

**Question – 13**

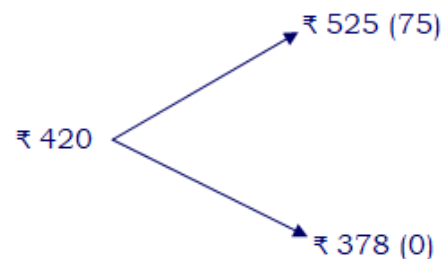
Following is the information available pertaining to shares of Omni Ltd.:

Current Market Price (₹)	₹ 420.00
Strike Price (₹)	₹ 450.00
Maximum Price (₹) expected in next 3 months' time	₹ 525.00
Minimum Price (₹) expected in next 3 months' time	₹ 378.00
Continuously Compounded Rate of Interest (p.a.) (%)	8.00%
$e^{rt}$	1.0202

From the above:

- Calculate the 3 months call option by using Binomial Method and Risk Neutral Method. Are the calculated values under both the models are same?
- State also clearly the basis of Valuation of options under these models.

(Exam Nov – 2023)

**Solution:****(i) (1) Call Option value using Binomial Model**

$$\Delta = \frac{₹ 75 - 0}{₹ 525 - ₹ 378} = 0.51$$

Delta of Call = 0.51 means write 1 call & buy 0.51 share.

$$\text{Initial Cash Outflows} = 420 \times 0.51 = 214.20$$

**Cash Flows on Maturity****If price 525**

$$\text{Sell share } (525 \times 0.51) = 267.75$$

$$\text{Call Exercise} = (75)$$

$$\text{Cash Inflows} = 192.75$$

### **If price 378**

$$\text{Sell Share } (378 \times 0.51) = 192.78$$

$$\text{Call Lapse} = 0$$

$$\text{Cash Inflows} = 192.78$$

$$\text{P.V. of payoff} = \frac{192.78}{1.0202} = 188.96$$

$$C_0 = 214.20 - 188.96 = ₹ 25.24$$

## **(2) Value of Call Option using Risk Neutral Method**

Let 'P' be the probability of Price increase, then

$$p \times 525 + (1 - p) \times 378 = 420(1.0202)$$

$$147p = 50.48$$

$$p = 0.34$$

$$\text{Probability of Price increase} = 0.34$$

$$\text{Probability of Price decrease} = 0.66$$

$$\frac{0.34 \times 75 + 0.66 \times 0}{1.0202} = ₹ 25.24$$

Yes, the value of option under both Models is same.

### **(ii) Basis of valuation of options :**

- Binomial model uses an approach called "Risk less Hedge Approach" to find the price of the option, by creating a portfolio which will have same value at expiration irrespective of any price.

Hedge means to create an equal and opposite position for protecting the value of portfolio.

- In Risk Neutral Model, valuation of options is based on arbitrage and is therefore independent of risk preferences; one should be able to value options assuming any set of risk preferences and get the same answer.

### **BLACK SCHOLES MODEL**

#### **Question – 14**

From the following data for certain stock, find the value of a call option:

Price of stock now	=	₹ 80
Exercise price	=	₹ 75
Standard deviation of continuously compounded annual return	=	0.40
Maturity period	=	6 months
Annual interest rate	=	12%

Given

Number of S.D. from Mean, (z)	Area of the left or right (one tail)
0.25	0.4013
0.30	0.3821
0.55	0.2912
0.60	0.2743

$$e^{0.12 \times 0.5} = 1.062$$

$$\ln 1.0667 = 0.0646$$

**(SM TYK – 25)**

**Solution:**

**Working Note 1:  $d_1$  &  $d_2$**

$$d_1 = \frac{\ln \frac{S_0}{E} + \left(r + \frac{(\sigma)^2}{2}\right)t}{\sigma\sqrt{t}}$$

$$d_1 = \frac{\ln \frac{80}{75} + \left(0.12 + \frac{(0.40)^2}{2}\right)0.5}{0.40\sqrt{0.5}}$$

$$d_1 = \frac{\ln 1.0667 + 0.10}{0.2828}$$

$$d_1 = \frac{0.0646 + 0.10}{0.2828} = 0.5820$$

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

$$= 0.5820 - 0.2828 = 0.2992$$

**Working Note 2: n (d<sub>1</sub>) & (d<sub>2</sub>)**

[BSM मे हमेशा Cumulative Area देखना है। But d<sub>1</sub> & d<sub>2</sub> negative दिया है तो फिर हम Tail Area देखेंगे]

**d<sub>1</sub> = 0.5820**

n(d<sub>1</sub>) =

0.55	0.2912
0.60	0.2743
0.05	0.0169

n(d<sub>1</sub>) = 0.2912 -  $\left(\frac{0.0169}{0.05} \times 0.032\right)$

n(d<sub>1</sub>) = 0.2804

n(d<sub>1</sub>) = 1 - 0.2804 = 0.7196

**d<sub>2</sub> = 0.2992**

n(d<sub>2</sub>) =

$$0.25 \qquad 0.4013$$

$$0.30 \qquad 0.3821$$

$$\underline{0.05} \qquad \underline{0.0192}$$

$$n(d_2) = 0.4013 - \left( \frac{0.0192}{0.05} \times 0.0492 \right)$$

$$n(d_2) = 0.3824$$

$$n(d_2) = 1 - 0.3824 = 0.6176$$

$$C_0 = S_0 \times n(d_1) - \frac{E}{e^{rt}} \times n(d_2)$$

$$= 80 \times 0.7196 - \frac{75}{e^{0.12 \times 0.5}} \times 0.6176$$

$$= 80 \times 0.7196 - \frac{75}{1.062} \times 0.6176$$

$$= ₹ 13.952$$

**Question – 15**

The shares of TIC Ltd. are currently priced at ₹ 415 and call option exercisable in three months' time has an exercise rate of ₹ 400. Risk free interest rate is 5% p.a. and standard deviation (volatility) of the share price is 22%. The TIC Ltd. is not going to declare any dividend over the next three months.

- (i) DECIDE whether the option worth buying for ₹ 25.
- (ii) CALCULATE the value of aforesaid call option if the current price of share is considered as ₹ 380.
- (iii) CALCULATE the value of aforesaid call option if present price of share is taken as ₹ 408 and a dividend of ₹ 10 is expected to be paid in the two months' time.

Given

$$\ln(1.0375) = 0.03681, \ln(0.95) = -0.05129 \text{ and } \ln(0.9952) = -0.00481$$

$$e^{0.0125} = 1.0126 \text{ and } e^{0.00833} = 1.0084$$

Cumulative Area of Number of S.D. from Mean (z)

<b>Z</b>	0.0150	0.1250	0.3933	0.5033	-0.2976	-0.4076
<b>Area</b>	0.5060	0.5497	0.6530	0.6926	0.3830	0.3418

(MTP Oct – 2022)

**Solution:****(1)** Current Price of share of TIC Ltd. = ₹ 415

Exercise rate = ₹ 400

Risk free interest rate is = 5% p.a.

SD (Volatility) = 22%

Based on the above bit is calculated value of an option based on Black Scholes Model:

$$d_1 = \frac{\ln\left(\frac{415}{400}\right) + \left[0.05 + \frac{1}{2}(0.22)^2\right]0.25}{0.22\sqrt{0.25}}$$

$$= \frac{0.03681 + 0.01855}{0.11} = 0.5033$$

$$d_2 = \frac{\ln\left(\frac{415}{400}\right) + \left[0.05 - \frac{1}{2}(0.22)^2\right]0.25}{0.22\sqrt{0.25}}$$

$$= \frac{0.03681 + 0.00645}{0.11} = 0.3933$$

$$V_o = V_s N(d_1) - \frac{E}{e^{rt}} N(d_2)$$

$$N(d_1) = N(0.5033) = 0.6926$$

$$N(d_2) = N(0.3933) = 0.6530$$

$$\text{Value of Option} = 415(0.6926) - \frac{400}{e^{(0.05)(0.25)}} (0.6530)$$

$$= 287.43 - \frac{400}{1.0126}(0.6530)$$

$$= 287.43 - 257.95 = ₹ 29.48$$

Since market price of ₹ 25 is less than ₹ 29.48 (Black Scholes Valuation Model) indicate that option is underpriced, hence worth buying.

**Extra Work**

**Value of Put Option:** अगर Value of Call दिया हुआ है तो Value of Put, Put Call Parity से Calculate किया जा सकता है।

**Put Call Parity:**

$$S_0 + P_0 = C_0 + P.V. \text{ of EP}$$

$$415 + P_0 = 29.48 + \frac{400}{1.0126}$$

$$P_0 = 9.50$$

**Black Scholes Model:**

$$\frac{E}{e^{rt}} \times N(-d_2) - S_0 N(-d_1)$$

$$\frac{400}{1.0126} \times 0.347 - 415 \times 0.3074$$

$$P_0 = 9.50$$

(2) If the current price is taken as ₹ 380 the computations are as follows:

$$d_1 = \frac{\ln\left(\frac{380}{400}\right) + \left[0.05 + \frac{1}{2}(0.22)^2\right]0.25}{0.22\sqrt{0.25}}$$

$$= \frac{-0.05129 + 0.01855}{0.11} = -0.2976$$

$$d_2 = \frac{\ln\left(\frac{380}{400}\right) + \left[0.05 - \frac{1}{2}(0.22)^2\right]0.25}{0.22\sqrt{0.25}}$$

$$= \frac{-0.05129 + 0.00645}{0.11} = -0.4076$$

$$N(d_1) = N(-0.2976) = 0.3830$$

$$N(d_2) = N(-0.4076) = 0.3418$$

$$\begin{aligned} \text{Value of Option} &= 380(0.3830) - \frac{400}{e^{(0.05)(0.25)}} (0.3418) \\ &= 145.54 - \frac{400}{1.0126}(0.3418) \\ &= 145.54 - 135.02 = ₹ 10.52 \end{aligned}$$

