

Loss = ₹ 200

Price of Shares ₹ 36

In this situation call option will Lapse & put option will Exercise

Gross payoff (40 – 36) = ₹ 4

(–) Cost of Strategy = ₹ 3

Gain = ₹ 1

(×) No. of shares = 100

Gain = ₹ 100

(III) OPTION PRICING & VALUATION

EXPECTED VALUE OF OPTION

Question – 06

Equity share of PQR Ltd. is presently quoted at ₹ 320. The Market Price of the share after 6 months has the following probability distribution:

Market Price	₹ 180	260	280	320	400
Probability	0.1	0.2	0.5	0.1	0.1

A put option with a strike price of ₹ 300 can be written.

You are required to find out expected value of option at maturity (i.e. 6 months)

(SM TYK – 17)

Solution:

Expected Value of Option

Share Price	Action	Gross Pay Off	Probability	Gross Pay Off × Probability
180	Exercised	120	0.1	12
260	Exercised	40	0.2	8
280	Exercised	20	0.5	10
320	Lapsed	0	0.1	0
400	Lapsed	0	0.1	0
Expected Value of Option				₹ 30

Question – 07

You had purchased a 3 month call option on the Equity shares of Satya Ltd for a premium of ₹ 30 each, the current market price of the share is ₹ 560 and the exercise price is ₹ 590. You expect the price range between ₹ 540 to ₹ 640.

The expected share price of Satya Ltd and related probability is given below:

Expected price (₹)	540	560	580	600	620	640
Probability	0.10	0.15	0.05	0.35	0.20	0.15

Compute the followings:

- (i) Expected share price at the end of 3 months,
- (ii) Value of call option at the end of 3 months, if the exercise price prevails,
- (iii) In case the option is held to its maturity, what will be the expected value of the call option?
- (iv) Find out the price of the shares quoted at the stock exchange to get the value of the call option as computed in (iii) above.

(Exam May – 2022)

Solution:

(i) Expected Share Price

$$\begin{aligned} \text{Expected Price} &= (540 \times 0.10) + (560 \times 0.15) + (580 \times 0.05) + (600 \times 0.35) + (620 \times 0.20) + (640 \times 0.15) \\ &= ₹ 597 \end{aligned}$$

(ii) Value of Call Option, If Exercise Price Prevails

[अगर Maturity को Exercise Price ही Market Price होगा]

$$\text{Value of Call} = 590 - 590 = 0$$

(iii) Expected Value of Option

Share Price	Action	Gross Pay Off	Probability	Gross Pay Off × Probability
540	Lapsed	0	0.10	0
560	Lapsed	0	0.15	0
580	Lapsed	0	0.05	0

600	Exercised	10	0.35	3.50
620	Exercised	30	0.20	6.00
640	Exercised	50	0.15	7.50
				₹ 17

(iv) Price of Share so that Value of Call be ₹ 17

$$\begin{aligned} \text{Price of Share} &= 590 + 17 \\ &= ₹ 607 \end{aligned}$$

BINOMIAL MODEL**Question – 08**

The current market price of an equity share of Penchant Ltd is ₹ 420. Within a period of 3 months, the maximum and minimum price of it is expected to be ₹ 500 and ₹ 400 respectively. If the risk free rate of interest be 8% p.a., what should be the value of a 3 months Call option under the “Risk Neutral” method at the strike rate of ₹ 450?

Given $e^{0.02} = 1.0202$

(SM TYK – 24)**Solution:****Step 1: Given**

$$S = ₹ 420$$

$$uS = \frac{₹ 500}{₹ 420} = ₹ 1.1905$$

$$dS = \frac{₹ 400}{₹ 420} = ₹ 0.9524$$

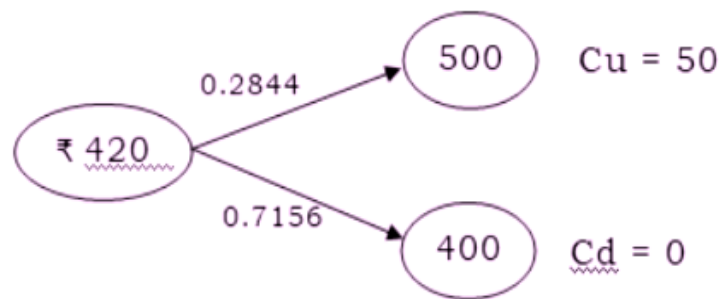
$$E = ₹ 450$$

$$R = 8 \times \frac{3}{12} = 2\%$$

$$E^{0.02} = 1.0202$$

Step 2: Risk Neutral Probability

$$P = \frac{e^{rt} - d}{u - d} = \frac{1.0202 - 0.9524}{1.1905 - 0.9524} = 0.2844$$

Step 3: Binomial Tree**Step 4: Value of Call Option**

$$\begin{aligned} C_0 &= \frac{C_u p + C_d (1 - p)}{e^{rt}} \\ &= \frac{(50 \times 0.2844) + (0 \times 0.7156)}{1.0202} \\ &= ₹ 13.94 \end{aligned}$$

Question - 09

Sumana wanted to buy shares of EIL which has a range of ₹ 411 to ₹ 592 a month later. The present price per share is ₹ 421. Her broker informs her that the price of this share can sore up to ₹ 522 within a month or so, so that she should buy a one-month CALL of EIL. In order to be prudent in buying the call, the share price should be more than or at least ₹ 522 the assurance of which could not be given by her broker.

