 0 - 2$

Long Put

$X - S$

$40 - 36 > 0$

Put Buyer will Exercise

$GP = 4$

$NP = 4 - 1$ ...

$= -2 \times 100$ | $= 3 \times 100$

$= -200$ | $= +300$

Investor's Position = Net Pay-off

$= -200 + 300$

$= +100$

DERIVATIVES – OPTIONS

Q.1E (Nov. 2020)

Long Call	Long Put
$X = 550$	$X = 450$
$OP = 30$	$OP = 5$

Lot size = 100

i) If on Expiry $S = 500$

Long Call	Long Put
$S - X$	$X - S$
$500 - 550 < 0$	$450 - 500 < 0$
Call Buyer will not	Put Buyer will not

Exercise

$GP = 0$

$NP = 0 - 30$

$= -30 \times 100$

$\Rightarrow -3000$

Exercise

$GP = 0$

$NP = 0 - 5$

$= -5 \times 100$

$= -500$

Net Pay-off $= -3000 - 500$

$= -3500$

(ii) If on Expiry $S = 350$:-

Long Call

$S - X$

$350 - 550 < 0$

Call Buyer will not

Long Put

$X - S$

$450 - 350 > 0$

Put Buyer will

Exercise

$GP = 0$

$NP = 0 - 30$

$= -30 \times 100$

$\Rightarrow -3000$

Exercise

$GP = 450 - 350$

$= 100$

$NP = 100 - 5$

$= +95 \times 100$

$= +9500$

Net Pay-off $\Rightarrow -3000 + 9500$

$\Rightarrow +6500$

(iii) If on Expiry $S = 600$

Long Call

$S - X$

$600 - 550 > 0$

Long Put

$X - S$

$450 - 600 < 0$

Call Buyer will Exercise

GP = 600 − 550

= +50

NP = +50 − 30

⇒ +20 × 100

⇒ +2000

Put Buyer will not Exercise

GP = 0

NP = 0 − 5

⇒ −5 × 100

⇒ −500

Net Pay-off ⇒ +2000 − 500

⇒ +1500

Example: Consider 1month Call & Put option on Tech Mahindra :-

X	Call (OP)	Put (OP)
750	66	22
800	38	43

Short Put

[Short Call]

A trader sold Put option at a Strike Price of ₹750 & also sold Call option at X = ₹800

Calculate his Net Pay-off on Expiry if share Price on Expiry turns out to be :-

(i) ₹630

(ii) ₹780

(iii) ₹945

Soln.:-

Short Call

$X = 800$

$OP = 38$

Short Put

$X = 750$

$OP = 22$

(i) If Price on Expiry is $S = 630$

Short Call

$S - X$

$630 - 800 < 0$

Call Buyer will not Exercise against us

$GP = 0$

$NP = 0 + 38$

$\Rightarrow +38$

Short Put

$X - S$

$750 - 630 > 0$

Put Buyer will Exercise against us

$GP = -120$

$NP = -120 + 22$

$\Rightarrow -98$

Net Pay-off ⇒ $+38-98$

⇒ $\underline{\underline{-60}}$

Case II :- If on Expiry $S = 720$

Short Call

$X = 800$

$OP = 38$

$S - X$

$720 - 800 < 0$

Call Buyer will not Exercise against us

$GP = 0$

$NP = 0 + 38$

Short Put

$X = 750$

$OP = 22$

$X - S$

$750 - 720 > 0$

Put Buyer will Exercise against us

$GP = -30$

$NP = -30 + 22$

⇒ +38 | ⇒ −8

Net Pay-off = +38 − 8
= +30

(iii) If on Expiry S = 945

Short Call	Short Put
S − X	X − S
945 − 800 > 0	750 − 945 < 0
Call Buyer will Exercise against US	Put Buyer will not exercise against US
GP ⇒ −145	GP = 0
NP = −145 + 38	NP = 0 + 22
⇒ −107	⇒ +22

$$\text{Net Pay-off} = -107 + 22$$

$$\Rightarrow \underline{\underline{-85}}$$

Concept:- Concept of Moneyness:-

Options
- Call option
- Put option

If we immediately Exercise an option

⇓

- +ve Pay-off (CAP) ⇓ (In-the-Money)
- −ve Pay-off ⇓ Out-of Money
- Zero Pay-off ⇓ At-the Money

Call → $S - X > 0$ }
Put → $X - S > 0$ } In-the-Money

Call → $S - X < 0$
Put → $X - S < 0$ } Out-of Money.

Call { $S - X = 0$
Put { $X - S = 0$ } At-the-Money

Concept: European & American options:-

(Just Names)

1) European options:-

Exercise only at Expiry.

2) American options:-

Exercise on or before Expiry.
i.e. at any time.

$$\boxed{V_{\text{American option}} \geq V_{\text{European option}}}$$

Concept: Action to be taken under the options Mkt:-

1) Cash Mkt.

↑ Prices are Expected to rise

Buy → Position

↓ Prices are Expected to fall

Sell → Position

2) Future Contract:-

↑ Long Position

↓ Short Position

3) Options Mkt.

- Call
  - Long Call
  - Short Call
- Put
  - Long Put
  - Short Put

1) Call option :-

↑ S

Long Call

↓ S

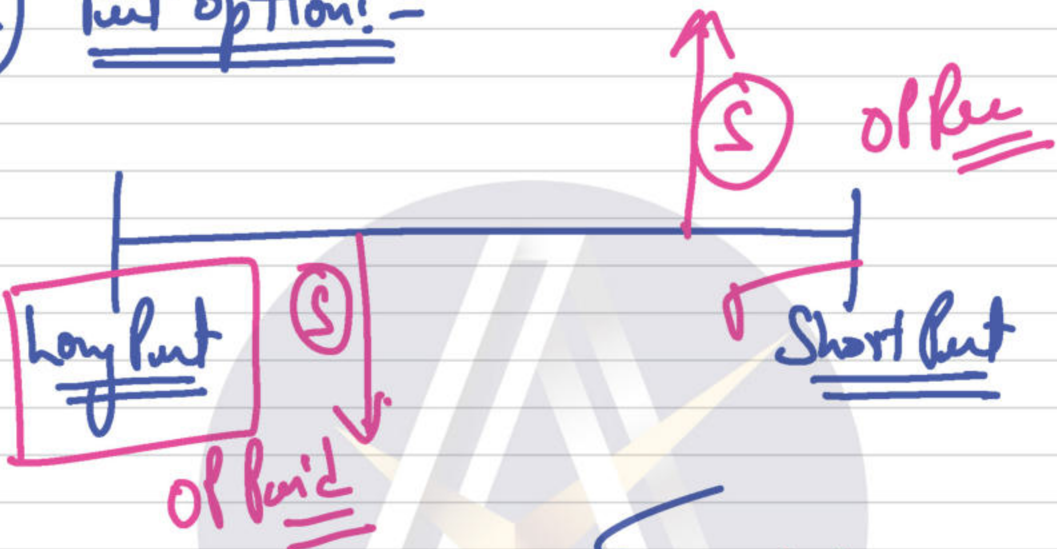
Short Call

Crux: Expecting ↑ → Long Call or Paid

Expecting ↓ ⟶ Short Call

O/ Rec

2) **Put option:-**



Expecting ↓ ⟶ Long Put

Expecting ↑ ⟶ Short Put

Final Crux:-

Long Call ↑ ↓ Short Call

Long Put ↓ ↑ Short Put

If Prices are Expected to rise ↑	Long Call **or**	Short Put
If Prices are Expected to fall ↓	Long Put **or**	Short Call

Note:

Expecting High Volatility:-

↑ Long Call

↓ Long Put

Expected Low Volatility:-

↑ Short Put

↓ Short Call

Concept: Intrensic Value & Entrensic Value of an option:-

↓

Time Value of an option

$\boxed{\text{Option Premium} \Rightarrow IV + EV(TVO)}$

IV ⇓ (Minimum Value an option will command)

EV(TVO) ⇓ Based on Expectation

1) Intrensic Value (IV):-

⇓

(Moneyness of an option)

⇓

(Minimum Value of an option)

Case I: Call option:- (Practical Approach)

$X = 1000$

$S = 1200$

$S = 900$

If we immediately Exercise an option

$S - X > 0$

$1200 - 1000 > 0$ $\qquad$ $900 - 1000 < 0$

+ve Pay-off $\Rightarrow 200$

(IV)

V_c at Expiry:-

$$\boxed{IV \Rightarrow [S - X, 0]\ max}$$

If $S = 900$

$900 - 1000 < 0$ Not Exercise

IV ⇒ $\boxed{V_c = 0}$ $[S - X, 0]$ Max.

OP/IV can never be negative, it can be zero or greater than zero

Crux

$\boxed{\text{Call option :- } IV = [S - X, 0] \text{ max.}}$

Put option.

$X = 1000$

$S = 700$

If we immediately exercise an option:-

$X - S$

$1000 - 800 > 0$ +ve Pay-off

$$\boxed{IV = [X - S, 0]\max.}$$

2) <u>Extrinsic Value:-</u> (EV) | <u>TVO:-</u>

$$\boxed{OP = IV + EV\,(TVO)}$$

↓

(Minimum Value)

Call → $[S - X, 0]\max$

Put → $[X - S, 0]\max.$

$\boxed{OP = 500} \Rightarrow IV = 200 + EV = 300$

EV → Based on Expectation

1 Delta → Δ in OP → Δ in UA

2 Gamma → Δ in Delta

3 Theta → Time to Expiration

4 Rho → Rate of Intt.

5 Vega → Volality VIX

$\boxed{\text{5 Greek Parameters}}$

↑ V ↑ T OP = ↑

3 mth 3 Day

Valuation (Vc / Vp)

- Simple Valuation Rules
  - On Expiry
  - Before Expiry
- Binomial Model
  - 1) Risk Neutral Approach
    - Two-Period Binomial Model
  - 2) Delta Hedging
- BSM
- PCPT

1) Simple Valuation Rules:-

- On Expiry
- Before Expiry

(i) On Expiry:-

- Call option
- Put option

(a) Value of Call on Expiry:-

Eg.

$S \Rightarrow 650$

(IV) $V_c \Rightarrow [S - X, 0]$ Max.

$V_c = [650 - 500, 0]$ Max

$V_c = 150$ (on Expiry)

$S = 400$

$V_c = [S - X, 0]$ max.

$= [400 - 500, 0]$ max.

$= 0$

Crux

$\downarrow \uparrow \quad S - X$ fixed $= V_c \quad \uparrow \downarrow$

(b) Value of Put option on Expiry:-

On Expiry

$X = 1500$

$S = 1100$

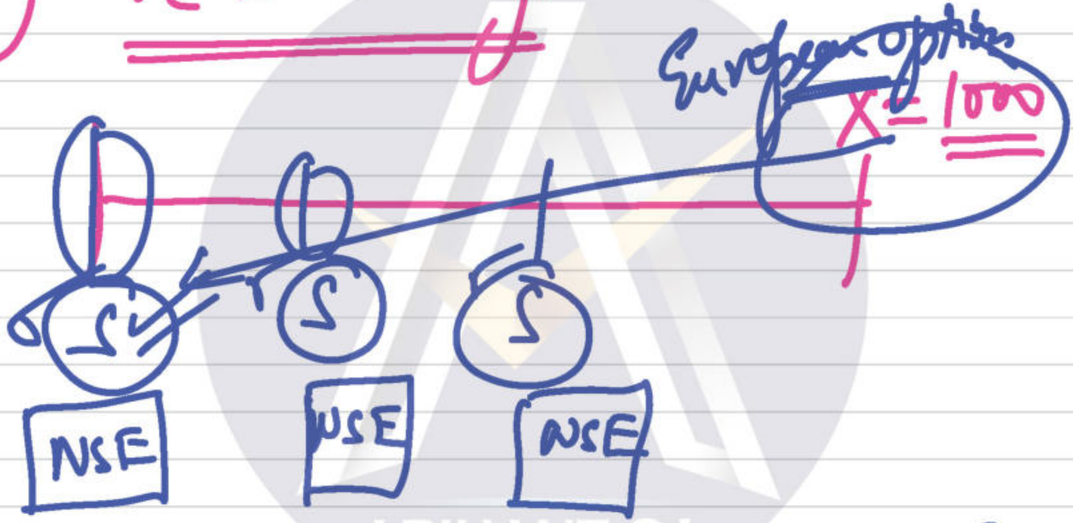
$V_p \Rightarrow [X - S, 0]$ max.

$= [1500 - 1100, 0]$ max

$\Rightarrow 400$ ✓

II Simple Valuation Rules:- (Before Expiry)

1) V_c as on today:-

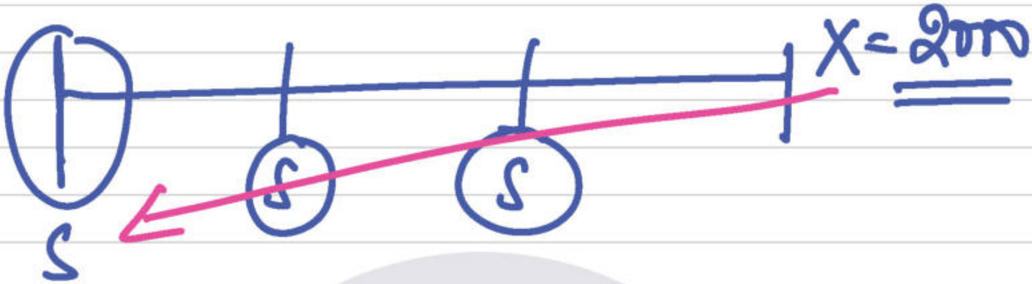


$$V_c = \left[\frac{S - X}{(1+r)^n \,/\, e^{rt}}, 0 \right]_{max}$$

$(1+r)^n \rightarrow$ [NC]

$e^{rt} \rightarrow$ [CC]

2) Vp as on today:- (Before Expiry)



$$\left[\frac{X}{(1+r)^n \,/\, e^{rt}} - S,\ 0\right]_{Max.} = Vp$$

Concept:- Expected Value of an option on Expiry:-

$X = 100$

$S = 1000$

3 mths

$S - X$

On Expiry

Exp.	Prob.
1100	.10
1200	.20
1300	.30
1400	.20
1500	.20
	1

On Expiry

$V_c \rightarrow [S - X, 0]_{max}$ $\quad V_0 \times \text{Prob.}$

$V_p = [X - S, 0]_{max.}$ $\quad V_0 \times \text{Prob}$

$V_0 \times \text{Prob}$

$V_0 \times$ Prob

$V_0 \times$ Prob

Expected Value of an option on Expiry

$\sum$ Value of option on Expiry $\times$ Prob.

$\Rightarrow$ Expected Value of an option on Expiry

Q.7A

(a) Expected MPS at the end of 4 months:

Stock Price on Expiry	Prob.	Expected MPS
120	0.05	120×0.05
140	0.20	140×0.20
160	0.50	160×0.50
180	0.10	$180 \times .10$
190	0.15	$190 \times .15$
	1	₹160.50

(b)

$X = 150$

$S = 150$

If Exercise Price prevails means:-

$$\underline{\underline{S = X}} = \underline{\underline{150}}$$

Value of Call on Expiry (V_c)

$$\Rightarrow [S - X, 0]\ \max.$$

$$= [150 - 150, 0]\ \max.$$

$$\boxed{V_c \Rightarrow 0}$$

(c) Expected Value of Call option on Expiry:-

$X = \underline{\underline{150}}$

Expected MPS = $\underline{\underline{16050}}$

$$V_c = [S - X, 0]_{max.}$$
$$= [160.50 - 150, 0]_{max.}$$
$$= 10.50$$

Value of call at Expiry.

$[S - X, 0]_{max.}$

	Prob.	Exp. Value of call on Expiry
$[120 - 150, 0]_{max.} = 0$	·05	0×0.05
$[140 - 150, 0]_{max} = 0$	·20	0×0.20
$[160 - 150, 0]_{max} = 10$	·50	$10 \times .50$
$[180 - 150, 0]_{max} = 30$	·10	$30 \times .10$
$[190 - 150, 0]_{max} = 40$	·15	$40 \times .15$

If Nothing is mentioned about Call or Put option, then always assume it to be Call option

⇒ If Position is missing i.e. Long or Short then always assume to be Long-Position.

Long Call ✓

X=150

OP=14 ✓

S=?

$[S - X, 0]max = \underline{\underline{14}}$

$[164 - 150, 0]max = \underline{\underline{14}}$

Q.7B

Value of Put on Expiry.	**Prob.**	**Exp. Value of Put option on Expiry**
$[X - S, 0]$ Max.	
$[300 - 180, 0]$ Max. $\Rightarrow 120$	$\cdot 10$	$120 \times \cdot 10$
$[300 - 260, 0]$ Max. $= 40$	$\cdot 20$	$40 \times \cdot 20$
$[300 - 280, 0]$ Max. $= 20$	$\cdot 50$	$20 \times \cdot 50$
$[300 - 320, 0]$ Max. $= 0$	$\cdot 10$	$0 \times \cdot 10$
$[300 - 400, 0]$ Max. $= 0$	$\cdot 10$	$0 \times \cdot 10$
	1	₹ 30

Concept: Most Imp. BINOMIAL MODEL

Risk Neutral Approach

One period Binomial Model

Vc/Vp as on today

Two-period Binomial Model

Delta Hedging

Vc/Vp as on today

Answer will be same under both approach.