- (3)** Since dividend is expected to be paid in two months time we have to adjust the share price and then use Black Scholes model to value the option:

Present Value of Dividend (using continuous discounting)

$$= \text{Dividend} \div e^{rt}$$

$$= ₹ 10 / 1.0084 = ₹ 9.92$$

Adjusted price of shares is ₹ 408.00 – ₹ 9.92 = ₹ 398.08

This can be used in Black Scholes model

$$d_1 = \frac{\ln\left(\frac{398.08}{400}\right) + \left[0.05 + \frac{1}{2}(0.22)^2\right]0.25}{0.22\sqrt{0.25}}$$

$$= \frac{-0.00481 + 0.01855}{0.11} = 0.1250$$

$$d_2 = \frac{\ln\left(\frac{398.08}{400}\right) + \left[0.05 - \frac{1}{2}(0.22)^2\right]0.25}{0.22\sqrt{0.25}}$$

$$= \frac{-0.00481 + 0.00645}{0.11} = 0.0150$$

$$N(d_1) = N(0.1250) = 0.5497$$

$$N(d_2) = N(0.0150) = 0.5060$$

$$\text{Value of Option} = 398.08(0.5497) - \frac{400}{e^{(0.05)(0.25)}} (0.5060)$$

$$= 218.82 - \frac{400}{1.0126} (0.5060)$$

$$= 218.82 - 199.88 = ₹ 18.94$$

**PART – 02: FUTURE****(V) MARGIN A/C****Question – 16**

On 31/08/2021 Mr. R has taken a Long position of Two lots of Nifty Futures at 17300.

One lot of Nifty future is 50 units.

Initial Margin required is 10% of Contract Value.

Maintenance Margin required is 80% of Initial Margin.

The closing price of 5 days are given below –

Date	Closing Price of Nifty Future
01/09/2021	17340
02/09/2021	17180
03/09/2021	16990
06/09/2021	16900
07/09/2021	17120

You are required to-

- Prepare a statement showing the daily balances in the margin account & payment on margin calls, if any.
- Compute the Gain or Loss of Mr. R, if contract squared off on 07/09/2021.
- What would be the Gain or Loss if Mr. R, had taken the short position?

**(Exam December – 2021)**

**Solution:**

$$\text{Initial Margin} = [17,300 \times 50 \times 2] \times 10\%$$

$$= ₹ 1,73,000$$

$$\begin{aligned} \text{Maintenance Margin} &= ₹ 1,73,000 \times 80\% \\ &= ₹ 1,38,400 \end{aligned}$$

**(i) Margin Account**

Date	Closing Price	Profit/Loss	Balance	Margin Call
31/08/2021	17,300	—	1,73,000	—
01/09/2021	17,340	40 × 100 = +4,000	1,77,000	—
02/09/2021	17,180	-160 × 100 = -16,000	1,61,000	—
03/09/2021	16,990	-190 × 100 = -19,000	1,42,000	—
06/09/2021	16,900	-90 × 100 = -9,000	1,73,000	40,000
07/09/2021	17,120	+220 × 100 = 22,000	1,95,000	—

**(ii) Gain or Loss**

$$\begin{aligned} \text{Closing Balance} &= ₹ 1,95,000 \\ (-) \text{Initial Margin} &= ₹ 1,73,000 \\ (-) \text{Variation Margin} &= ₹ 40,000 \\ \hline \text{Loss} &= ₹ 18,000 \end{aligned}$$

**OR**

$$(17,300 - 17,120) \times 100 = 18,000 \text{ (Loss)}$$

**(iii) Gain or Loss (Short Position)**

**Margin Account**

Date	Closing Price	Profit/Loss	Balance	Margin Call
31/08/2021	17,300	—	1,73,000	—
01/09/2021	17,340	-40 × 100 = -4,000	1,69,000	—
02/09/2021	17,180	160 × 100 = 16,000	1,85,000	—
03/09/2021	16,990	190 × 100 = 19,000	2,04,000	—
06/09/2021	16,900	90 × 100 = 9,000	2,13,000	—
07/09/2021	17,120	-220 × 100 = -22,000	1,91,000	—

**Gain or Loss**

$$\text{Closing Balance} = ₹ 1,91,000$$