Though she understands the uncertainty of the market, she wants to know the probability of attaining the share price ₹ 592 so that buying of a one-month CALL of EIL at the execution price of ₹ 522 is justified. Advice her. Take the risk-free interest to be 3.60% and $e^{0.036} = 1.037$.

(SM TYK - 21)**Solution:**

Risk Neutral Probability

$$P = \frac{e^{rt} - d}{u - d}$$

$$e^{rt} = e^{0.036} = 1.037$$

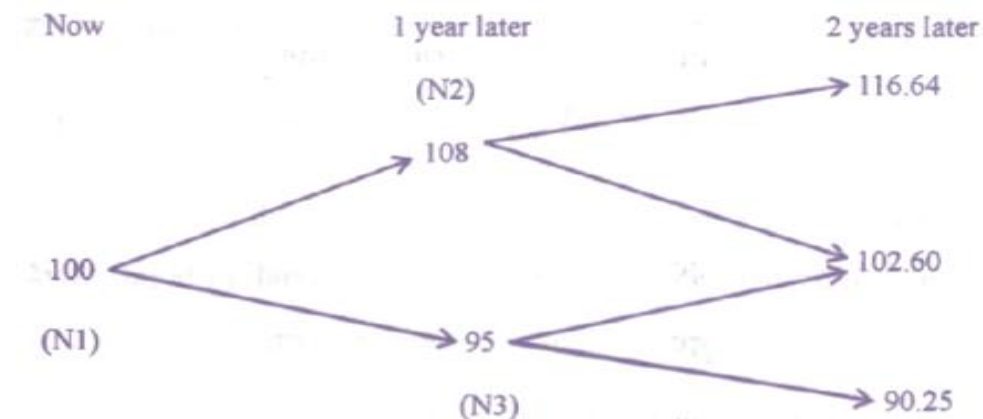
$$u = \frac{592}{421} = 1.4062$$

$$d = \frac{411}{421} = 0.9762$$

$$P = \frac{1.037 - 0.9762}{1.4062 - 0.9762} = 0.1414$$

TWO PERIOD BINOMIAL MODELS**Question – 10**

A two year tree for a share of stock in ABC Ltd., is as follows:



Consider a two years American call option on the stock of ABC Ltd., with a strike price of ₹ 98. The current price of the stock is ₹ 100. Risk free return is 5 per cent per annum with a continuous compounding and $e^{0.05} = 1.05127$. Assume two time periods of one year each.

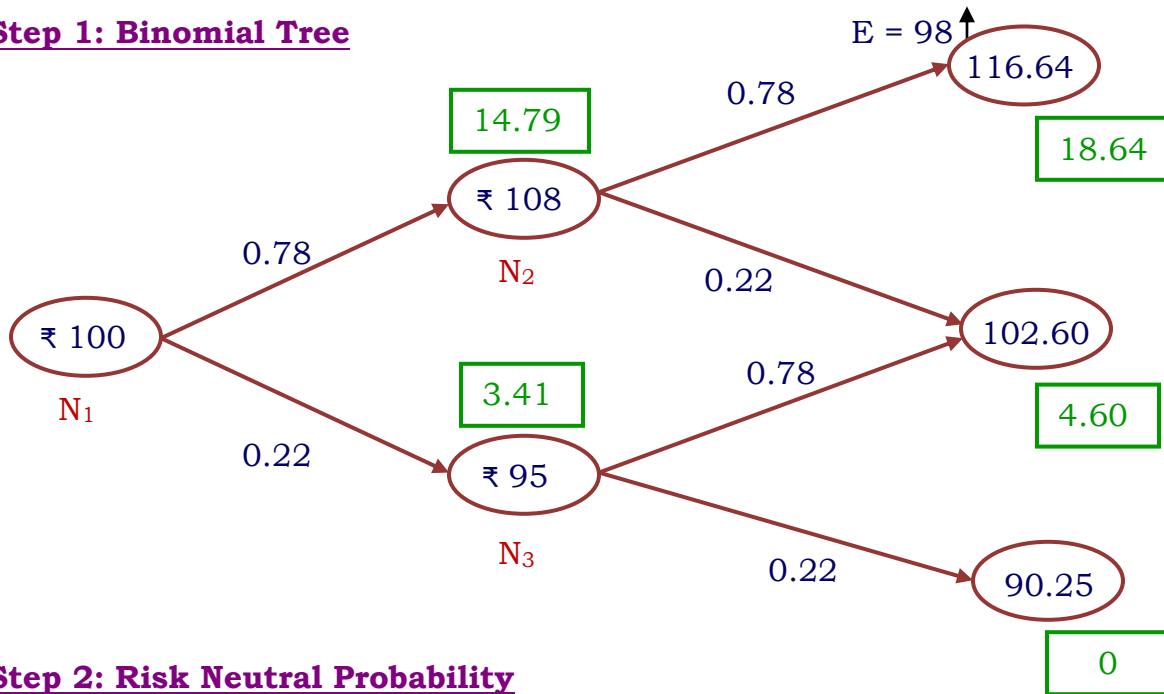
Using the Binomial Model, calculate:

- The probability of price moving up and down;
- Expected pay offs at each nodes i.e. N1, N2 and N3 (round off upto 2 decimal points).

(Exam Nov – 2020)

Solution:

Step 1: Binomial Tree



Step 2: Risk Neutral Probability

$$P = \frac{e^{rt} - d}{u - d}$$

$$P = \frac{1.05127 - 0.95}{1.08 - 0.95}$$

$$= 0.78$$

Step 3: Value of Option

N₂

$$C_0 = \frac{(18.64 \times 0.78) + (4.60 \times 0.22)}{1.0512}$$

$$= 14.79$$

$$\text{Intrinsic Value} = 108 - 98$$

$$= ₹ 10$$

Hence, value of option at node 2 is ₹ 14.79

N₃

$$C_0 = \frac{(4.60 \times 0.78) + (0 \times 0.22)}{1.0512}$$
$$= 3.41$$

Intrinsic Value = 0

Hence, value of option at node 3 is ₹ 3.41

N₁

$$C_0 = \frac{(14.79 \times 0.78) + (3.41 \times 0.22)}{1.0512}$$
$$= 11.69$$

Intrinsic Value = 2

Hence, value of call today is ₹ 11.69

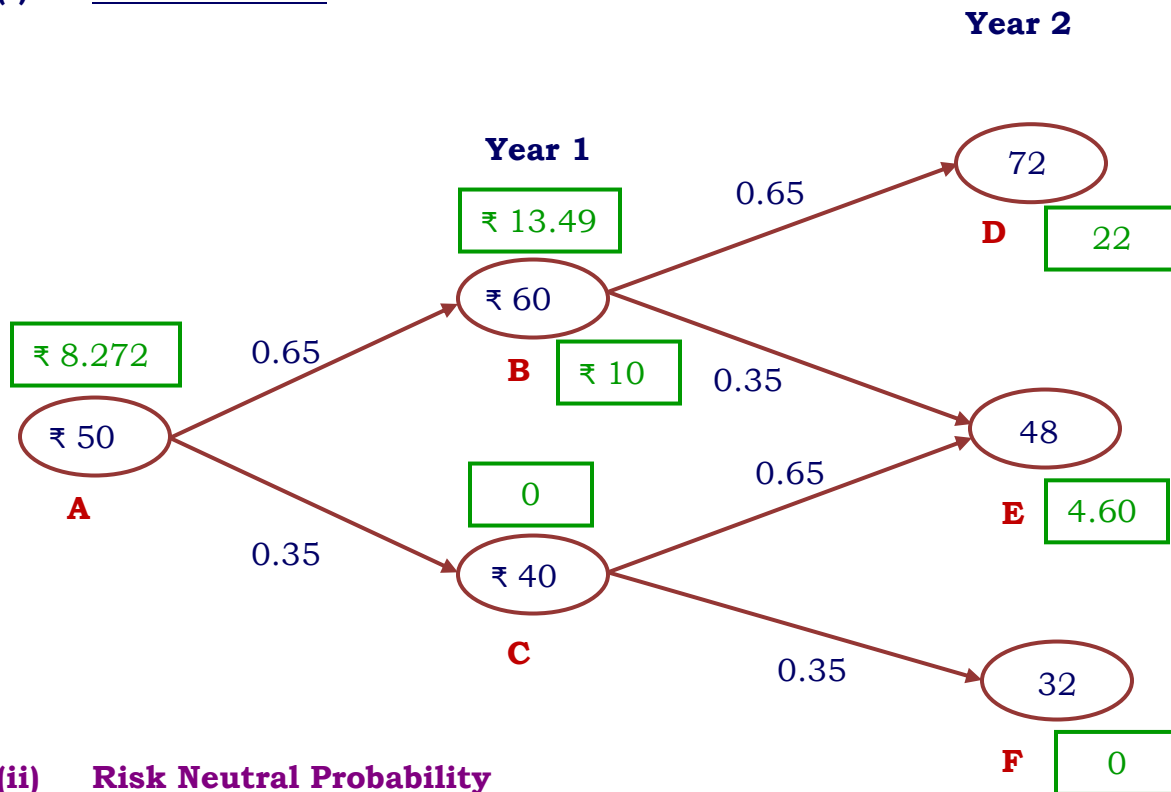
Question – 11

Consider a two-year call option with a strike price of ₹ 50 on a stock the current price of which is also ₹ 50. Assume that there are two-time periods of one year and in each year the stock price can move up or down by equal percentage of 20%. The risk-free interest rate is 6%. Using binominal option model, calculate the probability of price moving up and down. Also draw a two-step binomial tree showing prices and payoffs at each node.

(SM TYK – 23)

Solution:

(i) Binomial Tree



(ii) Risk Neutral Probability

$R = 6\%, \quad u = 1.20, \quad d = 0.80$

$P = \frac{R-d}{u-d} = \frac{1.06 - 0.80}{1.20 - 0.80} = 0.65$

(iii) Value of Option

Node B $= \frac{(22 \times 0.65) + (0 \times 0.35)}{1.06} = ₹ 13.49$

P.V. of Expected Payoff = ₹ 13.49

Intrinsic Value = ₹ 10

Value of option at Node B (Higher) = ₹ 13.49

Node C Value of Option = 0

Node A $= \frac{(₹ 13.49 \times 0.65) + (0 \times 0.35)}{1.06} = ₹ 8.272$

$$\text{Intrinsic Value} = 50 - 50 = 0$$

