			crore				crore
		(₹)	(₹)	(₹)	(₹)	(₹)	(₹)
A	Selling price per unit	100	100	97.5	100	100	100
B	Variable cost per unit	50	50	50	51.25	50	50
C	Contribution per unit (A – B)	50	50	47.5	48.75	50	50
		(₹in Cr.)	(₹in Cr.)	(₹in Cr.)	(₹in Cr.)	(₹in Cr.)	(₹in Cr.)
D	Number of units sold per year (units in Crores)	5	5	5	5	5	4.875
E	Total Contribution (C × D)	250	250	237.5	243.75	250	243.75
F	Fixed cost per year	50	50	50	50	51.25	50
G	Net Cash Inflow per year (E – F)	200	200	187.5	193.75	198.75	193.75
H	PV of Net cash Inflow per year (G × 2.673)	534.60	534.60	501.19	517.89	531.26	517.89
I	Initial capital cost	400	410	400	400	400	400
J	NPV (H – I)	134.60	124.60	101.19	117.89	131.26	117.89
	K Percentage Change in NPV	-	-7.43%	-24.82%	-12.41%	-2.48%	-12.41%

The above table shows that by changing one variable at a time by 2.5% (adverse) while keeping the others constant, the impact in percentage terms on the NPV of the project can be calculated. Thus, the change in selling price has the maximum effect on the NPV by 24.82%.

(ii) Scenario Analysis

Question – 17

XYZ Ltd. is considering a project "A" with an initial outlay of ₹ 14,00,000 and the possible three cash inflow attached with the project as follows:

Particulars	Year 1	Year 2	Year 3
Worst case	450	400	700
Most likely	550	450	800
Best case	650	500	900

Assuming the cost of capital as 9%, determine NPV in each scenario. If XYZ Ltd is certain about the most likely result in first two years but uncertain about the third year's cash flow, analyze what will be the NPV expecting worst scenario in the third year.

Solution:

The possible outcomes will be as follows:

Year	PVF @ 9%	Worst Case		Most likely		Best case	
		Cash Flow	PV	Cash Flow	PV	Cash Flow	PV
		(₹ '000)	(₹ '000)	(₹ '000)	(₹ '000)	(₹ '000)	(₹ '000)
0	1	(1,400)	(1,400)	(1,400)	(1,400)	(1,400)	(1,400)
1	0.917	450	412.65	550	504.35	650	596.05
2	0.842	400	336.80	450	378.90	500	421.00
3	0.772	700	540.40	800	617.60	900	694.80
NPV			-110.15		100.85		311.85

If XYZ Ltd. is certain about the most likely result in first two years but uncertain about the third year's cash flow, then, NPV expecting worst case scenario is expected in the third year will be as follows:

$$= - ₹\ 14,00,000 + \frac{₹\ 5,50,000}{(1+0.09)} + \frac{₹\ 4,50,000}{(1+0.09)^2} + \frac{₹\ 7,00,000}{(1+0.09)^3}$$

$$= - ₹\ 14,00,000 + ₹\ 5,04,587 + ₹\ 3,78,756 + ₹\ 5,40,528$$

$$= ₹\ 23,871$$

Question – 18

A firm has an investment proposal, requiring an outlay of ₹ 80,000. The investment proposal is expected to have two years economic life with no salvage value. In year 1, there is a 0.4 probability that cash inflow after tax will be ₹ 50,000 and 0.6 probability that cash inflow after tax will be ₹ 60,000. The probability assigned to cash inflow after tax for the year 2 is as follows:

The cash inflow year 1	₹ 50,000		₹ 60,000	
The cash inflow year 2		Probability		Probability
	₹ 24,000	0.2	₹ 40,000	0.4
	₹ 32,000	0.3	₹ 50,000	0.5
	₹ 44,000	0.5	₹ 60,000	0.1

The firm uses a 10% discount rate for this type of investment.

Required:

(i) Construct a decision tree for the proposed investment project and calculate the expected net present value (NPV).

(ii) What net present value will the project yield, if worst outcome is realized? What is the probability of occurrence of this NPV?

(iii) What will be the best outcome and the probability of that occurrence?