1) **Risk-Neutral Approach :-**
/ **One-period Binomial Model**

Binomial Model

$V_c \mid V_p$ as on today.

$$CMP = 100$$

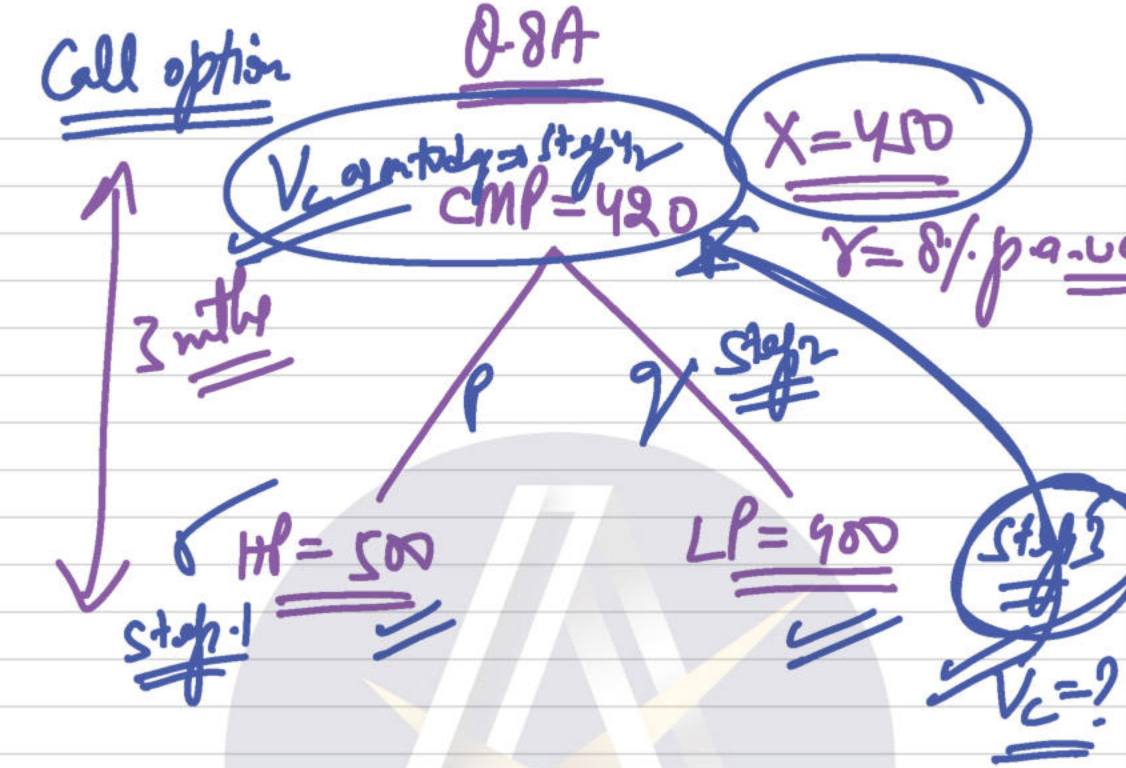
p (to High Price), q (to Low Price)

[On Expiry] High Price (HP) $\Rightarrow 150$

Low Price (LP) $= 70$

PV

$V_c \mid V_p$



Step 1: Cal. Value of Call at Expiry at HP + at LP:-

$$V_c \Rightarrow [S - X, 0]_{Max}$$

$$\text{At HP} \Rightarrow [500 - 450, 0]_{Max} \Rightarrow 50$$

$$\text{At LP} \Rightarrow [400 - 450, 0]_{Max} \Rightarrow 0$$

Step 2: (4) Cal. of Probability of HP & Prob. of LP :-

			Exp. MPS
HP	500	P	$500 \times P$
LP	400	$1-P$	$400 \times (1-P)$
		$\underline{\underline{1}}$	$\underline{\underline{500P + 400 - 400P}}$

CMP = ?

420

$$\frac{500P + 400 - 400P}{e^{.08 \times 3/12}}$$

$$420 = \frac{500P + 400 - 400P}{e^{.02}}$$

$$420\, e^{.02} = P(500-400)+400$$

$$\boxed{P \Rightarrow \frac{420\, e^{.02} - 400}{500-400}}$$

$$\boxed{\text{Prob. of HP} \Rightarrow \frac{CMP\, e^{rt} / (1+r)^n - LP}{HP - LP}}$$ ✓

$$P \Rightarrow \frac{420 \times 1.0202 - 400}{500-400}$$

Prob of HP ⇒ $\underline{\underline{0.2848}}$

Prob of LP = $1 - 0.2848 \Rightarrow \underline{\underline{0.7152}}$

Step 3: Cal. Expected Value of Call on Expiry.

V_c on Expiry	Prob.	Exp. V_c at Expiry
At HP = 50	.2848	$50 \times .2848$
At LP = 0	.7152	$0 \times .7152$
		14.24 ✓

Step 4:- Cal. Expected Value of Call as on today

$$\frac{14.24}{e^{rt}}$$

$$\Rightarrow \frac{14.24}{e^{.08 \times 3/12}} = \frac{14.24}{1.0202}$$

V_C as on today $\Rightarrow$ ₹ $\underline{\underline{13.96}}$ ✓

Derivatives – Options

Q.80 Nov. 2017

AOP = 1010/10gm

CMP = 26000/10gm

X = 26000/10gm

r = 12% p.a.

3 mth

HP = 27300

LP = 24700

Step 1. Cal. Value of call at Expiry at HP & At LP:-

$$V_c = [S - X, 0]\ \text{max.}$$

At HP: $[27300 - 26000, 0]\ \text{max} \Rightarrow 1300$

At LP: $[24700 - 26000, 0]\ \text{max} \Rightarrow 0$

Step 2: Cal. Prob. of HP & LP:-

$$\text{Prob. of HP} \Rightarrow \frac{CMP(1+r)^n - LP}{HP - LP}$$

$$\Rightarrow \frac{26000(1+.12\times 3/12) - 24700}{27300 - 24700}$$

$$\Rightarrow \frac{26780 - 24700}{2600}$$

$$\boxed{\text{Prob. of HP} \Rightarrow 0.80}$$

$$\text{Prob. of LP} = 1 - 0.80 = 0.20$$

Step 3: Cal. Expected Value of Call on Expiry:

V_c	Prob.	Exp. Value of Call at Expiry

At HP	1300	.80	$1300 \times .80$
At LP	0	.20	$0 \times .20$
		1	1040

Step 4:- Expected Value of Call as on today:

3mths

$$\frac{1040}{(1+r)^n}$$

$$V_c \text{ as on today} = \frac{1040}{\left(1 + .12 \times \frac{3}{12}\right)}$$

$$V_c \text{ as on today} \Rightarrow 1010$$

Investment Action: -

FOP = 1010 ⟶ AOP = 1010

(Valuation) Correctly Valued

The current option premium is justified

Concept: Investment Action in Options MKT:

or

Concept of over-Valued & Under-Value

1) Call option:-

As per our Valuation

FOP $\Longrightarrow$ AOP

(Fair option Premium) Actual OP

1) Simple Val. Rules
2) Binomial Model
3) RNM
4) PCPT

$\boxed{\text{Exchange}}$

Case I Call option

FOP = 50 → AOP = 30

Under-Valued

right → Buy

Long Call

Case II:

FOP = 50 → AOP = 80

Over-valued

(right → sell)

Short Call

PUT OPTION:-

Case I:

FOP = 100 → AOP = 60

Under-valued

right → Buy.

$\boxed{\text{Long Put}}$

CM II

FOP = 100 → AOP = 140

over-valued

right → Sell

$\boxed{\text{Short Put}}$

Concept: Relationship between:-

V_c & UA price / Stock Price

$$\boxed{V_c \rightarrow UA / S} = ?$$

$$\downarrow\uparrow\; S - X \rightarrow \text{Fix} = V_c \uparrow\downarrow$$

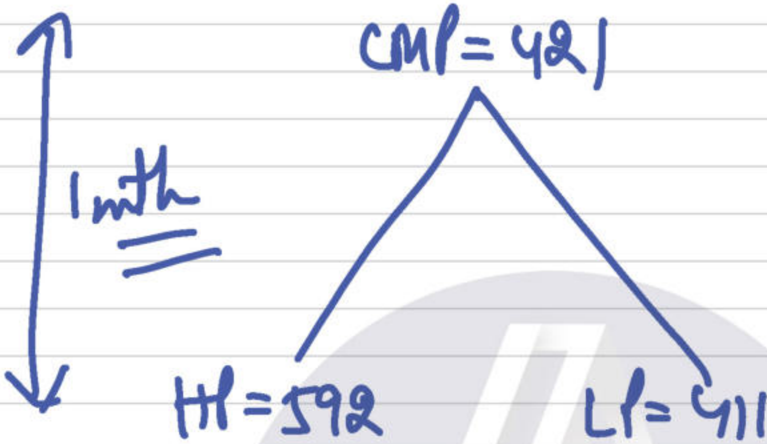
⇒ There is a direct relationship between Stock Price / UA Price & V_c.

⇒ V_p & UA Price / Stock Price:-

$$\underset{\text{Fix}}{X} - S \downarrow\uparrow = V_p \uparrow \quad V_p \downarrow$$

⇒ There is an inverse relationship between V_p & UA Price / Stock Price.

Q.8C (May 2012)



$X = 522$

$r = 3.6\%$ p.m. C.C

Sol^n Prob. of HP $\Rightarrow \dfrac{CMP\,e^{rt} - LP}{HP - LP}$

$$\Rightarrow \frac{421 \times e^{.036} - 411}{592 - 411}$$

$$\Rightarrow \frac{421 \times 1.037 - 411}{181}$$

$$\Rightarrow \frac{25.577}{181}$$

Prob. of High Price ⇒ 14.13%

Prob. of LP ⇒ 100 − 14.13 ⇒ 85.87%

Advice:- The Prob. of Attaining High Price is 14.13% only.

It is not prudent to take the Long Call better to take Long Put as the Prob. of attaining Low Price is 85.87%.

Q.8D (RTP)

OP = 15

Call option

SR = 60

X = 55

1 year

p

$q = 1 - p$

30% ↓

$r = 12\%$ p.a.

HP = ?

LP = 42

Step 1:- Cal. Value of call at HP & LP on Expiry:-

$$V_c \Rightarrow [S - X, 0]^{max.}$$

$$\text{At HP} = [HP - 55, 0]^{max} \Rightarrow HP - 55$$

$$\text{At LP} \Rightarrow [42 - 55, 0]^{max} \Rightarrow 0$$

Step 2:- Cal. Prob. of HP & LP:-

			Exp. MPS
At HP		p	$HP \times p$
At LP=42		$1-p$	$42(1-p)$

$$\Sigma = HP \times p + 42(1-p)$$

CMP = 60 $\qquad\qquad$ $\dfrac{HP \times p + 42(1-p)}{e^{.12 \times 1}}$

$$60 \Rightarrow \frac{HP \times p + 42 - 42p}{e^{.12}}$$

$$60 \times e^{.12} \Rightarrow p(HP - 42) + 42$$

Prob. of HP (p) $\Rightarrow \dfrac{60 \times e^{.12} - 42}{HP - 42}$

$$P \Rightarrow \frac{60 \times 1.1275 - 42}{HP - 42}$$

$$\boxed{P = \frac{25.65}{HP - 42}} \text{ — (i)}$$

Step 3:- Cal. Exp. Value of Call at Expiry.

Vc at Exp.	Prob.	Exp. Value of Call at Expiry
HP − 55	P	P(HP − 55)
0	1 − P	(1 − P)0
		P(HP − 55)

Step 4 Cal. Exp. Value of Call as on

today:-

OP = 15 $\qquad \frac{P(HP-55)}{e^{rt}}$

$$15 = \frac{P(HP-55)}{e^{.12\times 1}}$$

$$\Rightarrow 15\times e^{.12} = P(HP-55)$$

$$\Rightarrow 15\times 1.1275 = P(HP-55)$$

$$\Rightarrow \boxed{P \Rightarrow \frac{16.9125}{HP-55}} \text{ --- (ii)}$$

Equate both equations (i) & (ii)

$$\frac{16.9125}{Hl - 55} = \frac{25.65}{Hl - 42}$$

$$\Rightarrow 16.9125\,Hl - 710.325 = \underset{\substack{(-)\\1410.75}}{25.65\,Hl}$$

$$\Rightarrow 8.7375\,Hl = 700.425$$

$$\boxed{Hl \Rightarrow 80.16}$$

Put in eq. (ii)

$$\text{Prob. of } Hl = \frac{16.9125}{80.16 - 55}$$

$$\Rightarrow \underline{0.6722}$$

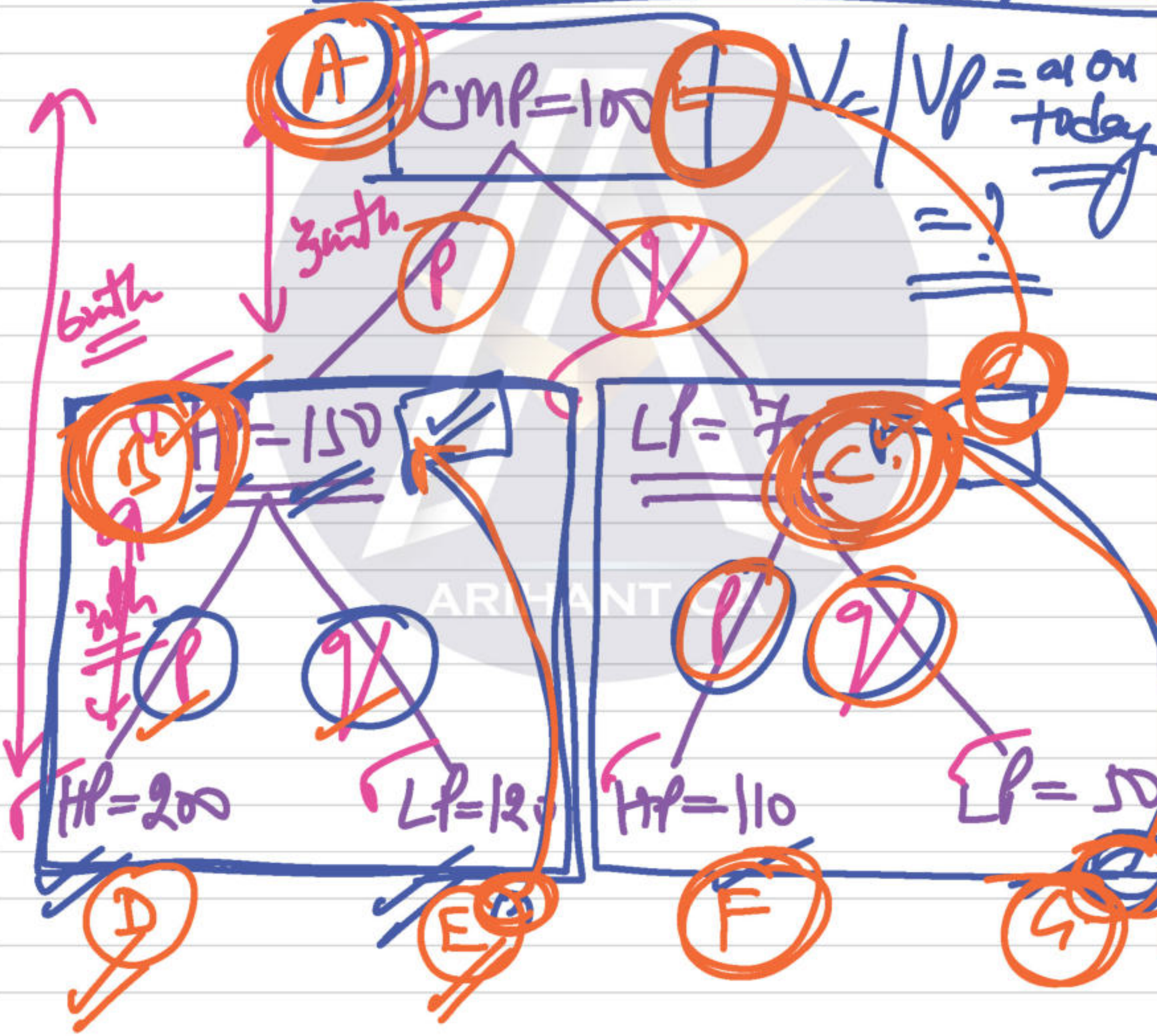
$$\%\text{ rise in Price} \Rightarrow \frac{80.16 - 60}{60} \times 100$$

$$\Rightarrow 33.60\%$$

Concept: Two Period Binomial Model:-

or Binomial Tree Approach

or Backward Induction Technique:-



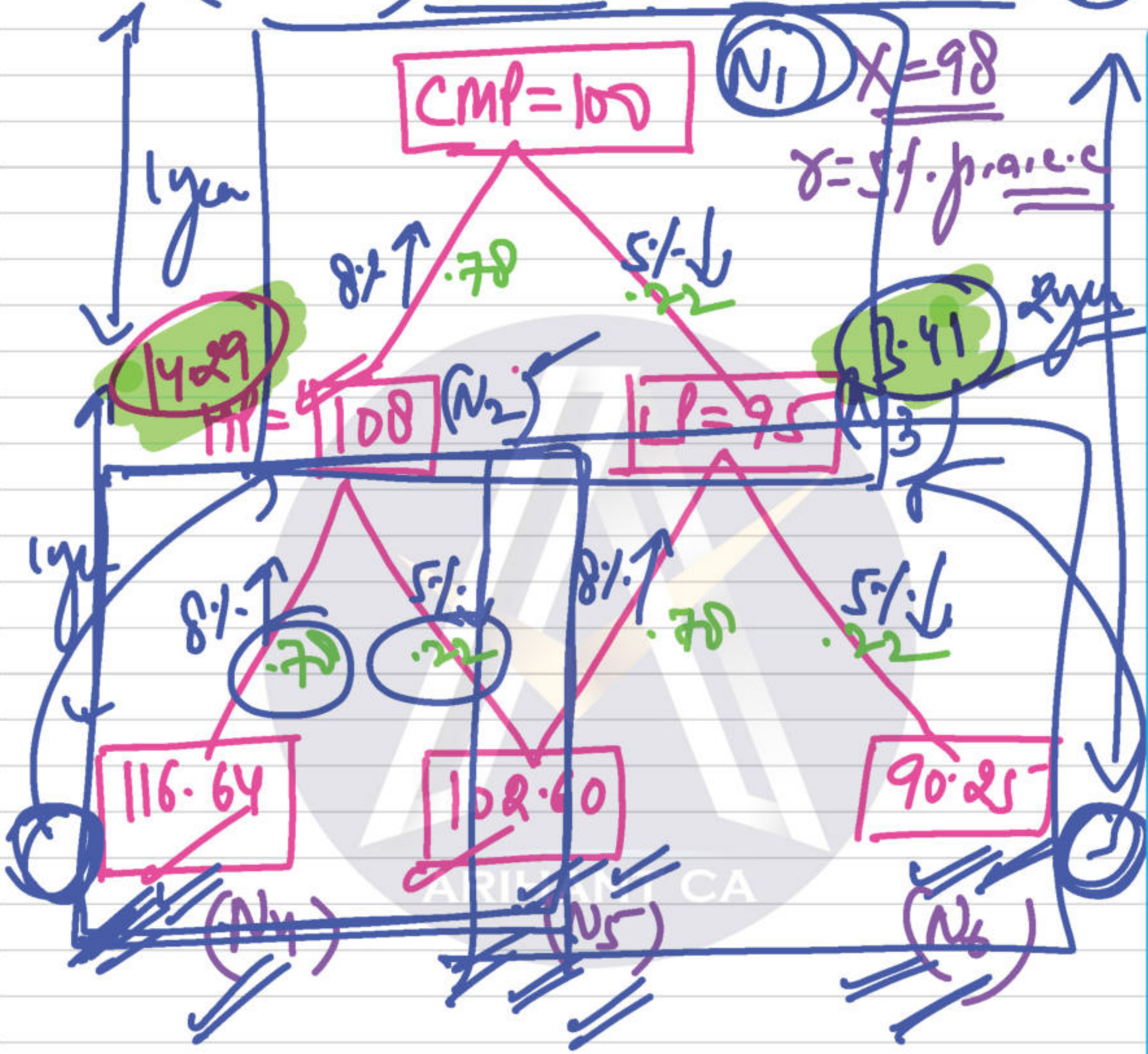
Note: For American options

We can exercise at anytime on or before expiry.

Value of option = Max. [IV, CV]

No such cross checking is required for European option.

(Nov 2020) Q.9c (American option) ans



1) Cal. of Prob. of HP & LP :-

CMP = 100

8% ↑   5% ↓   1 year

HP = 108   LP = 95

$$\text{Prob. of HP} = \frac{CMP\,e^{rt} - LP}{HP - LP}$$

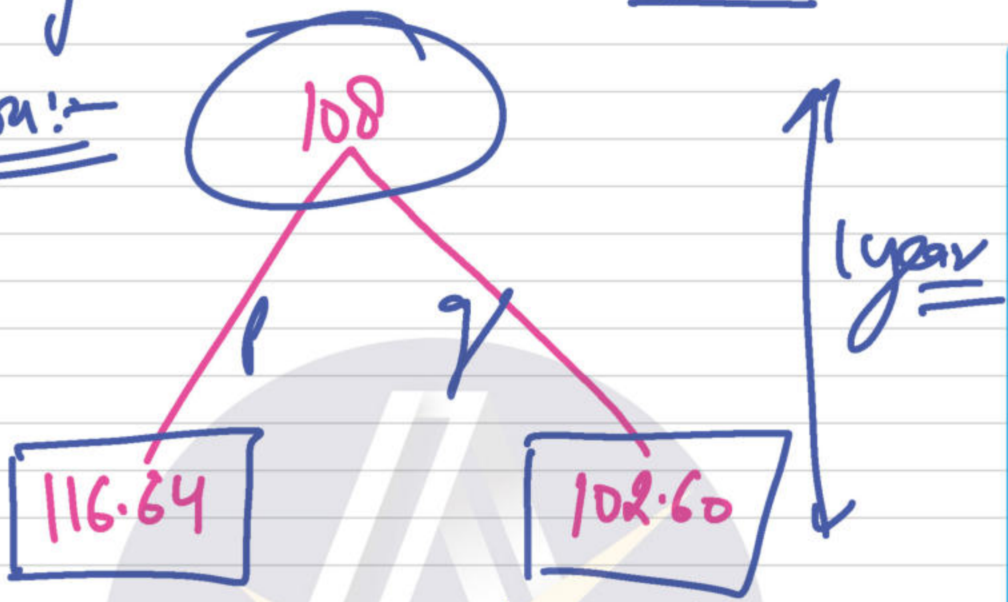
$$\Rightarrow \frac{100 \times e^{.05 \times 1} - 95}{108 - 95}$$

$$\text{Prob. of HP} \Rightarrow \frac{100 \times 1.05127 - 95}{13}$$

$$\Rightarrow \underline{\underline{0.78}}\ \checkmark$$

Prob. of LP $\Rightarrow 1 - .78 = \underline{\underline{0.22}}$

Extra:-



$$\text{Prob. of HP} = \frac{\text{CMP}\,e^{rt} - LP}{HP - LP}$$

$$\Rightarrow \frac{108 \times e^{.05 \times 1} - 102.60}{116.64 - 102.60}$$

$$\Rightarrow \frac{108 \times 1.05127 - 102.60}{14.04}$$

Prob. of HP. $\Rightarrow 0.78$

Prob. of LP = 0.22] Hence Proved

2) At Node N_4, N_5 & N_6 :-

V_c at Expiry = $[S - X, 0]$ Max.

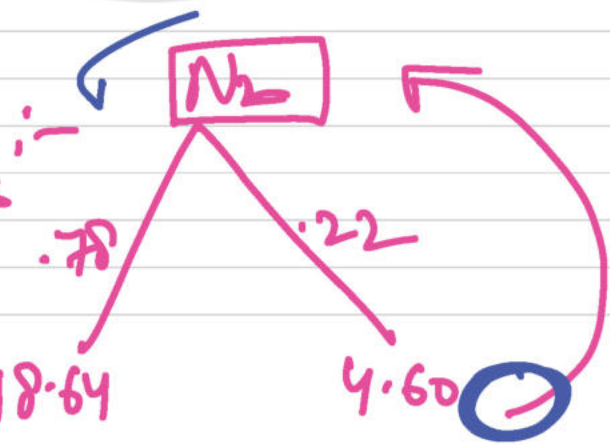
N_4 $(116.64 - 98, 0]$ Max $\Rightarrow$ 18.64

N_5 $[102.60 - 98, 0]$ Max. $\Rightarrow$ 4.60

N_6 $[90.25 - 98, 0]$ Max $\Rightarrow$ 0

$[CV, IV]$ Max.

At Node (N_2) :-



$$\Rightarrow \frac{18.64 \times .78 + 4.60 \times .22}{e^{.05 \times 1}}$$

$$\Rightarrow \frac{15.5512}{1.05127} \Rightarrow \underline{\underline{14.79}} \; \underline{\underline{(N_2)}}$$

<u>For American option:-</u>

$[CV, IV]$ max.

$CV = 14.79$ (Calculated Value)

$IV \Rightarrow [S - X, 0]$ max.

$\Rightarrow [108 - 98, 0]$ Max $\Rightarrow \underline{\underline{10}}$

$[CV, IV]$ max.

N_2

$= [14.79, 10]$ max $\Rightarrow \underline{\underline{14.29}}$

For (N_3) :-

$$
\begin{array}{ccc}
 & 95 & \\
.78 \swarrow & & \searrow .22 \\
4.60 & & 0
\end{array}
$$

$$\Rightarrow \frac{4.60 \times .78 + 0 \times .22}{e^{.05 \times 1}}$$

$$\boxed{N_3} \Rightarrow \frac{3.588}{1.05127} \Rightarrow \underline{\underline{3.41}}$$

For American option:-

$$\underline{\underline{CV = 3.41}}$$

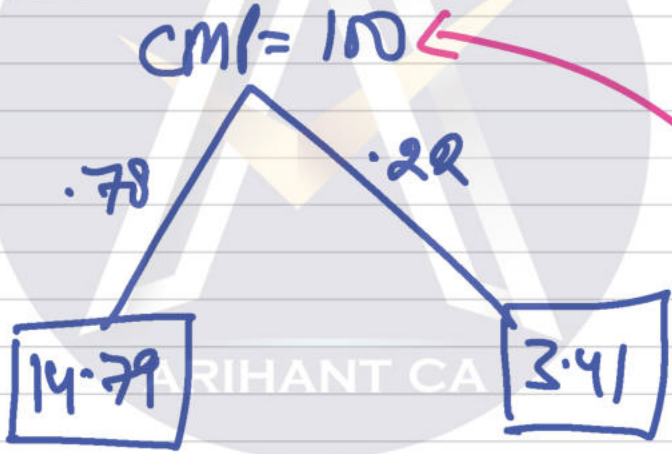
$$IV = [S - X, 0]\ \text{max.}$$

$$\rightarrow [95-98, 0]_{max} \Rightarrow \underline{\underline{0}}$$

$$N_3 = [CV, IV]_{max.}$$

$$= [3.41, 0]_{max} = \underline{\underline{3.41}}$$

For (N_1):-



$$N_1 \Rightarrow \frac{14.79 \times .78 + 3.41 \times .22}{e^{.05 \times 1} = 1.05127}$$

$$\boxed{N_1 \Rightarrow 11.69}$$

<u>For American option:-</u>

$$[CV, IV]\max.$$

$$CV = 11.69$$

$$IV \Rightarrow [S-X, 0]\max.$$

$$= [100-98, 0]\max$$

$$\rightarrow 2$$

$$N_1 = [11.69, 2]\max.$$

$$\boxed{N_1 = 11.69}$$

Concept: Put Call Parity Theory:-

(PCPT)

⇓

Equality

Put = Call

⇓

$\boxed{\text{Portfolio Value}} = \boxed{\text{Portfolio Value}}$

⇓

GP → $\boxed{\text{Pay-off}} = \boxed{\text{Pay-off}}$

⇓ ⇓

PCPT:-

$\boxed{\text{Protective Put}} = \boxed{\text{Fiduciary Call}}$

1) Protective Put:-

S (Buy) + Buy a Put option

Portfolio $\boxed{S^+ + P^+}$ → Long Put

↑ Profit + Not Exercise

↓ Loss + Exercise
$X - S$ ↓

Hedging Strategy

Cal. of Pay-off :- $S \uparrow\uparrow$

Case I: If $S > X$ [On Maturity]

⇒ Put option will be lapse ⇒ 0
(Not Exercise)

⇒ Sell stock in the Mkt. ⇒ S

Total Pay-off → S →

Case II: $S \Downarrow$ if $S < X$ [On Maturity]

Put option will be exercised (Pay-off) $\quad X - \cancel{S}$

Sell the stock in the MKT $\quad \cancel{S}$

Total Pay-off $\rightarrow X$

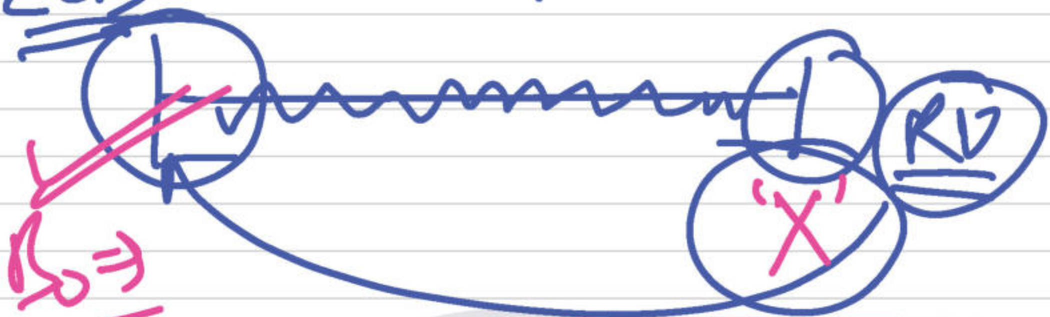
Case I:

$\boxed{\Uparrow \quad S}$ $\quad$ $\boxed{\Downarrow \quad \text{'}X\text{'}}$

2) Fiduciary Call:-

C^{+} + Buy a ZCB which will pay 'X' amount on maturity which is equal to Exercise Price

ZCB



$$\boxed{C^{+} + \frac{'X'}{e^{rt} / (1+r)^{n}}}$$

or Long call + PV of ZCB (X)

Cal. of Pay-off:- $S \uparrow$

Case I: If $S > X$ [on Maturity]

Call will be Exercised $\quad S - \cancel{X}$

Sell Bond in the Mkt. $\quad \cancel{X}$

S↑ Total Pay-off - S

Case II :- If $S < X$ [on Maturity]

S ⇓.

Call will be lapse (Pay-off) = 0

Sell Bond in Mkt = X

Total Pay-off X

Conx:

$\boxed{\text{Protective Put} = \text{Fiduciary Call}}$

⇓

Pay-off = Pay-off

↑ S = S

$$X = X$$

Hence Proved

$$\boxed{C + \frac{X}{e^{rt}} = P + S}$$

Application:

To Calculate the missing value.

Q.10

$t = 6$ mths $\quad r = 3\%$ p.a. $\quad X = ₹10$

As per PCPT :-

$$\boxed{C + \frac{X}{(1+r)^n} = P + S}$$

(i) $P = 2 \quad S = 9 \quad C = ? \quad X = 10$

$$C + \frac{10}{\left(1 + .03 \times \frac{6}{12}\right)} = 2 + 9$$

$$C + 9.85 = 2 + 9$$

$$\boxed{C \Rightarrow 1.15}$$

(ii) $P = 1 \quad C = 4 \quad S = ?$

$$4 + 9.85 = 1 + S$$

$$\boxed{S \Rightarrow 12.85}$$

(iii) $C = 5 \quad S = 12 \quad P = ?$

$$5 + 9.85 = P + 12$$

$$\boxed{P = 2.85}$$

Q. 1 I MTP April 24

⇒ Instead of Selling the stock of RIL, Ram must cover the risk by Buying the Put option i.e. buy Put @ X ⇒ 1000 − 5% = 950 since Risk appetite is 5%.

The Most Valuable price is X = 950 & paid ₹8 as a option Premium.

Protective Put

S ↑ + buy Put (X = 950)

↓ Loss ↓ Profit

Concept:- Option Strategies:- (Defined)

[Combination of Call & Put option]

Long Call	Short Call
Long Put	Short Put

1) Straddle
2) Strangle
3) Strip
4) Strap
5) Butterfly Spread

1) Straddle Position:-

Straddle

Long Straddle

Buy 1 Call

&

Buy 1 Put

1 : 1

i.e. 1 Long Call + 1 Long Put

Short Straddle

Sell 1 Call

&

Sell 1 Put

$\boxed{1 : 1}$

i.e. 1 Short Call

+

1 Short Put

for the same UA / same expiry / same Exercise price

for the same UA / same expiry / same Exercise Price

2) Strangle Strategy :-

fluctuating.

Long Strangle

1 : 1

Buy 1 Call + Buy 1 Put

for same UA

for same Expiry.

Short Strangle

1 : 1

Sell 1 Call + Sell 1 Put

for same UA

same expiry

but for different exercise price.

but different strike price

Strip (Bear)

2 Put +
1 Call +

Profit → High
Losses → limited

Strap (Bull)

2 Call +
1 Put +

Profit
Losses limited

5) Butterfly Spread:-

Nifty

Range Bound

24500 — Lowest

25500 — Highest

Strategy

Buy 1 Call at High 'X' Price 25500

Buy 1 Call at Low 'X' Price 24500

Sell 2 Call at Avg. of Both

X = 25000

$\frac{25500 + 24500}{2} = 25000$

$\boxed{1:1:2}$

Derivatives - Options

Concept: Binomial Model

Delta-Neutral Strategy

Delta-Hedging | Perfect Hedging.

Replicating Portfolio Strategy

Dynamic Hedging.

Binomial Model

⇓

Risk-Neutral Approach

⇓

Value of Call | Put option as on today

Delta Hedging.

⇓

Value of Call as on today.

Buyer side

⇓

Long position side

Seller side

(Short call side)

⇓

Back Calculation

CMP = 100

$\boxed{HP = 150}$ $\boxed{LP = 70}$

Answer will be same under both approach.

Strategy:

(1B)

Long call (OP Paid)

Short call (Unlimited Risk)

Or Received

⇓

Seller Side

⇓

V_c as on today.

⇓

Using Delta 'Δ'

Perfect Hedging Strategy

Strategy as on today:-

Option Mkt.	Cash Mkt.	Net Amt
Short Call	"Buy"	"Borrow"
i.e. obligation to sell '1x'	'Δ' No. of equity shares	

⇓

OP Received

⇓

Hedge Ratio

⇓

Buy at CMP

⇓

Perfect Hedging Strategy

Net Amt. Borrowed 'B' ⇒ ?

⇒ Δ No. of eq. shares ~~×~~ CMP − "OP Received"

⇓ ?

⇓

Back Cal. (Bal fig.)

(Missing Value)

⇓

Vc as on today.

⇒ Calculation of Delta :- ('Δ')

⇓

Hedge Ratio

Relationship between V_c & Stock Price :-

$\downarrow \uparrow S - X \rightarrow fix = V_c \uparrow \downarrow$

'Δ'

There is a direct relationship between the V_c & Stock Price.

$$\boxed{\text{'}\Delta\text{'} \Rightarrow \frac{\text{Change in Option Premium} \mid V_c}{\text{Change in Underlying Asset Price}}}$$

'Δ' of call ⇒ +ve (Positive)

$$\Delta = \frac{V_c \text{ at HP} - V_c \text{ at LP}}{HP - LP}$$

Example. V.V. Imp.

6 mths

CMP = 100

X = 90

r = 10% p.a.c.c

HP = 150

LP = 70

Step 1. Cal. V_c at HP & at LP on Expiry:

$$V_c = [S - X, 0]_{max}$$

$$\text{At HP} = [150 - 90, 0]_{max} = 60$$

$$\text{At LP} \Rightarrow [70 - 90, 0]_{max} = 0$$

Step 2: Cal. of Delta 'Δ' or Hedge Ratio:-

$$'\Delta' \Rightarrow \frac{\text{change in OP}}{\text{change in UA}}$$

OR

$$\boxed{'\Delta' = \frac{V_c \text{ at HP} - V_c \text{ at LP}}{\text{HP} - \text{LP}}}$$

$$'\Delta' \Rightarrow \frac{60 - 0}{150 - 70} \Rightarrow 0.75$$

Interpretation of 'Δ' = 0.75:-

1) One call is equivalent to 0.75 Shares

2) If Stock Price will go up by ₹ 1

than Call Premium is expected to rise by ₹0.75.

Step 3:- Construct a Delta Hedge Portfolio / Perfect Hedge Portfolio | Risk-less Portfolio

Option Mkt.	Cash Mkt.	Net Amt
Short Call i.e. obligation to sell ⇓ OP. Received	Buy. 'Δ' No. of eq. sha @ CMP	(Borrow)

Net Borrowed Amt. ⇒ 'Δ' × CMP — OP Received

(given)

(B) ! ? ?

(Bul. ff.)

(Vc as on today)

(Seller Side)

Step 4: Cal. of Borrowed Amt. as on today:-

Borrowed Amt. as on today

PV

Borrowed Amt. on Expiry

HP LP

Borrowed Amt. at Expiry.

At HP:- HP = 150

$B \Rightarrow \Delta \times HP - O$ at Expiry.

$\Rightarrow .75 \times 150 - 60$

$\Rightarrow \underline{\underline{52.5}}$

At LP: $B = \Delta \times LP - OP$ at Expiry

$= 0.75 \times 70 - 0$

$\Rightarrow \underline{\underline{52.5}}$

Borrowed Amt. as on today:-

$B = \dfrac{52.50}{e^{.10 \times \frac{6}{12}}}$

$B_0 \Rightarrow \dfrac{52.50}{e^{.05}} \Rightarrow \dfrac{52.50}{1.0513}$

$\Rightarrow ₹\ \underline{\underline{49.94}}$

Step 5: Cal. Value of Call as on today:-

$$B_0 = \Delta \times CMP - O/ \text{Received } (V_{c_0})$$

$$49.94 = 0.75 \times 100 - O/ V_c$$

$$V_c \text{ as on today} = \underline{\underline{₹\,25.06}}$$

Q.11B (Nov. 2019) 2-3 times

3 mths

CMP = 500 X = 550

r = 5% for 3 mths

.70 .30

HP = 650 LP = 450

Solⁿ Step 1:- Cal. Value of Call at Expiry at HP & at LP:-

$$[S - X, 0]\ \text{Max}.$$

At HP ⇒ $[650 - 550, 0]$ Max ⇒ 100

At LP ⇒ $[450 - 550, 0]$ Max ⇒ 0

2) Cal. Delta / Hedge Ratio:

$$'\Delta' \Rightarrow \frac{V_c \text{ at } HP - V_c \text{ at } LP}{HP - LP}$$

$$'\Delta' \Rightarrow \frac{100 - 0}{650 - 450} \Rightarrow 0.50$$

(i) Investor should sell one Call & Buy 0.50 Shares for perfect hedging.

Option Mkt.	Cash Mkt.	Net Amt.
Short Call ⇓ OP Rec.	Buy 'Δ' = 0.50 No. of eq. share @ CMP = 500	Borrowed

$$'B' = '\Delta' \times CMP - OP \text{ Rec.} = ?$$

V_{co}

W.N.: Cal. of Borrowed Amt. as on today

$B_0 = ?$ PV

At LP $B = \Delta \times LP - OP$

$= 0.50 \times 450 - 0$

$\Rightarrow 225$

$$B_0 \Rightarrow \frac{225}{(1+.05)} \Rightarrow ₹\,214.29$$

Value of call as on today:-

$$B = \Delta \times CMP - OP/V_c$$

$$214.29 = 0.50 \times 500 - V_c/OP$$

$$V_c \Rightarrow 35.71$$

(ii) Investor will be able to maintain his position if he purchase 0.50 shares for 1 call option:-

CMP = 550

650 | 450

(1) If Price on Expiry goes up 650:-

Call Buyer will exercise against us:-

$S - X > 0$

$650 - 550 > 0$ $\quad -100$

Pay-off ⇒ (Loss on Short Call)

Sell share in the MKt:- ⇒ +325

650 × ·50

Cash flow position after 3 mths ⇒ +225

(b) If Price on Expiry falls to ₹450:-

Call option will be lapse NIL

Sell stock in the MKt. +225

450 × ·50

Cash flow position after 3 mths +225

(iii) Value of Call as on today = 35·71

(CW. No. 2)

(iv) Cal. of Expected Return:-

$V_c = 35.71$

Expected V_c at Expiry

	V_c	P	Exp. Value at Expiry
At HP	100	.70	100 × .70
At LP	0	.30	0 × .30
		1	70

% Return

35.71 —— 3 mths —— 70

$$\Rightarrow \frac{70 - 35.71}{35.71} \times 100$$

$$\Rightarrow 96.02\% \text{ for } \underline{\underline{3 \text{ mths}}}$$

<u>% Return p.a.:-</u>

$$\frac{96.02\%}{3} \times 12 \Rightarrow 384.08\% \ \underline{\underline{\text{p.a.}}}$$

Q.11c (Nov. 2022) (8 marks)

3 mths

CMP = 420

HP = 525 LP = 378

$X = 450$

$r = 8\%$ p.a.c.c

$e^{.02} = 1.0202$

1) Risk Neutral Approach:-

Step 1:- Cal. of Value of Call at Expiry at HP & LP:-

$V_c = [S - X, 0]$ Max.

At HP $\Rightarrow [525 - 450, 0]$ Max $= 75$

At LP $\Rightarrow [378 - 450, 0]$ Max $= 0$

Step 2:- Cal. of Prob. of HP & LP:-

			Exp. MPS
HP	525	P	$525 \times P$
LP	378	$1-P$	$378(1-P)$
			$525P + 378 - 378P$

CMP = 420

$$\frac{P(525-378)+378}{e^{rt}}$$

OR

$$\text{Prob. of HP} = \frac{CMP\,e^{rt} - LP}{HP - LP}$$

$$\Rightarrow \frac{420 \times e^{.02} - 378}{525 - 378}$$

$$\Rightarrow \frac{420 \times 1.0202 - 378}{147}$$

Prob. of HP $\Rightarrow$ 0.3434

Prob. of LP $\Rightarrow$ 0.6566

Step 3:- Cal. Exp. Value of Call at Expiry:-

	Vc	Prob.	Exp. Value at Expiry
At HP	75	.3434	75 × .3434
At LP	0	.6566	0 × .6566
		1	25.755

Step 4. Cal. of Exp. Value of Call as on today:-

$$\underline{\underline{V_c = ?}} \qquad \frac{25.755}{e^{.02}}$$

$$V_{c_0} \Rightarrow \frac{25.755}{1.0202} \Rightarrow \underline{\underline{25.24}}$$

2) Binomial Model / Delta-Neutral:-

Step 1: V_c at Expiry

At HP = 75

At LP = 0

Step 2: Cal. 'Δ'

$$\Delta \Rightarrow \frac{V_c \text{ at HP} - V_c \text{ at LP}}{HP - LP}$$

$$\Rightarrow \frac{75-0}{525-378} \Rightarrow \frac{75}{147}$$

$$\boxed{\Delta \Rightarrow 0.51}$$

1 Call is equivalent to 0.51 Share

Step 3:- Construct Delta Hedge Portfolio:

Option Mkt	Cash Mkt	Net Amt
Short Call i.e. Obligation to sell OP Rec.	Buy Δ No. of eq. Share at CMP	Borrowed

$$? \Rightarrow \underset{?}{\Delta} \times \underset{\text{given}}{CMP} - \underset{\text{(Mkt. fig.)}}{OP\ Received}$$

Step 4: Cal. of Borrowed Amt. as on today:-

At LP

$$B = \Delta \times LP - OP$$

$$\Rightarrow 0.51 \times 378 - 0$$

$$\Rightarrow \underline{\underline{192.78}}$$

$$B_0 \Rightarrow \frac{192.78}{1.0202} \Rightarrow \underline{\underline{188.96}}$$

Step 5: Cal. V_c as on today:-

$$B = \Delta \times CMP - V_c/OP$$

$$188.96 = 0.51 \times 420 - V_c/OP$$

$V_c | OP$ ₹ $\underline{\underline{25.24}}$

Yes, the Value of Call under both methods will be same.

Concept:- BSM [Black-Scholes Model]

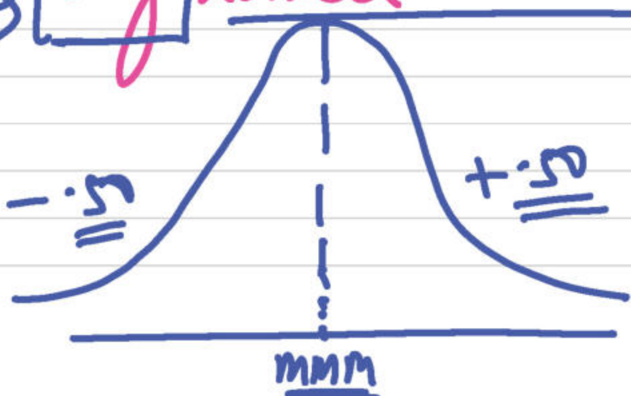
(1976)

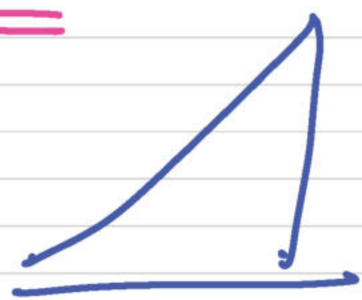
⇒ As the number of period in the Binomial Model tends towards infinity in such situation when prices are changing on real time basis, Use **BSM**

⇒ **Assumptions:-** [3-4 Marks] V.Imp. (2 times)

1) The Price of the UA follows a

⇒ $\boxed{\text{log}}$ normal distribution.





2) Markets are frictionless:-

i.e. there is no taxes, no transaction cost, no restriction on short sell or use of short-sell proceeds.

3) The options valued are European options.

4) Risk-free continuous compounded [CC] interest rate is known and constant.

5) Annualized S.D (σ) / Volatility of stock is known & constant.

6) The Underlying Asset has no cashflows such as Dividends.

Valuation:-

V_c / V_p as on today?

1) Value of Call as on today using BSM

$$V_c \Rightarrow S\,N(d_1) - \frac{X}{e^{rt}}\,N(d_2)$$

Now, we need to incorporate the probability terms

$\Delta \rightarrow N(d_1)$ .60

Prob. of Prices goes-up

$N(d_2)$ .70

Probability of Call option being exercised

$\Downarrow$

$S > X$

.40 $\Downarrow$

$1 - N(d_1)$

Prob. of Price will going down

$1 - N(d_2)$ · 30

Prob. of Put option being Exercised

i.e. $S < X$

Note: Where $N(d_1)$ / Δ', it refers to the Δ' of the call option

$N(d_2)$ It is the prob. that call option will be exercised on Expiry.

i.e. Prob. of $S > X$

How to Cal.

$$V_c = S\,N(d_1) - \frac{X}{e^{rt}} N(d_2)$$

$$d_1 \Rightarrow \frac{\ln\left[\frac{S}{X}\right] + (r + .50^{-2})t}{\sigma\sqrt{t}}$$

$$d_2 = d_1 - \sigma\sqrt{t}$$

Note! Cal. of $N(d_1)$ & $N(d_2)$:—
(From Table)

Ex 1 $N(0.72) \Rightarrow .7642$ $.2358$

Ex.2 $N(1.75) \Rightarrow .9558$

Ex.3 $N(1.1575) \Rightarrow ?$ $.0075$

$1.15 \Rightarrow .8749$

$1.16 \Rightarrow .8770$

$\underline{\underline{0.01}}$ $\underline{\underline{0.0021}}$

$$1 = \frac{0.0021}{0.01} \times .0075$$

$$\Rightarrow 0.001575$$

$$N(1.1575) = 0.8749 + 0.001575$$

$$\Rightarrow \underline{\underline{0.8765}}$$

$$N(-1.1575) \Rightarrow 1 - 0.8765$$

$$\Rightarrow \underline{0.1235}$$

2) Value of Put option as on today using BSM :-

$$V_p \Rightarrow \frac{X}{e^{rt}}\left[1-N(d_2)\right] - S\left[1-N(d_1)\right]$$

$$d_1 \Rightarrow \frac{\ln\left[\frac{S}{X}\right] + \left[r + .50\,\sigma^2\right]t}{\sigma\sqrt{t}}$$

$$d_2 = d_1 - \sigma\sqrt{t}$$

Q.12B (RTP) V.V.Imp.

$S = 80 \quad X = 75 \quad \sigma = 0.40$

$r = 12\%$ p.a.c.c $\quad t = 6$ mths

Soln Value of Call option as on today using BSM:-

$$V_c = S\,N(d_1) - \frac{X}{e^{rt}} N(d_2)$$

$$d_1 = \frac{\ln\left[\frac{S}{X}\right] + [r + .50\sigma^2]t}{\sigma\sqrt{t}}$$

$$d_2 = d_1 - \sigma\sqrt{t}$$

W.N. Cal. of d_1 & d_2

$$d_1 = \frac{\ln\left[\frac{S}{X}\right] + \left[r + .50^{2}\right]t}{\sigma\sqrt{t}}$$

$$\Rightarrow \frac{\ln\left[\frac{80}{75}\right] + \left[.12 + .5 \times .40^{2}\right]\frac{6}{12}}{.40\sqrt{\frac{6}{12}}}$$

$$\Rightarrow \frac{\ln\left[1.0667\right] + 0.10}{0.2828}$$

$$d_1 \Rightarrow \frac{0.0646 + .10}{0.2828} \Rightarrow \underline{\underline{0.5820}}$$

$$d_2 = d_1 - \sigma\sqrt{t}$$

$$\Rightarrow 0.5820 - 0.2828$$

$\Rightarrow 0.2992$ ✓

W.No.2 Cal. of $N(d_1)$ & $N(d_2)$

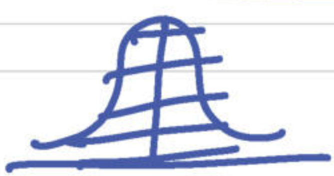
$N(d_1) = N[0.5820] \Rightarrow ?$

Note: To Cal. Cumulative Values:-

$1 -$ One-tail Value | Cumulative

0.25	1 − .4013	⇒ 0.5987
0.30	1 − .3821	⇒ 0.6179
0.55	1 − .2912	⇒ 0.7088
0.60	1 − .2743	⇒ 0.7257

Extra Point:



If two-tail values are given:-

$\cdot 25 \Rightarrow \left[\underline{\underline{\cdot 4013 \times 2}}\right] \Rightarrow \left[\frac{\cdot 8026}{2}\right]$

Two-tail Value

$\Rightarrow \underline{\underline{0 \cdot 8026}}$

$\Rightarrow \underline{\underline{\cdot 4013}}$

One-tail

Cumulative

$1 - \cdot 4013 \Rightarrow \cdot 5987$

Cal. $N(d_1) = N(0.5820)$

$\cdot 0320$

$0.55 = \cdot 7088$

$0.60 = \cdot 7257$

$0.05 \qquad 0.0169$

$$1 = \frac{0.0169}{0.05} \times 0.0320$$

$$\Rightarrow \underline{\underline{0.0108}}$$

$$N(0.5820) \Rightarrow 0.7088 + 0.0108$$

$$\Rightarrow \underline{\underline{0.7196}}$$

$$N(d_2) = N(0.2992) = 0.0492$$

$$.25 \Rightarrow .5987$$

$$.30 \Rightarrow .6179$$

$$\overline{.05} \qquad \overline{0.0192}$$

$$1 \Rightarrow \frac{0.0192}{0.05} \times 0.0492$$

$$\Rightarrow \underline{\underline{0.0189}}$$

$N(d_2) \Rightarrow 0.5987 + 0.0189$

$\Rightarrow \underline{\underline{0.6176}}$

Final Answer:-

$$V_c \Rightarrow S\,N(d_1) - \frac{X}{e^{rt}} N(d_2)$$

$$\Rightarrow 80 \times 0.7196 - \frac{75}{e^{.12 \times \frac{6}{12}}} \times .6176$$

$e^{.12 \times \frac{6}{12}} \rightarrow 1.062$

$$\Rightarrow 57.568 - 43.62$$

$$V_{c_0} \Rightarrow \underline{\underline{13.95}}$$

Extra Part:

$$V_p \Rightarrow \frac{X}{e^{rt}}\left[1 - N(d_2)\right] - S\left[1 - N(d_1)\right]$$

$$\Rightarrow \frac{75}{1.062}[1-.6176] - 80[1-.7196]$$

$$V_p \Rightarrow 27.01 - 22.43$$

$$\Rightarrow 4.58$$

OR

$V_p \rightarrow$ using PCPT

$$C + \frac{X}{e^{rt}} = P + S$$

$$13.95 + \frac{75}{1.062} = P + 80$$

$$84.57 = P + 80$$

$$V_p = 4.57$$

Adjustment of Dividend :- (DI)

$$[S - PV \text{ of } DI] \rightarrow \text{Ex-Dividend Price}$$

$$\boxed{V_c \Rightarrow [S - PV \text{ of } DI]\, N(d_1) - \frac{X}{e^{rt}} N(d_2)}$$

$$d_1 = \frac{\ln\left[\frac{S - PV \text{ of } DI}{X}\right] + [r + .5\sigma^2]t}{\sigma\sqrt{t}}$$

$$\boxed{d_2 \Rightarrow d_1 - \sigma\sqrt{t}}$$