Hence Value of Call Option today is ₹ 8.272

DELTA HEDGING BINOMIAL MODEL

Question – 12

Mr. Dayal is interested in purchasing equity shares of ABC Ltd. which are currently selling at ₹ 600 each. He expects that price of share may go upto ₹ 780 or may go down to ₹ 480 in three months. The chances of occurring such variations are 60% and 40% respectively. A call option on the shares of ABC Ltd. can be exercised at the end of three months with a strike price of ₹ 630.

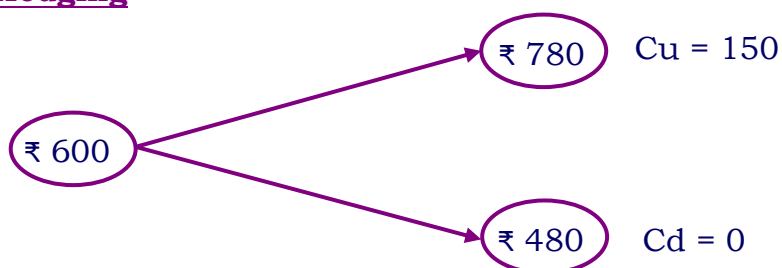
- (i) What combination of share and option should Mr. Dayal select if he wants a perfect hedge?
- (ii) What should be the value of option today (the risk free rate is 10% p.a.)?
- (iii) What is the expected rate of return on the option?

(SM TYK – 22)

Solution:

Given: S = ₹ 600
 us = ₹ 780
 ds = ₹ 480
 Period = 3 Months
 E = ₹ 630
 Option = Call

Delta Hedging



(i) Combination of Shares & Options

$$\begin{aligned} \text{Delta of Call} &= \frac{C_u - C_d}{u_s - d_s} \\ &= \frac{150 - 0}{\text{₹ } 780 - \text{₹ } 480} = 0.5 \end{aligned}$$

Write a Call Option & buy 0.5 share today for perfect hedge.

(ii) Cash Flow**(1) Price = ₹ 780**

Call Option Exercised	= (150)
Sell Shares (₹ 780 × 0.5)	= 390
Cash Inflows	<u>= 240</u>

(2) Price = ₹ 480

Call Option Lapsed	= 0
Sell Shares (₹ 480 × 0.5)	= 240
Cash Inflows	<u>= 240</u>

$$\begin{aligned} \text{Present Value Cash Inflow} &= \frac{240}{1.025} \\ &= 234.15 \end{aligned}$$

$$\begin{aligned} \text{Value of Call} &= 0.5 \times 600 - 234.15 \\ &= \text{₹ } 65.85 \end{aligned}$$

(3) Cost of option = 65.85

$$\begin{aligned} \text{Expected Profit} &= (150 \times 0.6) + (0 \times 0.5) \\ &= \text{₹ } 90 \end{aligned}$$

$$\begin{aligned} \text{Expected Rate of Return} &= \frac{90 - 65.85}{65.85} \times 100 \\ &= 36.67\% \end{aligned}$$