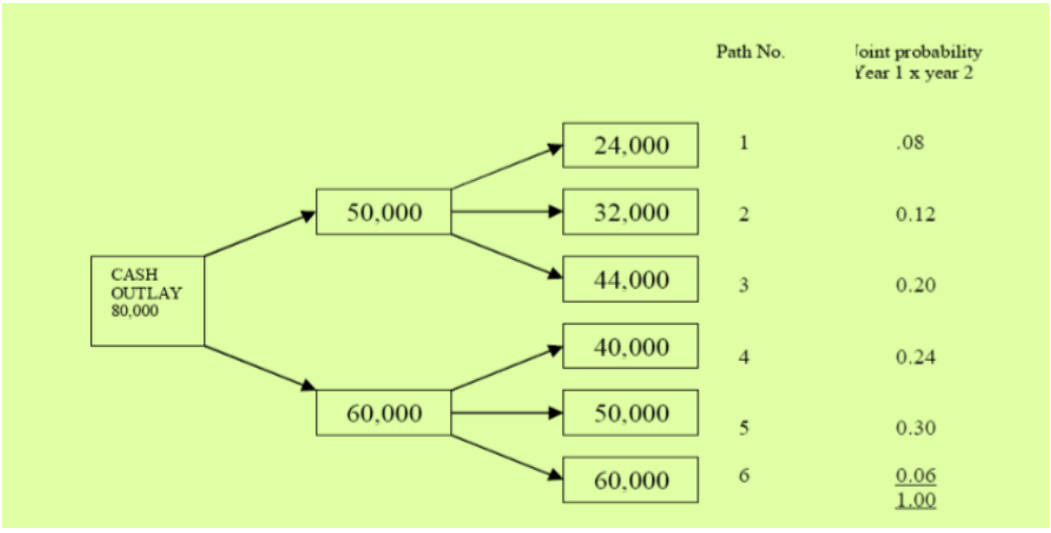
(iv) Will the project be accepted?

(Note: 10% discount factor 1 year 0.909; 2 year 0.826)

(SM TYK – 20)

Solution:

(i) The decision tree diagram is presented in the chart, identifying various paths and outcomes, and the computation of various paths/outcomes and NPV of each path are presented in the following tables:



The Net Present Value (NPV) of each path at 10% discount rate is given below:

Path	Year 1 Cash Flows (₹)	Year 2 Cash Flows (₹)	Total Cash Inflows (PV) (₹)	Cash Inflows NPV (₹)	(₹)
1	50,000 × 0.909 = 45,450	24,000 × 0.826 = 19,824	65,274	80,000	(-) 14,726
2	45,450	32,000 × 0.826 = 26,432	71,882	80,000	(-) 8,118
3	45,450	44,000 × 0.826 = 36,344	81,794	80,000	1,794
4	60,000 × 0.909 = 54,540	40,000 × 0.826 = 33,040	87,580	80,000	7,580
5	54,540	50,000 × 0.826 = 41,300	95,840	80,000	15,840
6	54,540	60,000 × 0.826 = 49,560	1,04,100	80,000	24,100

Statement showing Expected Net Present Value ₹

z	NPV (₹)	Joint Probability	Expected NPV
1	-14,726	0.08	-1,178.08
2	-8,118	0.12	-974.16
3	1,794	0.20	358.80
4	7,580	0.24	1,819.20
5	15,840	0.30	4,752.00
6	24,100	0.06	1,446.00
			6,223.76

(ii) If the worst outcome is realized the project will yield NPV of – ₹ 14,726. The probability of occurrence of this NPV is 8% and a loss of ₹ 1,178 (path 1).

(iii) The best outcome will be path 6 when the NPV is at ₹ 24,100. The probability of occurrence of this NPV is 6% and a expected profit of ₹ 1,446.

(iv) The project should be accepted because the expected NPV is positive at ₹ 6,223.76 based on joint probability.

Question – 19

Skylark Airways is planning to acquire a light commercial aircraft for flying class clients at an investment of ₹ 50,00,000. The expected cash flow after tax for the next three years is as follows: **(₹)**

Year 1		Year 2		Year 3	
CFAT	Probability	CFAT	Probability	CFAT	Probability
14,00,000	0.1	15,00,000	0.1	18,00,000	0.2
18,00,000	0.2	20,00,000	0.3	25,00,000	0.5
25,00,000	0.4	32,00,000	0.4	35,00,000	0.2
40,00,000	0.3	45,00,000	0.2	48,00,000	0.1

The Company wishes to take into consideration all possible risk factors relating to airline operations. The company wants to know:

(i) The expected NPV of this venture assuming independent probability distribution with 6 per cent risk free rate of interest.

(ii) The possible deviation in the expected value.

(iii) How would standard deviation of the present value distribution help in Capital Budgeting decisions?

(SM TYK – 01)

Solution:

(i) Expected NPV

(₹ in lakhs)

Year I			Year II			Year III		
CFAT	P	CF × P	CFAT	P	CF × P	CFAT	P	CF × P
14	0.1	1.4	15	0.1	1.5	18	0.2	3.6
18	0.2	3.6	20	0.3	6.0	25	0.5	12.5
25	0.4	10.0	32	0.4	12.8	35	0.2	7.0
40	0.3	12.0	45	0.2	9	48	0.1	4.8
	$\bar{x}$ or CF	27.0		$\bar{x}$ or CF	29.3			$\bar{x}$ or CF 27.9

NPV	PV factor @ 6%	Total PV
27	0.943	25.461

29.3	0.890	26.077
27.9	0.840	23.436
	PV of cash inflow	74.974
	Less: Cash outflow	50.000
	NPV	24.974

(ii) Possible deviation in the expected value

Year I				
$X - \bar{X}$	$X - \bar{X}$	$X - \bar{X}^2$	P_1	$X - \bar{X}^2 P_1$
14 – 27	-13	169	0.1	16.9
18 – 27	-9	81	0.2	16.2
25 – 27	-2	4	0.4	1.6
40 – 27	13	169	0.3	50.7
				85.4

$\sigma_1 \sqrt{85.4} = 9.241$

Year II				
$X - \bar{X}$	$X - \bar{X}$	$(X - \bar{X})^2$	P_2	$(X - \bar{X})^2 P_2$
15-29.3	-14.3	204.49	0.1	20.449
20-29.3	-9.3	86.49	0.3	25.947
32-29.3	2.7	7.29	0.4	2.916
45-29.3	15.7	246.49	0.2	49.298
				98.61

$\sigma_2 \sqrt{98.61} = 9.930$

Year III				
$X - \bar{X}$	$X - \bar{X}$	$(X - \bar{X})^2$	P_3	$(X - \bar{X})^2 P_3$
18-27.9	-9.9	98.01	0.2	19.602
25-27.9	-2.9	8.41	0.5	4.205
35-27.9	7.1	50.41	0.2	10.082
48-27.9	20.1	404.01	0.1	40.401
				74.29

$\sigma_3 \sqrt{74.29} = 8.619$

Standard deviation about the expected value:

$$\sigma \sqrt{\frac{85.4}{(1.06)^2} + \frac{98.61}{(1.06)^4} + \frac{74.29}{(1.06)^6}} = 14.3696$$

(iii) Standard deviation is a statistical measure of dispersion; it measures the deviation from a central number i.e. the mean.

In the context of capital budgeting decisions especially where we take up two or more projects giving somewhat similar mean cash flows, by calculating standard deviation in such cases, we can measure in each case the extent of variation. It can then be used to identify which of the projects is least risky in terms of variability of cash flows.

A project, which has a lower coefficient of variation will be preferred if sizes are heterogeneous.

Besides this, if we assume that probability distribution is approximately normal we are able to calculate the probability of a capital budgeting project generating a net present value less than or more than a specified amount.

Question – 20

Project X and Project Y are under the evaluation of XY Co. The estimated cash flows and their probabilities are as below:

Project X : Investment (year 0) ₹ 70 lakhs

Probability Weights	0.30	0.40	0.30
Years	₹ lakhs	₹ lakhs	₹ lakhs
1	30	50	65
2	30	40	55
3	30	40	45

Project Y: Investment (year 0) ₹ 80 lakhs.

Probability Weighted	Annual cash flows through life
	₹ lakhs
0.20	40
0.50	45
0.30	50

(a) Which project is better based on NPV, criterion with a discount rate of 10%?

(b) Compute the standard deviation of the present value distribution and analyze the inherent risk of the projects.

(SM TYK – 05)

Solution:

(a) Calculation of NPV of XY Co.:

Project X		Cash flow	PVF	PV
Year				
1	(30 × 0.3) + (50 × 0.4) + (65 × 0.3)	48.5	0.909	44.09
2	(30 × 0.3) + (40 × 0.4) + (55 × 0.3)	41.5	0.826	34.28
3	(30 × 0.3) + (40 × 0.4) + (45 × 0.3)	38.5	0.751	28.91
				107.28
	NPV: (107.28 – 70.00) =			(+) 37.28

Project Y (For 1-3 Years)

1-3	(40 × 0.2) + (45 × 0.5) + (50 × 0.3)	45.5	2.487	113.16
	NPV (113.16 – 80.00)=			(+) 33.16

(b) Calculation of Standard deviation σ

As per Hiller's model

Project X

Year

1 $\sqrt{(30-48.5)^2 0.30 + (50-48.5)^2 0.40 + (65-48.5)^2 0.30}$

$= \sqrt{185.25} = 13.61$

2 $\sqrt{(30-41.5)^2 0.30 + (40-41.5)^2 0.40 + (55-41.5)^2 0.30}$

$= \sqrt{95.25} = 9.76$

3 $\sqrt{(30-38.5)^2 0.30 + (40-38.5)^2 0.40 + (45-38.5)^2 0.30}$

$= \sqrt{35.25} = 5.94$

Standard Deviation about the expected value

$$= \sqrt{\frac{185.25}{(1+0.10)^2} + \frac{95.25}{(1+0.10)^4} + \frac{35.25}{(1+0.10)^6}}$$

$$= \sqrt{\frac{185.25}{1.21} + \frac{95.25}{1.4641} + \frac{35.25}{1.7716}}$$

$$= \sqrt{153.10 + 65.06 + 19.90}$$

$$= \sqrt{238.06}$$

$$= 15.43$$

Project Y (For 1-3 Years)

$$\sqrt{(40-45.5)^2 0.20 + (45-45.5)^2 0.50 + (50-45.5)^2 0.30}$$

$= \sqrt{12.25} = 3.50$

Standard Deviation about the expected value

$$= \sqrt{\frac{12.25}{(1+0.10)^2} + \frac{12.25}{(1+0.10)^4} + \frac{12.25}{(1+0.10)^6}}$$

$$= \sqrt{\frac{12.25}{1.21} + \frac{12.25}{1.4641} + \frac{12.25}{1.7716}}$$

$$= \sqrt{10.12 + 8.37 + 6.91}$$

$$= \sqrt{25.4}$$

$$= 5.03$$

Analysis: Project Y is less risky as its Standard Deviation is less than Project X.

Question – 21

XY Ltd. has under its consideration a project with an initial investment of ₹ 1,00,000. Three probable cash inflow scenarios with their probabilities of occurrence have been estimated as below:

Annual cash inflow (₹)	20,000	30,000	40,000
Probability	0.1	0.7	0.2

The project life is 5 years and the desired rate of return is 20%. The estimated terminal values for the project assets under the three probability alternatives, respectively, are ₹ 0, 20,000 and 30,000.

You are required to:

(i) Find the probable NPV;

(ii) Find the worst-case NPV and the best-case NPV; and

(iii) State the probability occurrence of the worst case, if the cash flows are perfectly positively correlated over time.

(SM TYK – 08)

Solution:

(i) NPV based on expected cash flows would be as follows:

Worst Case:

$$= ₹\ 1,00,000 + \frac{₹\ 20,000}{(1+0.20)^1} + \frac{₹\ 20,000}{(1+0.20)^2} + \frac{₹\ 20,000}{(1+0.20)^3} + \frac{₹\ 20,000}{(1+0.20)^4} + \frac{₹\ 20,000}{(1+0.20)^5}$$

= - ₹ 1,00,000 + ₹ 16,666.67 + ₹ 13,888.89 + ₹ 11,574.07 + ₹ 9,645.06 + ₹ 8037.76

NPV = - ₹ 40,187.76

Base Case:

$$= -₹\ 1,00,000 + \frac{₹\ 30,000}{(1+0.20)^1} + \frac{₹\ 30,000}{(1+0.20)^2} + \frac{₹\ 30,000}{(1+0.20)^3} + \frac{₹\ 30,000}{(1+0.20)^4} + \frac{₹\ 30,000}{(1+0.20)^5} + \frac{₹\ 20,000}{(1+0.20)^5}$$

NPV = -₹ 2,244.08

Best Case: