

① Advanced Capital Budgeting

- ① Basics
- ② Inflation in Capital Budgeting
- ③ Risk Analysis in Capital Budgeting
- ④ Replacement decision
- ⑤ Adjusted present Value

1 BASICS

Long Term Investment

↓
Evaluation

↓
Capital Budgeting

Non DCF Techniques

- ① Pay Back period
- ② Accounting Rate of Return

Disc. Cash Flow Techniques.

- ① Discounting PBP
- ② Net present Value
- ③ profitability Index
- ④ IRR

Eg 1

Cost of project = ₹ 125000

life = 5 years

Salvage = ₹ 35000

Dep. = 25% p.a. WDV

Sales

1	90000
2	80000
3	110000
4	75000
5	50000

$$NPV = \underbrace{PVC I} - PVC O$$

VC @ 35%

FC (Excluding Dep) = ₹ 10,000 p.a.

Tax = 30%

Cost of Capital = 10%

Calculate

- ① PBP
- ② ARR
- ③ Disc. PBP
- ④ NPV
- ⑤ PI
- H.W

31250
~~22500~~

W.N.1 Calculation of Cash flows

	1	2	3	4	5
Sales	90000	80000	110000	75000	50000
(-) VC @ 35%	31500	28000	38500	26250	17500
(-) FC	10000	10000	10000	10000	10000
EBITDA/CFBT	48500	42000	61500	38750	22500
(-) Dep.	31250	23437	17578	13184	9888
PBT	17250	18563	43922	25566	12612
Tax @ 30%	5175	5569	13177	7670	3784
PAT	12075	12994	30745	17896	8828
(+) Dep.	31250	23437	17578	13184	9888
CFAT	43325	36431	48323	31080	18716

W.N.2

Terminal Value

$$\text{Sales consideration} = 35000 - \textcircled{I}$$

$$(-) \text{WDV/B.V.} = 29663$$

$$\text{Capital Gain} = 5337$$

$$\text{Tax @ 30\%} = 1601 - \textcircled{II}$$

$$\text{Terminal Value} = 33399$$

(i-ii)

③ Calculation of NPV (Imp)

	YEAR	PVF (10%)	Amount	P.V.
(A) <u>Cash Outflows</u> Cost of Machine (A)	0	1.000	125000	125000
				<u>125000</u>
(B) <u>Cash Inflows</u> CFAT (w.N.1)	1	0.909	43325	39382
	2	0.826	36431	30092
	3	0.751	48323	36291
	4	0.683	31080	21228
	5	0.621	18716	11623
Terminal Value (w.N.2) (B)	5	0.621	33399	20741
				<u>159357</u>
				34357

NPV(B-A)

④ PI

$$PI = \frac{PVCI}{PVCO}$$

$$= \frac{159357}{125000}$$

$$= 1.275$$

② Accounting Rate of Return

$$ARR = \frac{\text{Avg PAT}}{\text{Initial Investment}} \times 100$$

$$= \frac{16508}{125000} \times 100 = 13.21\%$$

① Calculation of PBP (125000)

<u>YEAR</u>	<u>CFAT</u>	<u>Cum CFAT</u>
1	43325	43325
2	36431	79756
3	48323	128079

1

2

3

$$\begin{aligned} \text{Hence PBP} &= 2 \text{ YEAR} + \left(\frac{1}{48323} \times 45244 \right) \\ &= 2.94 \text{ YEARS} \end{aligned}$$

Eg 2

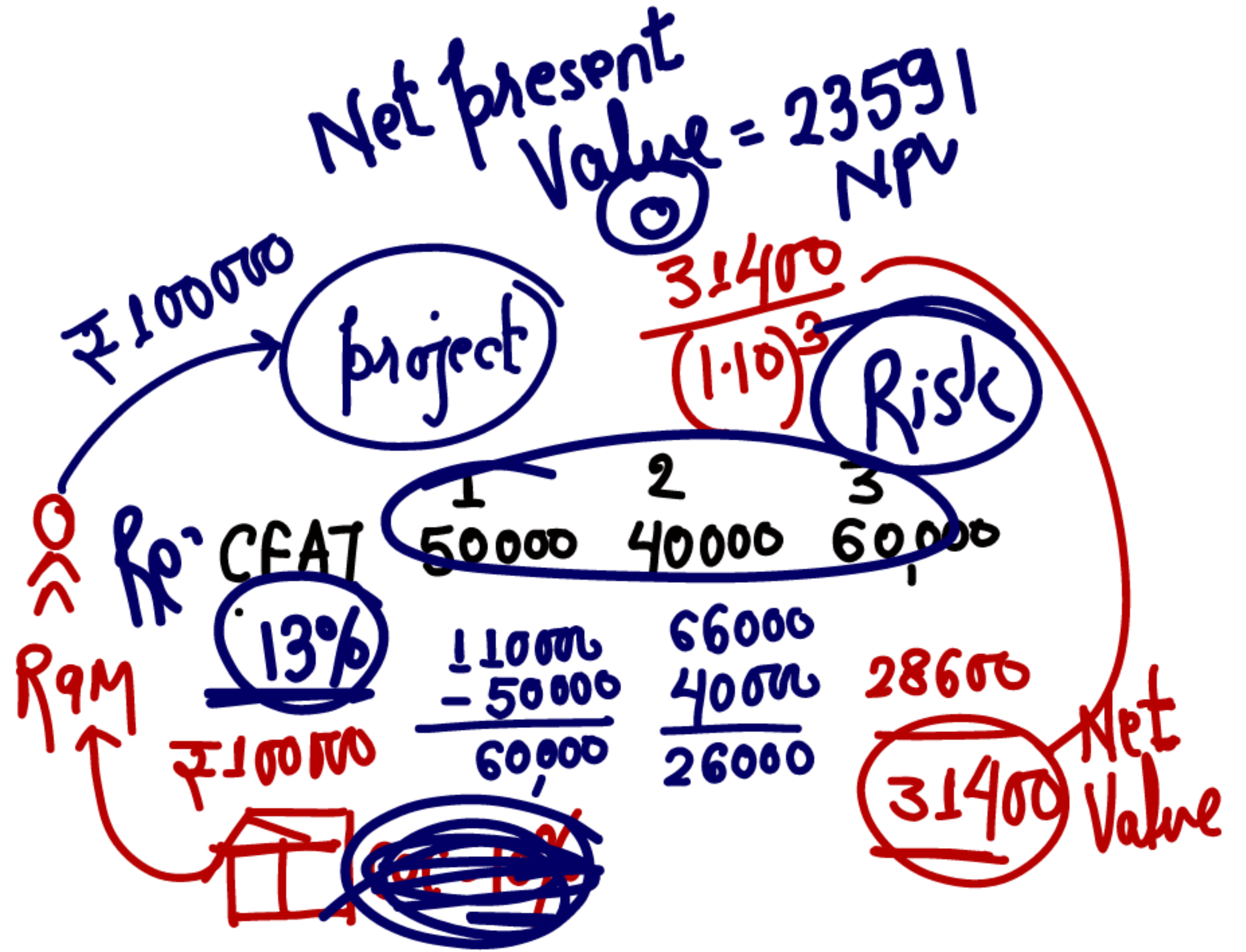
Cost of project = ₹ 100000

CFAT
1 50000
2 40000
3 60000

Cost of Capital = 10%

Calculate NPV

NPV = 23591



Eg 3

	A	B
Cost	100000	120000
CFAT	28000 p.a.	27000 p.a.
life	5 YEARS	8 YEAR
Salvage	10000	15000

Discounting Rate = 12% p.a.
 which project should be accepted?

Project A

$$NPV = (28000 \times 3.605) + (10000 \times 0.567) - 100000 = \text{₹} 6610$$

$$EANPV = \frac{NPV}{PVAF} = \frac{6610}{3.605} = 1833$$

Project B Accept

$$NPV = (27000 \times 4.968) + (15000 \times 0.404) - 120000 = 20196$$

$$EANPV = \frac{20196}{4.968} = 4065$$

Eg 4

	A	B
Cost	100000	125000
life	<u>5 YEARS</u>	8 YEARS
Running cost	25000 p.y.	20000 p.y.
Salvage	10000	15000

COE = 15%
 Which Machine should be purchased?

Calculation of PVCO

Project A

$$\begin{aligned}
 PVCO &= 100000 + (25000 \times 3.352) \\
 &\quad - (10000 \times 0.497) \\
 &= 178830
 \end{aligned}$$

$$EAPVCO = \frac{178830}{3.352} = 53350$$

Project B

$$PVCO = 209843$$

$$EAPVCO = 46765$$

5

Cost of project = 100000

Cash Inflows at the end of 5th YEAR = ₹ 184243

IRR = ?

Method I Dirty Power

$$100000(1+r)^5 = 184243$$

$$r = \left[\left(\frac{184243}{100000} \right)^{1/5} - 1 \right] \times 100$$

$$= 13\%$$

Method II P.V. Method

$$100000 = \frac{184243}{(1+r)^5}$$

$$PVCO = PVC\bar{I}$$

IRR is a rate at which
 $PVC\bar{I} = PVCO$ or $NPV = 0$ or $PI = 1$

Let assume Disc. Rate 10%

$$NPV = PVC\bar{I} - PVCO$$

$$= \frac{184243}{(1.10)^5} - 100000$$

$$= 14400$$

Disc. Rate = 15%

$$NPV = \frac{184243}{(1.15)^5} - 100000$$

$$= (8399)$$



Interpolation

10% — 14400

15% — (8399)
5% — 22799

$$IRR = 10 + \left(\frac{5}{22799} \times 14400 \right)$$
$$= 13.16\%$$

2 Inflation & Capital Budgeting

Calculation

1 Calculation of Nominal Cash Flows from Real Cash flows.

- Nominal Cash flows (After considering Inflation)
- Real Cash flows (without Inflation)

FORMULA

$$NCF = RCF(1+i)^n$$

~~50~~
200 10%
220

Ex 1 Selling price per unit = ₹50

<u>YEAR</u>	<u>Units</u>
1	1000 unit
2	1000 units
3	1000 units

Inflation Rate = 10% p.a.
Calculate RCF & NCF

① RCF

1	50000
2	50000
3	50000

② NCF

<u>YEAR</u>	<u>CF</u>
1	55000
2	60500
3	66550

Eg 2

<u>YEAR</u>	<u>RCF</u>
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1

60000

2

70000

3

50000

Inflation Rate = 5% p.a.

NCF = ?

<u>YEAR</u>	<u>NCF</u>
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1

63000

2

77175

3

57881

Eq 3

<u>YEAR</u>	<u>NCF</u>
1	80000
2	60000
3	40000

Inflation rate = 5% p.a.

Calculate RCF

RCF

$$1 \quad \frac{80000}{(1.05)^1} = 76190$$

$$2 \quad \frac{60000}{(1.05)^2} = 54422$$

$$3 \quad \frac{40000}{(1.05)^3} = 34554$$

Eg 4

<u>YEAR</u>	<u>RCF</u>
1	32000
2	40000
3	25000

Inflation Rate

1 10%

2 9%

3 12%

Calculate NCF

NCF

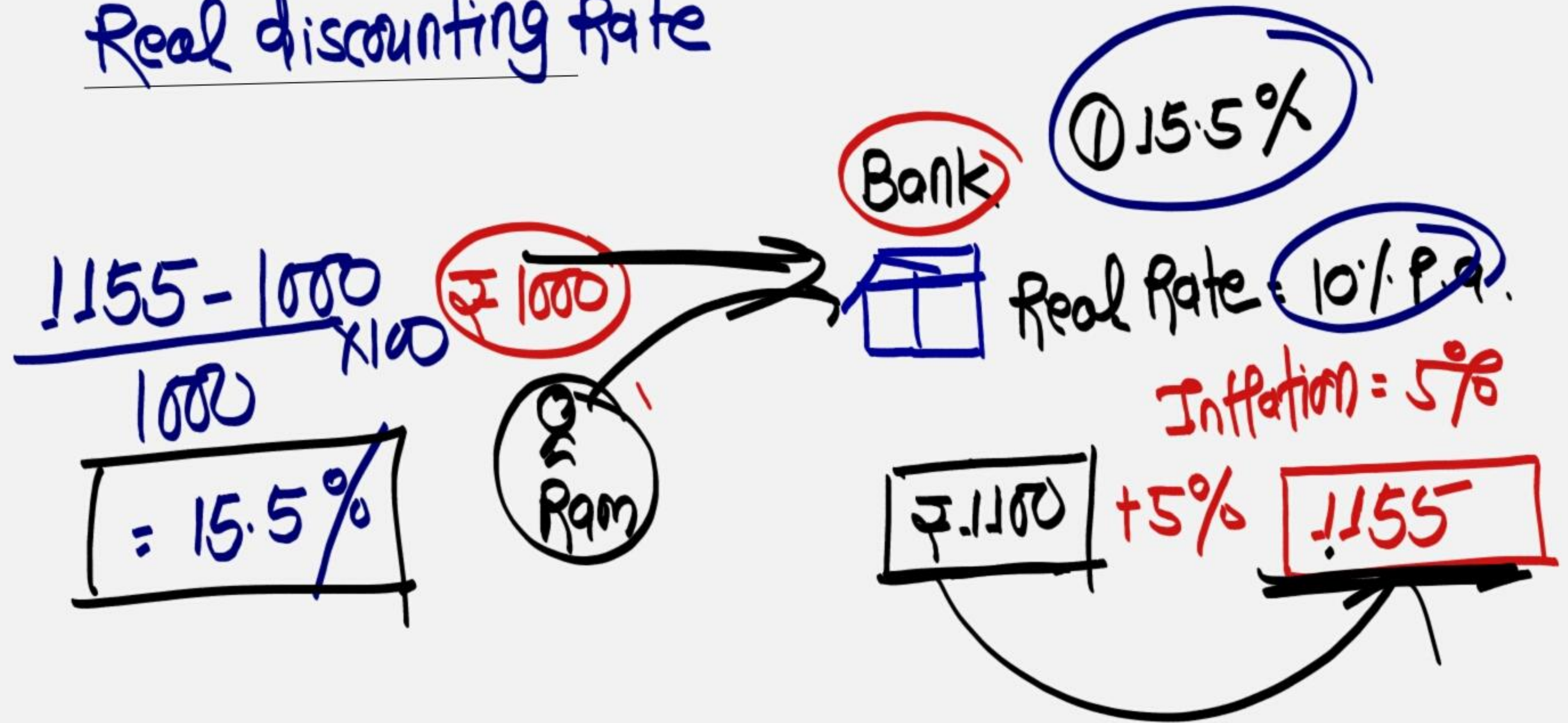
1 YEAR $32000(1.10) = 35200$

2 YEAR $40000(1.10)(1.09) = 47960$

3 YEAR $25000(1.10)(1.09)(1.12) = 33572$

② Real Cost of Capital & Nominal Cost of Capital

Calculation of Nominal discounting rate from Real discounting rate



FORMULA

$$NDR = [(1 + RDR)(1 + i)] - 1$$

Factor x factor

Eq 1 RDR = 17%
Inflation Rate = 4%

NDR = ?

$$NDR = [(1.17)(1.04) - 1] \times 100 = 21.68\%$$

Q2

NDR = 18%

Inflation = 5%

$$RDR = \left(\frac{1.18}{1.05} - 1 \right) \times 100$$

$$= 12.38\%$$

How to Calculate NPV

- Real Cash flows should be discounted with Real discounting Rate.
- Nominal Cash flows should be discounted with Nominal discounting Rate.

Eg

Cost of project = ₹ 100000

Cash flows

1	70000
2	50000
3	40000

Discounting rate = 10% p.a.

① Calculate NPV assuming
No Inflation.

RCF & RDR

$$\begin{aligned} \text{NPV} &= \frac{70000}{(1.10)^1} + \frac{50000}{(1.10)^2} \\ &+ \frac{40000}{(1.10)^3} - 100000 \\ &= \boxed{35011} \end{aligned}$$

$$\begin{aligned} \text{NPV} &= (70000 \times 0.909) + (50000 \times 0.826) \\ &+ (40000 \times 0.751) - 100000 \\ &= 34970 \end{aligned}$$

② Suppose Inflation Rate 5% p.a.
 Calculate NPV using NCF & NDR

1 Nominal Cash flows

<u>YEAR</u>	<u>NCF</u>
1	73500
2	55125
3	46305

② NDR

$$\text{NDR} = (1.10 \times 1.05) - 1$$

$$= 15.5\% \text{ p.a.}$$

$$\text{NPV} = \frac{73500}{(1.155)^1} + \frac{55125}{(1.155)^2} + \frac{46305}{(1.155)^3} - 100000 = \boxed{35044}$$

$$\text{NPV} = (73500 \times \underline{0.866}) + (55125 \times \underline{0.750})$$

$$+ (46305 \times \underline{0.649}) - 100000 = 35047$$

10% RDR	$\frac{0.909}{(1.05)}$	$\frac{0.826}{(1.10)^2}$	0.757
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Eg

<u>YEAR</u>	<u>NCF</u>
1	40000
2	30000
3	25000

Cost of project = ₹ 50,000

Inflation Rate = 5% p.a.

PVF (RDR) =

1	0.890
2	0.792
3	0.704

Calculate NPV
using NCF & NDR

YEAR Factor (NDR)

1 $0.890 / 1.05 = 0.848$

2 $0.792 / (1.05)^2 = 0.718$

3 $0.704 / (1.05)^3 = 0.608$

$$\begin{aligned} \text{NPV} &= (40000 \times 0.848) + (30000 \times 0.718) \\ &+ (25000 \times 0.608) - 50000 \\ &= 20660 \end{aligned}$$

Question: 44

(TYK 17)

A firm has projected the following cash flows from a project under evaluation:

Year	₹ lakhs
0	(70)
1	30
2	40
3	30

(NCF)

The above cash flows have been made at expected prices after recognizing inflation. The firm's cost of capital is 10%. The expected annual rate of inflation is 5%.

Show how the viability of the project is to be evaluated.

IN·N·I Calculation of NDR

$$\begin{aligned} \text{NDR} &= \left[(1.10)(1.05) \right]^{-1} \\ &= .15.5\% \end{aligned}$$

Calculation of NPV (NCF & NDR) (Lakhs)

	YEAR	PVF (15.5%)	Amt	P.V.
Cash outflows Cost of project	0	1.000	70	70
				70
Cash Inflows NCF	1	0.866	30	25.98
	2	0.750	40	30.00
	3	0.649	30	19.47
				75.45
NPV				5.45

project is
Viable due
to positive
NPV

Question: 45

(TYK 18)

Shashi Co. Ltd has projected the following cash flows from a project under evaluation:

Year	0	1	2	3
₹ (in lakhs)	(72)	30	40	30

H.W

The above cash flows have been made at expected prices after recognizing inflation. The firm's cost of capital is ~~10%~~ 10%. The expected annual rate of inflation is 5%. Show how the viability of the project is to be evaluated. [PVF at 10% for 1-3 years are 0.909, 0.826 and 0.751.]

A1 RCF & RDR
A2 NCF & NDR

Question: 46

KLM Ltd. requires ₹ 15,00,000 for a new project.

Useful life of project is 3 years.

Salvage value - NIL. Depreciation is ₹ 5,00,000 p.a.

Given below are projected revenues and costs (excluding depreciation) ignoring inflation:

Year	1	2	3
Revenues in ₹	10,00,000	13,00,000	14,00,000
Costs in ₹	5,00,000	6,00,000	6,50,000

Applicable tax rate is 35%. Assume cost of capital to be 14% (after tax). The inflation rates for revenues and costs are as under:

Year	Revenues %	Costs %
1	9	10
2	8	9
3	6	7

PVF at 14%, for 3 years = 0.877, 0.769 and 0.675

Show amount to the nearest rupee in calculations.

You are required to calculate net present value of the project.

W.N.1 Calculation of Revenue after Inflation

YEAR

1 $1000000(1.09) = 1090000$

2 $1300000(1.09)(1.08) = 1530360$

3 $1400000(1.09)(1.08)(1.06) = 1746965$

W.N.2 Calculation of Cost

1 $500000(1.10) = 550000$

2 $600000(1.10)(1.09) = 719400$

3 $650000(1.10)(1.09)(1.07) = 833905$

Calculation of NPV (NCF & NDR)

	1	2	3
Revenue	1090000	1530360	1746965
(-) Cost	550000	719400	833905
CFBT - (i)	540000	810960	918060
(-) Dep.	500000	500000	500000
PBT	40000	310960	418060
Tax @ 35% - (ii)	14000	108836	144571
CFAT (i-ii)	526000	702124	768489
(v) PVF (14%)	0.877	0.769	0.675
PVCI	461902	539933	518730
PVCI	1519965		
(-) PVCO	1500000		
NPV	19965		

Since NPV is positive, hence project should be accepted.

Eg

RCF	1	10000
	2	12000
	3	8000

RDR: 10% p.a.

Inflation Rate

1	9%
2	10%
3	8%

Calculate PVCI

① RCF & RDR

② NCF & NDR

① RCF & RDR

$$PVCI = (10000 \times 0.909) + (12000 \times 0.826) + (8000 \times 0.751) = 25010$$

② NCF & NDR

NCF	1	$10000 \times 1.09 = 10900$
	2	$12000 \times 1.09 \times 1.10 = 14388$
	3	$8000 \times 1.09 \times 1.10 \times 1.08 = 10359$

NDR (factor)

$$1 \quad \frac{0.909}{1.09} = 0.834$$

$$2 \quad \frac{0.826}{(1.09)(1.10)} = 0.689$$

$$3 \quad \frac{0.751}{(1.09)(1.10)(1.08)} = 0.580$$

$$PVCI = (10900 \times 0.834)$$

$$+ (14388 \times 0.689) +$$

$$(10359 \times 0.580) = 25010$$

Question: 47

(SM)

Determine NPV of the project with the following information:

Initial Outlay of project

₹40,000 ✓

Annual revenues (Without inflation)

₹30,000

Annual costs excluding depreciation
(Without inflation)

₹10,000

Useful life

4 years

Salvage value

Nil

Tax Rate

50% ✓

Cost of Capital (Including inflation
premium of 10%)

12%

(NDR)

Calculation CFAT
(RCF)

Revenue = ✓ 30000
(-) Cost = ✓ 10000

CFBT - ① 20000
(-) Dep ($\frac{40000}{4}$) 10000
PBT 10000

Tax @ 50% - ② 5000
CFAT (i-ii) 15000

RDR

$$RDR = \left[\frac{1.12}{1.10} - 1 \right] \times 100 = 1.818\%$$

$$NPV = (-15000 \times PVA_{1.82\%, 4}) - 40000 = (15000 \times 3.824) - 40000 = 17360$$

Question: 48

XYZ Ltd. requires ₹ 8,00,000 for an unit. Useful life of project - 4 years. Salvage value - Nil. Depreciation Charge ₹ 2,00,000 p.a. Expected revenues & costs (excluding depreciation) ignoring inflation.

RCP

Year	1	2	3	4
Revenues	₹ 6,00,000	₹ 7,00,000	₹ 8,00,000	₹ 8,00,000
Costs	₹ 3,00,000	₹ 4,00,000	₹ 4,00,000	₹ 4,00,000

Tax Rate 60% cost of capital 10% (including inflation premium).

Calculate NPV of the project if inflation rates for revenues & costs are as follows:

NDR

Year	Revenues	Costs
1	10%	12%
2	9%	10%
3	8%	9%
4	7%	8%

SM

H.W

③ Risk Analysis in Capital Budgeting

- ① Statistical Techniques
- ② Conventional Techniques
- ③ Other Techniques

1 Statistical Techniques

In this Technique, we calculate standard deviation & Co-efficient of Variation to find out Risk

Following steps are applied

Step 1 Calculate Expected NPV

$$\bar{x} = \sum P(x)$$

Step 2 Calculate standard deviation

$$\sigma_x = \sqrt{\sum (x - \bar{x})^2 P}$$

Step 3 = Calculate coefficient of Variation

$$C.V. = \frac{\sigma}{\bar{x}} \quad (\text{High C.V. means High Risk})$$

Eg

<u>Economy</u>	<u>prob.</u>	<u>NPV</u>
Boom	0.7	400
Normal	0.2	100
Recession	0.1	20

① Expected NPV

② Variance in NPV

③ standard deviation in NPV

Calculation of Expected NPV & S.D.

<u>P</u>	<u>x</u>	<u>P(x)</u>	<u>(x - \bar{x})</u>	<u>(x - \bar{x})²P</u>
0.7	400	280	98	6722.80
0.2	100	20	-202	8160.80
0.1	20	2	-282	7952.40

$$\bar{x} = \underline{\underline{302}}$$

$$\text{Variance} = \underline{\underline{22836}}$$

$$\text{Expected NPV} = 302$$

$$\text{Standard deviation} = \sqrt{22836} \\ = 151$$

Question: 13

TYKG

Shivam Ltd. is considering two mutually exclusive projects A and B. Project A costs ₹ 36,000 and project B ₹ 30,000. You have been given below the net present value probability distribution for each project.

Project A		Project B	
NPV Estimates (₹)	Probability	NPV Estimates (₹)	Probability
15,000 ✓	0.2	15,000 ✓	0.1
12,000 ✓	0.3	12,000 ✓	0.4
6,000 ✓	0.3	6,000 ✓	0.4
3,000 ✓	0.2	3,000 ✓	0.1

- (i) Compute the expected net present values of projects A and B.
- (ii) Compute the risk attached to each project i.e. standard deviation of each probability distribution.
- (iii) Compute the profitability index of each project.
- (iv) Which project do you recommend? State with reasons.

Expected NPV: A = 9000, B = 9000
 S.D.: A = 4450, B = 3795

iii) Calculate of PI

$$PI = \frac{PVCI}{PVCO}$$

$$A = \frac{36000 + 9000}{36000} = 1.25$$

$$B = \frac{30000 + 9000}{30000} = 1.30$$

iv) Calculation of Coefficient of variation

$$C.V. = \frac{S.D.}{X}$$

$$A = \frac{4450}{9000} = 0.494$$

$$B = \frac{3795}{9000} = 0.422$$

Since C.V. of project B is lower (less risky), hence project B should be accepted.

Calculation of Expected NPV & S.D.

P	x	P(x)	(x - \bar{x})	(x - \bar{x}) ² P	P	y	P(y)	(y - \bar{y})	(y - \bar{y}) ² P
0.2	15000	3000	6000	7200000	0.1	15000	1500	6000	3600000
0.3	12000	3600	3000	2700000	0.4	12000	4800	3000	3600000
0.3	6000	1800	-3000	2700000	0.4	6000	2400	-3000	3600000
0.2	3000	600	-6000	7200000	0.1	3000	300	-6000	3600000
		<u>9000</u>		<u>19800000</u>			<u>9000</u>		<u>14400000</u>
		$\bar{x} = 9000$		Variance = 19800000		Expected NPV = 9000		$\sigma_y = \sqrt{14400000}$	
				$\sigma_x = \sqrt{19800000}$				= 3795	
				= ₹ 4450					

Eg

Cost of project = ₹ 1000

life = 5 years

probability Cash Flows (p.a.)

0.3 300

0.5 400

0.2 100

Cost of capital = 10% p.a.

① Calculate Expected NPV

② standard deviation

① Expected NPV

Expected CF

$$(300 \times 0.3) + (400 \times 0.5)$$

$$+ (100 \times 0.2) = ₹ 310 \text{ p.a.}$$

Expected NPV = PVCI - PVCO

$$= (310 \times PVAF, 10\%, 5)$$

$$- 1000$$

$$= (310 \times 3.791) - 1000$$

$$= 175.143$$

③ S.D. in NPV [Logical]

$$\text{NPV } ① (300 \times 3.791) - 1000 = 137.30$$

$$② (400 \times 3.791) - 1000 = 516.40$$

$$③ (100 \times 3.791) - 1000 = -620.90$$

$$\text{Expected NPV } (137.30 \times 0.3) + (516.40 \times 0.5) \\ + (-620.90 \times 0.2) = 175.143$$

$$\text{S.D.} = \sqrt{(137.30 - 175.14)^2 \times 0.3 + (516.40 - 175.14)^2 \times 0.5 \\ + (-620.90 - 175.14)^2 \times 0.2} \\ = 430.57$$

2. Calculation of S.D. of Cash flows (ICAI)

$$\begin{aligned}\sigma_x &= \sqrt{(300-310)^2 \times 0.3 + (400-310)^2 \times 0.5} \\ &\quad + (100-310)^2 \times 0.2 \\ &= 113.58\end{aligned}$$

TYK 2

Question: 15

Cyber Company is considering two mutually exclusive projects. Investment outlay of both the projects is ₹ 5,00,000 and each is expected to have a life of 5 years. Under three possible situations their annual cash flows and probabilities are as under:

Situation	Probabilities	Cash Flow (₹)	
		Project A	Project B
Good	0.3	6,00,000	5,00,000
Normal	0.4	4,00,000	4,00,000
Worse	0.3	2,00,000	3,00,000

The cost of capital is 7 per cent, which project should be accepted? Explain with workings.

project B

$$\text{Expected NPV} = 4,00,000$$

$$OB = 77459$$

① Calculation of Expected NPV

project A

$$\begin{aligned} \text{Expected CF} &= (6,00,000 \times 0.3) + \\ & (4,00,000 \times 0.4) + (2,00,000 \times 0.3) \\ &= 4,00,000 \text{ p.a.} \end{aligned}$$

$$\begin{aligned} \text{Expected NPV} &= (4,00,000 \times \text{PVAF}, 7\%, 5) \\ & \quad - 5,00,000 \\ &= (4,00,000 \times 4.100) - 5,00,000 \\ &= 1,140,000 \end{aligned}$$

Calculation of S.D. of project A (000)

P	x	P(x)	(x - \bar{x})	(x - \bar{x}) ² P
0.3	600	180	200	12000
0.4	400	160	0	0
0.3	200	60	-200	12000
		400		24000

$$\sigma_x = \sqrt{24000} = 154.919$$

₹ 154919

	A	B
Expected NPV	1140000	1140000
<u>S.D.</u>	154919	77459

project B should be accepted
due to lower risk.

TYK 3

Question: 16

A company is considering Projects X and Y with following information:

Project	Expected NPV (₹)	Standard Deviation
X	1,22,000	90,000
Y	2,25,000	1,20,000

- (i) Which project will you recommend based on the above data?
- (ii) Explain whether your opinion will change, if you use coefficient of variation as a measure of risk.
- (iii) Which measure is more appropriate in this situation and why?

H.W

Question: 18

Probabilities for net cash flows for 3 years of a project are as follows:

Year 1		Year 2		Year 3	
Cash Flow (₹)	Probability	Cash Flow (₹)	Probability	Cash Flow (₹)	Probability
2,000	0.1	2,000	0.2	2,000	0.3
4,000	0.2	4,000	0.3	4,000	0.4
6,000	0.3	6,000	0.4	6,000	0.2
8,000	0.4	8,000	0.1	8,000	0.1

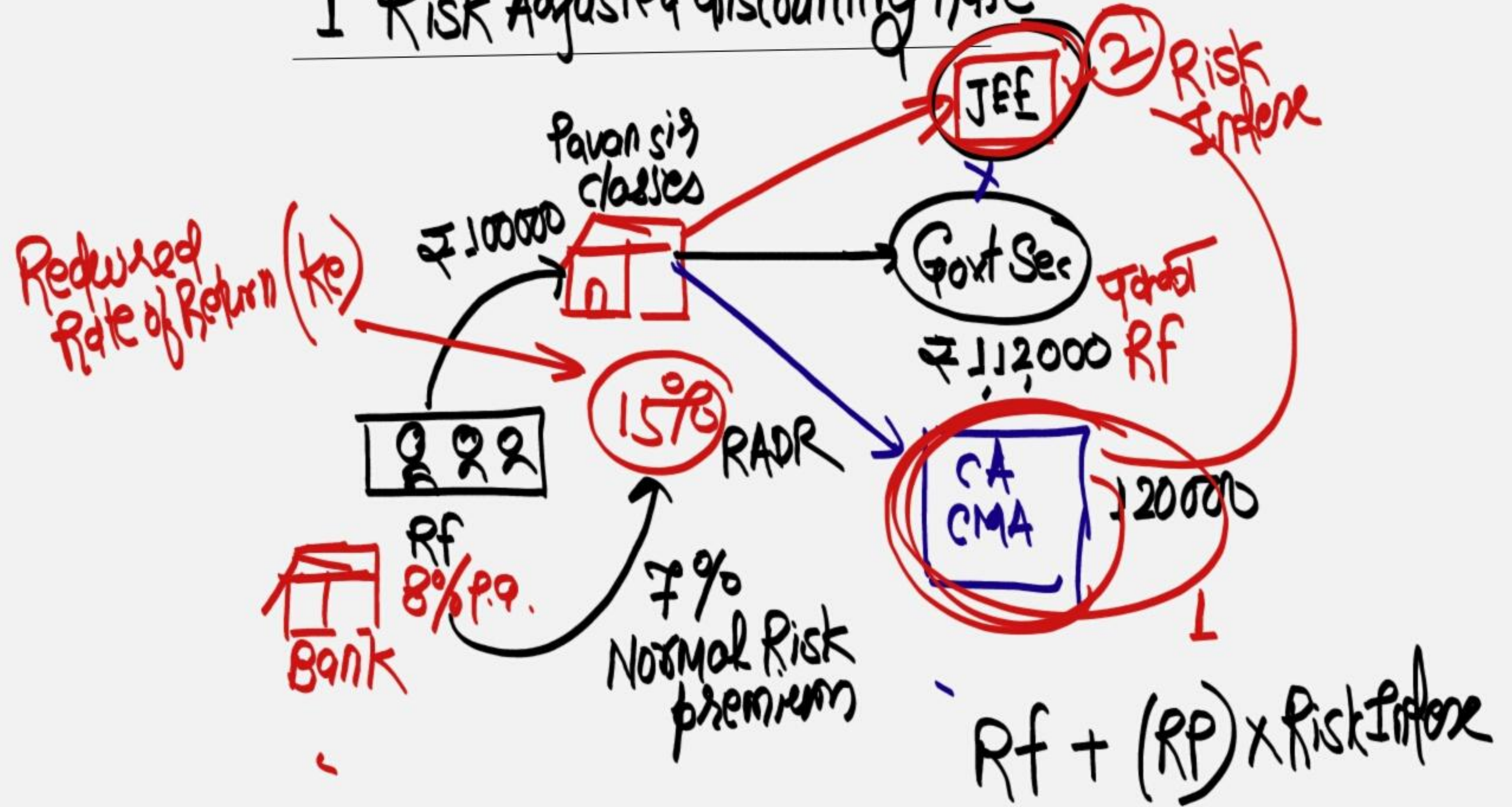
H.W

Calculate the expected net present value of the project using 10 per cent discount rate if the Initial Investment of the project is ₹ 10,000.

2. Conventional Techniques

- ① Risk Adjusted Discounting Rate (RADR)
- ② Certainty Equivalent

1 Risk Adjusted discounting Rate



Following steps are applied to calculate
NPV in RADR Method

$$R_f + R_P \cdot C.V. \cdot R_I$$

① Calculate RADR

- $RADR = R_f + \text{Risk premium (Same Business)}$
- $RADR = R_f + (\text{Risk premium}) \times \text{Risk Index (Other Business)}$
- RADR depends on C.V.
[Higher C.V. than a higher RADR]

② Calculate NPV using RADR as a discounting
Rate

Question: 21

Determine the risk adjusted net present value of the following projects:

	X	Y	Z
Net cash outlays (₹)	2,10,000	1,20,000	1,00,000
Project life	5 years	5 years	5 years
Annual Cash inflow (₹)	70,000	42,000	30,000
Coefficient of variation	1.2	0.8	0.4

The Company selects the risk-adjusted rate of discount on the basis of the coefficient of variation:

Coefficient of Variation	Risk-Adjusted Rate of Return	P.V. Factor 1 to 5 years At risk adjusted rate of discount
0.0	10%	3.791
0.4	12%	3.605
0.8	14%	3.433
1.2	16%	3.274
1.6	18%	3.127
2.0	22%	2.864
More than 2.0	25%	2.689

H.W

Question: 22

New Projects Ltd. is evaluating 3 projects, P-I, P-II, P-III. Following information is available in respect of these projects:

	P-I	P-II	P-III
Cost	₹ 15,00,000	₹ 11,00,000	₹ 19,00,000
Inflow	6,00,000	6,00,000	4,00,000
Year 1	6,00,000	4,00,000	6,00,000
Year 2	6,00,000	5,00,000	8,00,000
Year 3	6,00,000	2,00,000	12,00,000
Year 4	1.80	1.00	0.60
Risk Index			

CFAT

Minimum required rate of return of the firm is 15% and ~~applicable tax rate is 40%~~. The risk free interest rate is 10%.

Required:

- (i) Find out the risk-adjusted discount rate (RADR) for these projects.
- (ii) Which project is the best?

Calculation of RADR

$$RADR = R_f + (k_e - R_f) \text{Risk Index}$$

$$A = 10 + (15 - 10) 1.80 = 19\%$$

$$B = 10 + (5 \times 1) = 15\%$$

$$C = 10 + (5 \times 0.60) = 13\%$$

Calculation of NPV

$$NPV = PVC I - PVC O$$

$$\begin{aligned} P I (19\%) &= (600000 \times PVAF, 19\%, 4) - 1500000 \\ &= (600000 \times 2.639) - 1500000 \\ &= \text{₹ } 83400 \end{aligned}$$

$$\begin{aligned} P II &= (600000 \times 0.870) + (400000 \times 0.756) \\ (15\%) &+ (500000 \times 0.657) + (200000 \times 0.572) \\ &- 1100000 = 167200 \end{aligned}$$

$$P III \Rightarrow 213800$$

Project III
is the best
due to the highest
NPV.

Question 23

An enterprise is investing ₹ 100 lakhs in a project. The risk-free rate of return is 7%. Risk premium expected by the Management is 7%. The life of the project is 5 years. Following are the cash flows that are estimated over the life of the project:

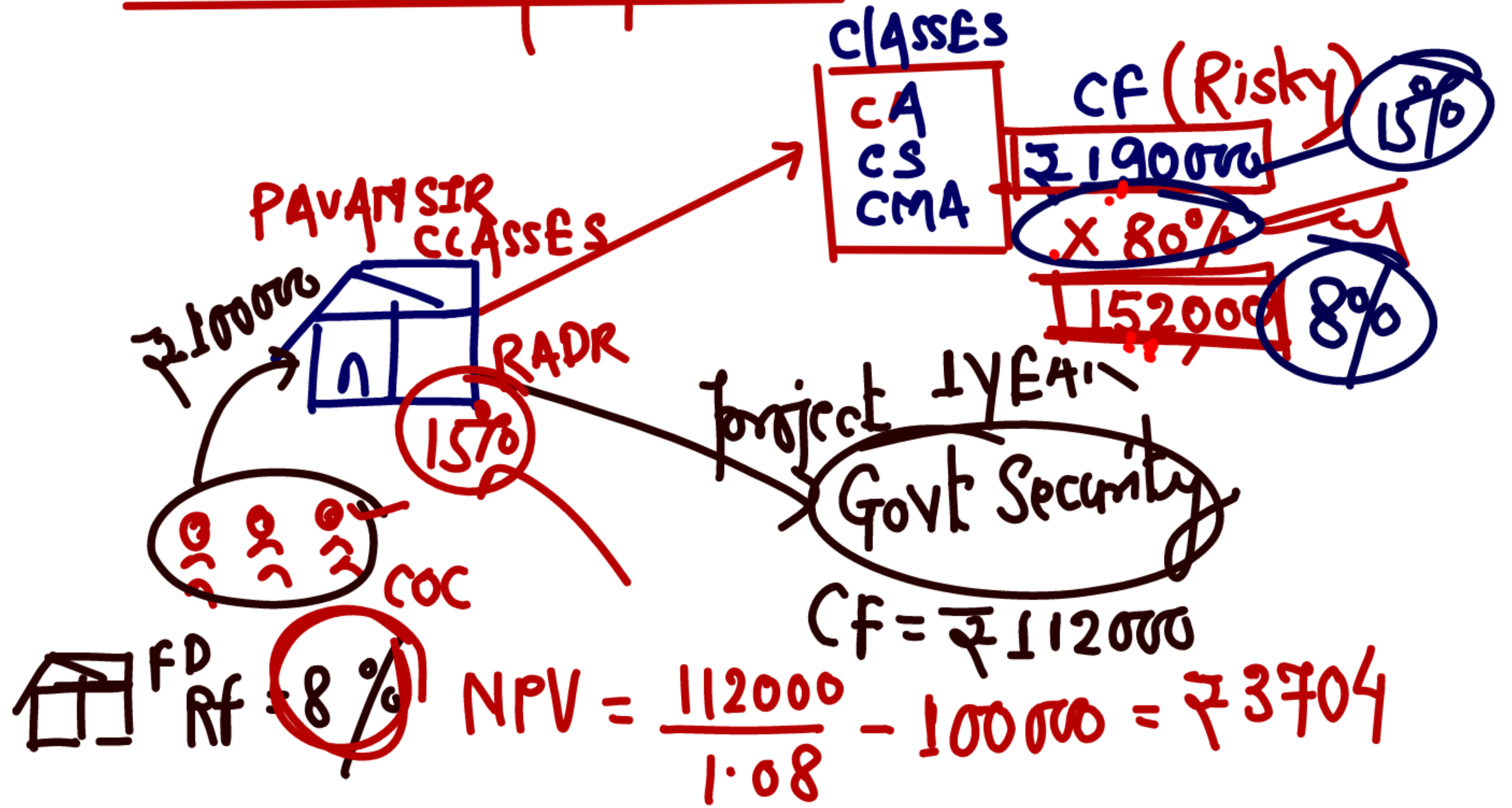
H.W

Year	Cash flows (₹ in lakhs)
1	25
2	60
3	75
4	80
5	65

~~7%~~

Calculate Net Present Value of the project based on Risk free rate and also on the basis of Risks adjusted discount rate

2. Certainty Equivalent



C.E

Following steps are applied to calculate NPV as per Certainty Equivalent approach

Step 1 Calculate Risk free Cash flows

$$\text{Risk free Cash flows} = \text{Expected Cash Flows} \times \text{C.E.}$$

Step 2 Calculate NPV using R_f as a discounting Rate.

Cost of project = 120000

YEAR	Expected CF	C.E.
1	80000	0.8
2	92000	0.7
3	78000	0.5

Rf Rate = 6% P.A.

Calculate NPV using C.E. Approach

Calculation of NPV

YEAR	Exp. CF	C.E.	RF CF	PVF (6%)	P.V.
1	80000	0.8	64000	0.943	60352
2	92000	0.7	64400	0.890	57316
3	78000	0.5	39000	0.840	32760
					<u>150428</u>
					(-) 120000
					<u>30428</u>

PVCI
 (-) PVCO
 NPV

H.W

Question: 24

The Textile Manufacturing Company Ltd., is considering one of two mutually exclusive proposals Projects M and N, which require cash outlays of ₹ 8,50,000 and ₹ 8,25,000 respectively. The certainty-equivalent (C.E.) approach is used in incorporating risk in capital budgeting decisions. The current yield on government bonds is 6% and this is used as the risk free rate. The expected net cash flows and their certainty equivalents are as follows:

C.E ↓ Risk ↑
RADR ↑

V. RADR Higher

Year-end	Project M		Project N	
	Cash Flow ₹	C.E.	Cash Flow ₹	C.E.
✓ 1	4,50,000	0.8 ✓	4,50,000	0.9
✓ 2	5,00,000	0.7 ✓	4,50,000	0.8
✓ 3	5,00,000	0.5 ✓	5,00,000	0.7

class work copy

Present value factors of ₹ 1 discounted at 6% at the end of year 1, 2 and 3 are 0.943, 0.890 and 0.840 respectively.

Required:

- (i) Which project should be accepted?
- (ii) If risk adjusted discount rate method is used, which project would be appraised with a higher rate and why?


Question: 25

If Investment proposal costs ₹ 45,00,000 and risk free rate is 5%, calculate net present value under certainty equivalent technique.

Year	Expected cash flow (₹)	Certainty Equivalent coefficient
1	10,00,000	0.90
2	15,00,000	0.85
3	20,00,000	0.82
4	25,00,000	0.78

H.W
H.W copy

3. Other Techniques

- ① Sensitivity Analysis
 - ② Scenario Analysis
 - ③ Simulation
 - ④ Decision Tree
- 

Sensitivity Analysis

Eg Cost of project = 120000
CFAT = 45000
life = 5
COC = 10% P/A.

Calculate NPV

Calculate Sensitivity

इसमें
ज्यादा
change
की जा
सकता

COP = 42.16%

CFAT = 29.66%

life = 34.80%

COC = 154.30%

Sensitivity

① Cost of project

Let assume Cost of project be x
at which NPV should be "0"

$$(45000 \times 3.791) - x = 0$$

$$x = 170595$$

$$\text{Sensitivity in COP} = \frac{170595 - 120000}{120000} \times 100$$
$$= 42.16\%$$

FORMULA

$$\text{Sensitivity in COP} = \frac{NPV}{COP} \times 100$$

② Annual CFAT

Let assume Annual CFAT be x ₹ which NPV should be "0"

$$(x \times 3.791) - 120000 = 0$$

$$x = \frac{120000}{3.791} = ₹ 31654$$

$$\begin{aligned} \text{Sensitivity in CFAT} &= \frac{45000 - 31654}{45000} \times 100 \\ &= 29.66\% \end{aligned}$$

FORMULA

$$\text{Sensitivity in CFAT} = \frac{\text{NPV}}{\text{PVCFAT}} = \frac{50595}{45000 \times 3.791} = 29.66\%$$

3. Life of project

Assume life of project be 4 YEARS

$$NPV = (45000 \times 3.170) - 120000 = 22650$$

(PVAF, 10%, 4)

Life 3 YEAR

$$NPV (45000 \times 2.487) - 120000 = (8085)$$

(PVAF, 10%, 3)

Interpolation

4 YEARS

3 YEARS

1 YEAR

$$\begin{array}{l} 22650 \checkmark \rightarrow 22650 \\ (8085) \downarrow \rightarrow 0 \text{ NPV} \end{array}$$

$$\underline{\underline{30735}}$$

$$\text{Life} = 4 \text{ YEARS} - \left(\frac{1}{30735} \times 22650 \right)$$
$$= 3.26 \text{ YEARS}$$

Sensitivity in life =

Discounting PBP (120000)

<u>YEAR</u>	<u>PVCFAT</u> (10%)	<u>CumCFAT</u>
1	40909	40909
2	37190	78099
3	33809	111908
4	30736	
5	27941	

$$3 \text{ YEARS} + \left(\frac{1}{30736} \times 8092 \right)$$

$$= 3.26 \text{ YEARS}$$

$$\frac{5 \text{ YEARS} - 3.26 \text{ YEARS}}{5 \text{ YEARS}} \times 100 = 34.8\%$$

④ Sensitivity in CoC

Discounting Rate at which NPV = 0

10%	=	50595	
20%	=	14577	
25%	=	1018	25%
28%	=	(6060)	28%

$$\frac{3\%}{28\%}$$

$$\frac{(6060)}{7078}$$

$$IRR = 25 + \left(\frac{3}{7078} \times 1018 \right)$$

$$= 25.43\%$$

25.66%

25.33% - 25.85%

$$\text{Sensitivity in CoC} = \frac{25.43 - 10}{10} \times 100$$

$$= 154.30\%$$

Sensitivity Analysis

(i) Cost of project (20%)

(अगर project cost 20% से increase होता है तो NPV पर क्या Effect होगा)

$$NPV = (45000 \times 3.791 - 144000) = ₹ 26595$$

(COP = 120000 + 20%)

$$\Delta NPV = \frac{50595 - 26595}{50595} \times 100 = \boxed{47.44\%}$$

② Annual CFAT (20% ↓)

$$CFAT = 45000 \times 80\% = 36000$$

$$NPV = (36000 \times 3.791) - 120000 = 16476$$

$$\Delta NPV = \frac{50595 - 16476}{50595} \times 100 = \boxed{67.44\%}$$

③ life of project (20% ↓)

$$\text{life } 5 \text{ YEAR} - 20\% = 4 \text{ YEARS}$$

$$NPV = (45000 \times 3.170) - 120000 = 22650$$

$$\Delta NPV = \frac{50595 - 22650}{50595} \times 100 = \boxed{55.23\%}$$

④ Cost of Capital 10% (20% ↑) = 12%

$$NPV = (45000 \times 3.605) - 120000 = 42225$$

$$\Delta NPV = \frac{50595 - 42225}{50595} \times 100 = \boxed{16.56\%}$$

Most critical factor is CFAT

$$\text{Cost of project} = \boxed{47.44\%}$$

Sensitivity Analysis

- Sensitivity Analysis means analysis of various variables of project like Cost of project, Selling price of product, Cost of product, life of project, Cost of Capital etc.
- In Sensitivity Analysis, we change each factor in unfavorable direction, keeping other factors constant to find out critical factor so that further research may carry out about such factor before accepting the project.

H.W

TYK 10

10%

Question: 31

From the following details relating to a project, analyze the sensitivity of the project to changes in initial project cost, annual cash inflow and cost of capital:

1st

Initial Project Cost (₹)

1,20,000

10%

Annual Cash Inflow (₹)

45,000

10%

Project Life (Years)

4

5

Cost of Capital

10%

11%

To which of the three factors, the project is most sensitive? (Use annuity factors: for 10% 3.169 and 11% 3.103).

TYK 9

Question: 32

XYZ Ltd. is considering a project for which the following estimates are available:

	₹
Initial Cost of the project	10,00,000
Sales price/unit	60
Cost/unit	40
Sales volumes	
Year 1	20000 units
Year 2	30000 units
Year 3	30000 units

Discount rate is 10% p.a.

You are required to measure the sensitivity of the project in relation to each of the following parameters:

- (a) Sales Price/unit
- (b) Unit cost
- (c) Sales volume
- (d) Initial outlay and
- (e) Project lifetime Taxation may be ignored.

$$\frac{60 - 55.26}{60} \times 100 = 7.9\%$$

Calculation of NPV (55.26)

$$NPV = \frac{PVC_1}{(1.10)^1} + \frac{PVC_2}{(1.10)^2} + \frac{PVC_3}{(1.10)^3} - PVC_0$$

$$= \frac{20000(60-40)}{(1.10)^1} + \frac{30000(60-40)}{(1.10)^2} + \frac{30000(60-40)}{(1.10)^3} - 1000000$$

$$= 20 \times \left[\frac{20000}{(1.10)^1} + \frac{36000}{(1.10)^2} + \frac{30000}{(1.10)^3} \right] - 1000000$$

$$= 20 \times 65514.65 - 1000000 = 310293$$

16

1 Sensitivity in selling price per unit

1st Approach

$$\text{Selling price } ₹60 (10\% \downarrow) = ₹54$$

$$\text{NPV} = -82795$$

$$\Delta \text{NPV} = \frac{310293 - (-82795)}{310293} \times 100 = 126.68\%$$

2nd Approach

Let assume contribution per unit be x so that NPV should be zero

$$x \times 65514.651 - 1000000 = 0$$

$$x = \frac{1000000}{65514.651} = ₹15.26$$

$$\text{Change in CPV} = ₹20 - ₹15.26 = ₹4.74$$

It means maximum decrease in selling price ₹4.74

$$\text{Sensitivity in selling price} = \frac{₹4.74}{60} \times 100 = 7.9\%$$

3. Sensitivity in Sales Volume

1st Approach (10% ↓)

Units 1st YEAR = 18000, 2 YEAR = 27000, 3 YEAR = 27000

$$NPV = 179264$$

$$\text{Sensitivity} = \frac{310293 - 179264}{310293} \times 100 = 42.22\%$$

2nd Approach

$$20 \times x - 1000000 = 0$$

$$x = \frac{1000000}{20} = 50000 \text{ units}$$

$$\text{Sensitivity} = \frac{65514.651 - 50000}{65514.651} \times 100 = 23.68\%$$

(ii) Sensitivity in unit cost

1st Approach

$$\text{Unit cost} = ₹ 40 (10\% \uparrow) = ₹ 44$$

$$\text{NPV} = ₹ 48234$$

$$\text{Sensitivity}_Q = \frac{310293 - 48234}{310293} \times 100 = 84.46\%$$

2nd Approach

$$\text{Sensitivity in unit cost} = \frac{4.74}{40} \times 100 = 11.85\%$$

Alternative

$$20 \times \left[\frac{2x}{(1.10)^1} + \frac{3x}{(1.10)^2} + \frac{3x}{(1.10)^3} \right] - 1000000 = 0$$

$$20 \times 6.5515x = 1000000$$

$$x = \frac{1000000}{20 \times 6.5515} = \boxed{7631.84}$$

YEAR	Units	
1	(2×7631.84)	$= 15263.68$ ← 20000
2	(3×7631.84)	$= 22895.52$ ← 30000
3	(3×7631.84)	$= 22895.52$ ← 8000
		<u>61054.72</u>

$$\text{Sensitivity}_Q = \frac{80000 - 61054.72}{80000} \times 100 = 23.68\%$$

(d) Sensitivity in Initial Outlays

Approach 1

$$\text{Initial Outlays} = 1000000 (10\% \uparrow) = ₹ 1100000$$

$$\text{NPV} = 210293$$

$$\text{Sensitivity} = \frac{310293 - 210293}{310293} \times 100 = 32.23\%$$

Approach 2

$$\text{Sensitivity} = \frac{310293}{1000000} \times 100 = 31.03\%$$

(e) Project Life

2nd Approach

Calculate Discounting PBP (1000000)

<u>YEAR</u>	<u>PV of CF</u>	<u>Cum PV of</u>
1	363636	363636
2	495868	859504
3	450789	1310293

$$\text{Disc. PBP} = 2 \text{ YEARS} + \left(\frac{1 \text{ YEAR}}{450789} \times 140496 \right)$$
$$= 2.312 \text{ YEARS.}$$

$$\text{Sensitivity} = \frac{3 - 2.312}{3} \times 100 = 22.93\%$$

1st Approach (अगर life देखा नहीं और last में जाकर फंस गए)

project life (33.33% ↓)

$$3 \text{ YEARS} - 33.33\% = 2 \text{ YEARS}$$

$$\text{NPV} = 363636 + 495868 - 1000000 = -140496$$

$$\Delta \text{ in NPV} = \frac{310293 - (-140496)}{310293} \times 100$$

$$= 145.28\%$$
$$\text{Sensitivity} = \frac{145.28}{33.33\%} \times 10\% = 43.59\%$$

4:31

Question: 33

TYK 11

Red Ltd. is considering a project with the following Cash flows:

H.W

Years	Cost of Plant	Recurring Cost	Savings
0	10,000		
1		4,000	12,000
2		5,000	14,000

The cost of capital is 9%. Measure the sensitivity of the project to changes in the levels of plant value, running cost and savings (considering each factor at a time) such that the NPV becomes zero. The P.V. factor at 9% are as under:

Year	Factor
0	1
1	0.917
2	0.842

C.W Copy

Which factor is the most sensitive to affect the acceptability of the project?

Question – 33

Red Ltd. is considering a project with the following Cash flows:

Years	Cost of Plant	Recurring Cost	Savings
0	10,000		
1		4,000	12,000 = 8000
2		5,000	14,000 = 9000

The cost of capital is 9%. Measure the sensitivity of the project to changes in the levels of plant value, running cost and savings (considering each factor at a time) such that the NPV becomes zero. The P.V. factor at 9% are as under:

Year	Factor
0	1
1	0.917
2	0.842

Which factor is the most sensitive to affect the acceptability of the project?

P.V. of Savings = 22792
 $(12000 \times 0.917) + (14000 \times 0.842)$

P.V. of Recurring cost
 $(4000 \times 0.917) + (5000 \times 0.842)$
 = 7878

NPV = 22792 - 7878 - 10000 = 4914

$\frac{4914}{22792} \times 100 = 21.56\%$

$\frac{4914}{7878} \times 100 = 62.38\%$

$\frac{4914}{10000} \times 100 = 49.14\%$

Question - 34

The Easygoing Company Limited is considering a new project with initial investment for a product "Survival". It is estimated that IRR of the project is 16% having an estimated life of 5 years.

Financial Manager has studied that project with sensitivity analysis and informed that annual fixed cost sensitivity is 7.8416%, whereas cost of capital (discount rate) sensitivity is 60%.

Other information available are:

- Profit Volume Ratio (P/V) is 70%,
- Variable cost ₹ 60/- per unit
- Annual Cash Flow ₹ 57,500/-

Ignore Depreciation on initial investment and impact of taxation. Calculate

- (i) Initial Investment of the Project
- (ii) Net Present Value of the Project
- (iii) Annual Fixed Cost
- (iv) Estimated annual unit of sales
- (v) Break Even Units

Cumulative Discounting Factor for 5 years

8%	9%	10%	11%	12%	13%	14%	15%	16%	17%	18%
3.339	3.890	3.791	3.696	3.605	3.517	3.433	3.352	3.274	3.199	3.127

Handwritten notes:
 S.P. = 2000
 VC = 60
 FC = 100000
 CF = 57500

$$x + (x \times 60\%) = 16\%$$

W.N. 1

$$\text{COC sensitivity} = \frac{\text{IRR} - \text{COC}}{\text{COC}} \times 100$$

$$0.60 = \frac{16 - x}{x}$$

$$x = \frac{16}{1.60} = 10\%$$

W.N. 2 Selling price per unit

$$\text{Selling price} = \frac{\text{VC}}{30\%} = \frac{260}{0.30} = 2200$$

IRR is a rate at which .

$$PVC I = PVC O$$

$$PVC O \text{ (cost of project)} = \text{Annual CFAT} \times PVA F_{(IRR)}$$

$$PVC I = \text{Annual CFAT} \times PVA F_{(COC)}$$

① Initial Investment

$$\begin{aligned} \text{Initial Investment} &= \text{Annual Cash flows} \times PVA F_{(IRR)}^{16\%} \\ &= 57500 \times 3.274 = ₹ 188255 \end{aligned}$$

$$\begin{aligned} \text{② NPV} &= PVC I - PVC O \\ &= (57500 \times PVA F_{10\%, 5}) - 188255 = ₹ 29727.50 \end{aligned}$$

③ Annual fixed Cost

fixed cost sensitivity is 7.8416%

(It means if fixed cost 7.8416% से बढ़ाया जाये तो NPV (29728) से 0 हो जाएगा)

$$\text{Sensitivity in fixed cost} = \frac{\text{NPV}}{\text{PVFC}} \times 100$$

$$0.078416 = \frac{29727.50}{x}$$

$$x = \frac{29727.50}{0.078416} = ₹ 379106$$

$$\text{PV of FC} = \text{Annual FC} \times \text{PVAF}(10\%, 10)$$

$$379106 = x \times 3.791$$

$$x = ₹ 100000$$

(iv) Estimated Annual units of sales

$$Q (200 - 60) - 100000 = 57500$$

$$Q = \frac{157500}{140} = 1125 \text{ units}$$

⑤ BEP

$$\text{BEP} = \frac{FC}{CPU} = \frac{100000}{140} = 714.285 \text{ units}$$

Question - 35

Unnat Ltd. is considering investing ₹ 50,00,000 in a new machine. The expected life of machine is five years and has no scrap value. It is expected that 2,00,000 units will be produced and sold each year at a selling price of ₹ 30.00 per unit. It is expected that the variable costs to be ₹ 16.50 per unit and fixed costs to be ₹ 10,00,000 per year. The cost of capital of Unnat Ltd. is 12% and acceptable level of risk is 20%.

You are required to measure the sensitivity of the project's net present value to a change in the following project variables:

- (a) sale price;
- (b) sales volume;
- (c) variable cost;
- (d) On further investigation it is found that there is a significant chance that the expected sales volume of 2,00,000 units per year will not be achieved. The sales manager of Unnat Ltd. suggests that sales volumes could depend on expected economic states which could be assigned the following probabilities:

State of Economy	Annual Sales (in Units)	Probability
Poor	1,75,000	0.30
Normal	2,00,000	0.60
Good	2,25,000	0.10

Calculate expected net present value of the project and give your decision whether company should accept the project or not.

① Calculation of NPV

$$\text{NPV} = (30 - 16.50) (200000 \times 3.605) - (1000000 \times 3.605) - 5000000$$
$$13.50 \times 721000 - 3605000 - 5000000$$

(a) Sensitivity in Selling price = ₹ 1128500

$$x \times 721000 - 3605000 - 5000000 = 0$$

$$x = \frac{5000000 + 3605000}{721000} = ₹ 11.93$$

$$\text{Sensitivity in selling price} = \frac{13.50 - 11.93}{30} \times 100 = 5.23\%$$

(b) Sensitivity in Sales Volume

$$13.50 \times x - 3605000 - 5000000 = 0$$

$$x = 637407.41$$

$$\text{Sensitivity}_Q = \frac{721000 - 637407.41}{721000} \times 100$$
$$= 11.59\%$$

(c) Sensitivity in VC per unit

$$\text{Sensitivity}_Q = \frac{1.57}{16.50} \times 100 = 9.52\%$$

(d) Calculation of NPV

$$\text{Poor} = (13.50 \times 175000 \times 3.605) - 3605000 - 5000000$$
$$= -88188$$

$$\text{Normal (200000 units)} = \text{NPV} = 1128500$$

$$\text{Good} \quad \text{NPV} = 2345188$$

<u>NPV</u>	<u>probability</u>
-88188	30%
1128500	60%
2345188	10%

$$\begin{aligned} \text{Expected NPV} &= (-88188 \times 30\%) \\ &+ (1128500 \times 60\%) + (2345188 \times 10\%) \\ &= ₹ 885163 \end{aligned}$$

Since Acceptable Risk is 20%, it means if chances of Negative NPV is more than 20%, project should be Rejected. In this question, probability of Negative NPV is 30% hence project should be rejected.

Question – 36

X Ltd. is considering its new project with the following details: **H.W**

Sr. No.	Particulars	Figures
✓ 1	Initial capital cost	₹ 400 Cr.
✓ 2	Annual unit sales	5 Cr.
✓ 3	Selling price per unit	₹ 100
✓ 4	Variable cost per unit	₹ 50
✓ 5	Fixed costs per year	₹ 50 Cr.
6	Discount Rate	6%

H.W

Required:

1. Calculate the **NPV** of the project.
2. Compute the impact on the project's NPV considering a **2.5 per cent** adverse variance in each variable. Which variable is having maximum effect?

Consider Life of the project as **3 years**.

Scenario Analysis

Question - 43

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:

H/W

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.

2. Scenario Analysis

- There is a limitation of Sensitivity Analysis that one factor will change at one time, it means factors are independent.

But In real life, factors are dependent on each other. If selling price of product decreases, then sales volume will increase. Hence Introduce Scenario Analysis.

- In Scenario Analysis, we change All factors of project simultaneously & calculate NPV in different-different scenario.

3 Decision Tree

Decision Tree is a graphical presentation of decision problem.

Question - 26

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:

- Construct a decision tree for the proposed investment project and calculate the expected net present value (NPV).
- What net present value will the project yield, if worst outcome is realized? What is the probability of occurrence of this NPV?
- What will be the best outcome and the probability of that occurrence?
- Will the project be accepted?

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

v) What is the prob. of Negative NPV =

ii) Worst Outcomes

$$NPV = -14728$$

$$\text{prob.} = 0.08 \text{ or } 8\%$$

$$\text{Expected } (-14728 \times 0.08)$$

iii) Best Outcomes

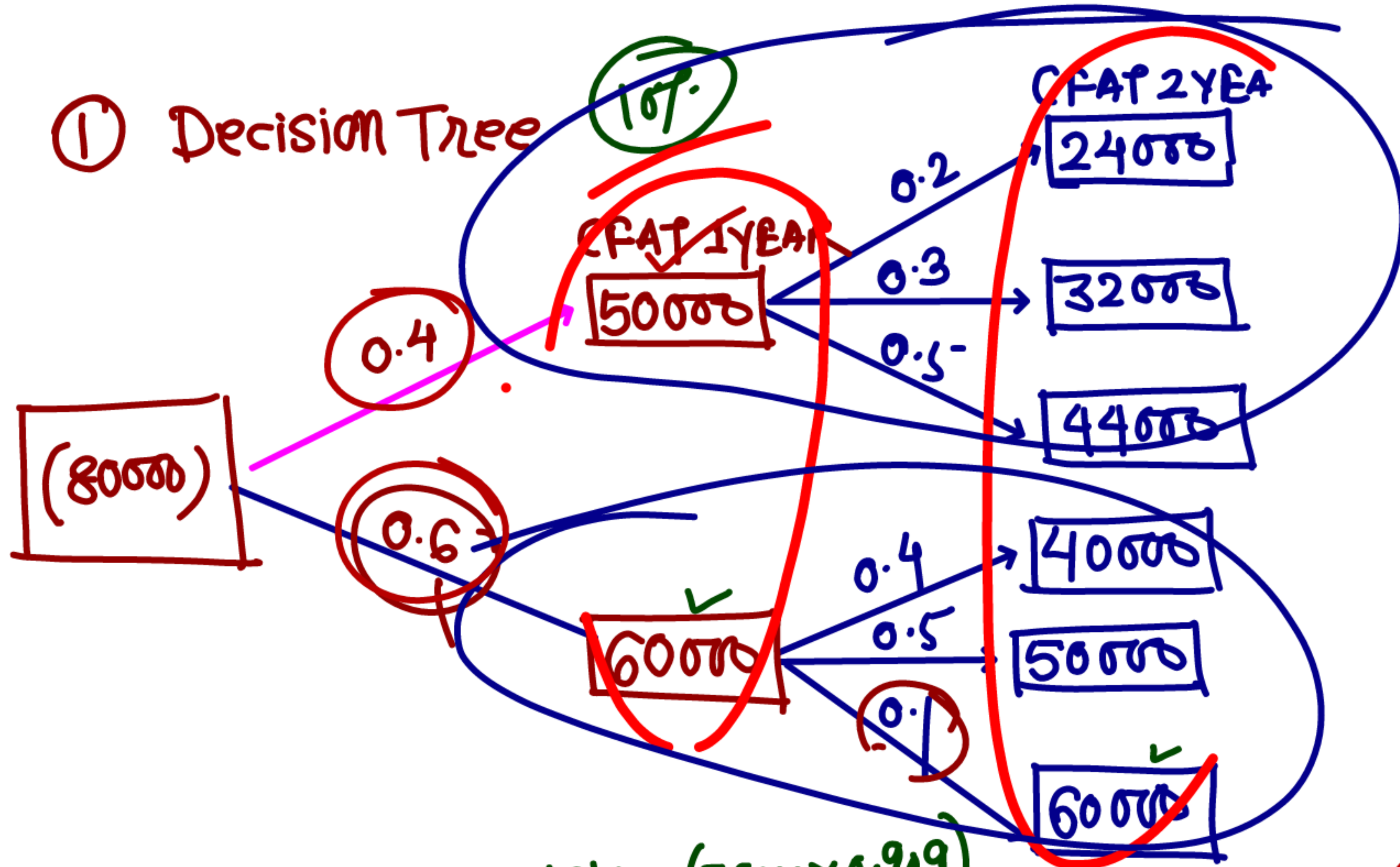
$$NPV = 24100$$

$$\text{prob.} = 0.06$$

$$\text{Expected } (24100 \times 0.06) = 1446$$

iv) Since Expected NPV is positive hence project should be accepted.

① Decision Tree



$$NPV = (56000 \times 0.909) + (42760 \times 0.826) - 80000$$

PATH 1

$$1 \quad 50,000 \times 0.909$$

$$2 \quad 36400 \times 0.826$$

$$- 80000 = (4484)$$

PATH 2

$$1 \quad 60000 \times 0.909$$

$$2 \quad 47600 \times 0.826$$

$$- 80000 = 13362$$

$$(-4484 \times 0.4) + (13362 \times 0.6)$$

Calculation of Expected NPV

Scenario	NPV = PVC I - PVC O	Joint prob.	NPV x J.P.
1	$(50000 \times 0.909) + (24000 \times 0.826) - 80000 = \text{NPV} = (14726)$	0.08	(1178)
2	$(50000 \times 0.909) + (32000 \times 0.826) - 80000 = (8118)$	0.12	(974)
3	$(50000 \times 0.909) + (44000 \times 0.826) - 80000 = 1794$	0.20	359
4	$(60000 \times 0.909) + (40000 \times 0.826) - 80000 = 7580$	0.24	1819
5	$(60000 \times 0.909) + (50000 \times 0.826) - 80000 = 15840$	0.30	4752
6	$(60000 \times 0.909) + (60000 \times 0.826) - 80000 = 24100$	0.06	1446
Expected NPV =			<u>6224</u>

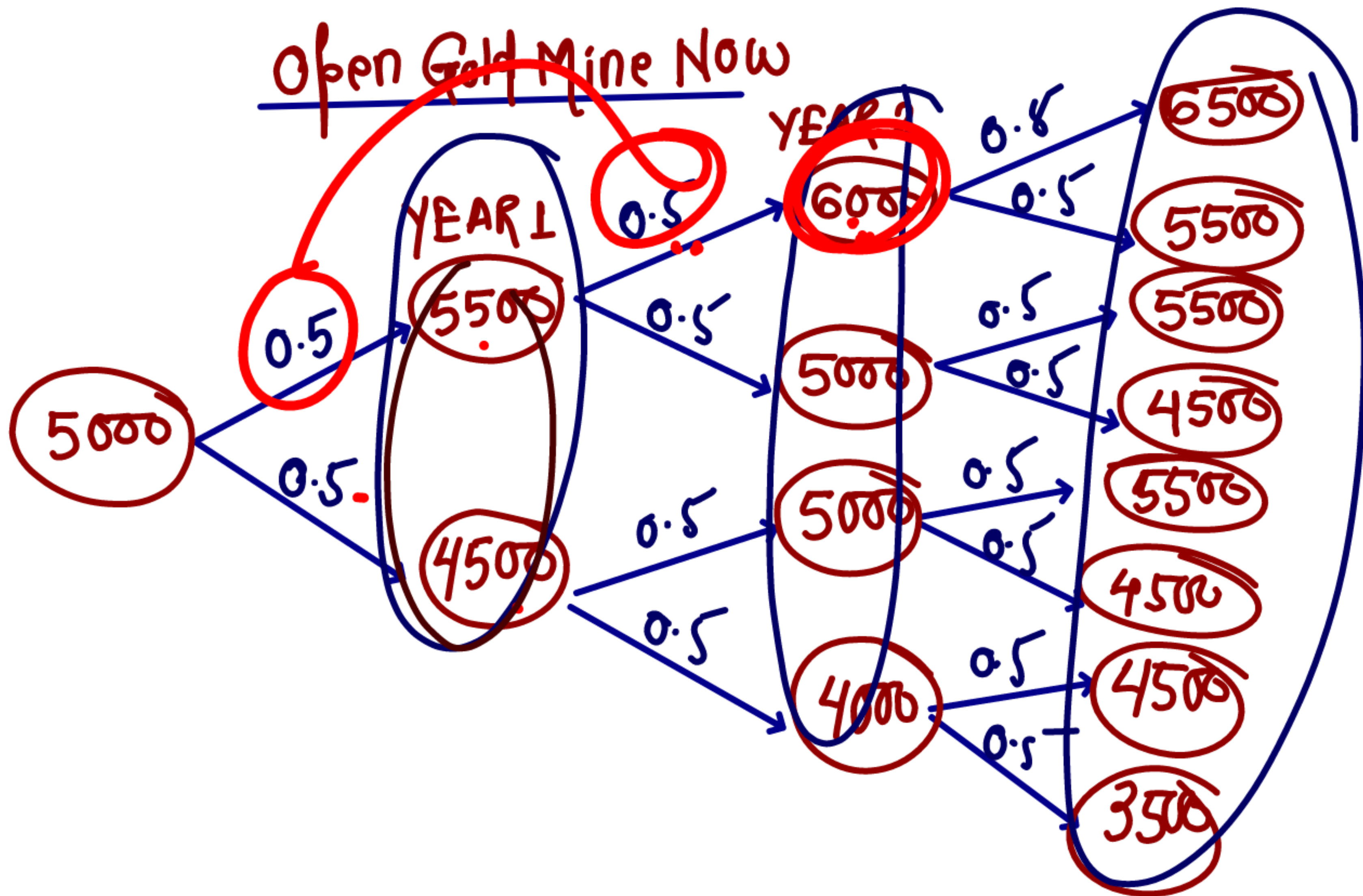
Question – 27

You own an unused Gold mine that will cost ₹10,00,000 to reopen. If you open the mine, you expect to be able to extract 1,000 ounces of Gold a year for each of three years. After that the deposit will be exhausted. The Gold price is currently ₹5,000 an ounce, and each year the price is equally likely to rise or fall by ₹500 from its level at the start of year. The extraction cost is ₹4,600 an ounce and the discount rate is 10 per cent.

Required:

- (a) Should you open the mine now or delay one year in the hope of a rise in the Gold price?
- (b) What difference would it make to your decision if you could costlessly (but irreversibly) shut down the mine at any stage? Show the value of abandonment option.

Open Gold Mine Now



Expected price of Gold

$$\text{YEAR 1} = (5500 + 4500) \times 0.5 = ₹ 5000$$

$$\text{YEAR 2} = (6000 + 5000 + 5000 + 4000) \times (0.5)^2 = ₹ 5000$$

$$\text{YEAR 3} = \quad \quad \quad \times (0.5)^3 = ₹ 5000$$

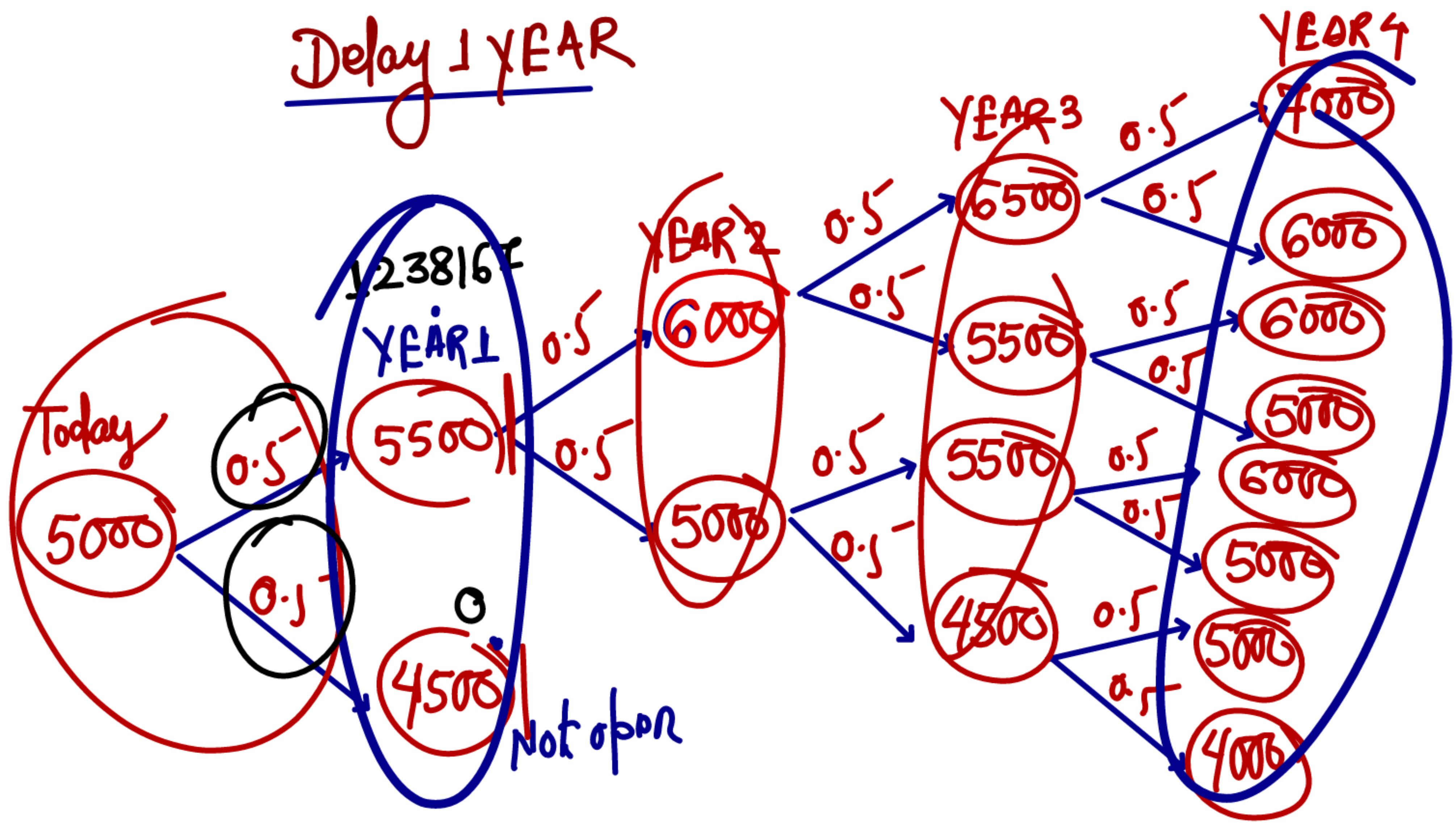
Calculation of NPV

$$\text{Gold price} = ₹ 5000$$

$$\begin{aligned} \text{(-) Extraction cost} &= ₹ 4600 \\ \text{Cash Inflow} & ₹ 400 \text{ per ounce} \\ \text{(x) Quantity} & \frac{1000}{400000} \end{aligned}$$

$$\begin{aligned} \text{NPV} &= \frac{400000}{(1.10)^1} + \frac{400000}{(1.10)^2} \\ &+ \frac{400000}{(1.10)^3} - 1000000 \\ &= (5260) \end{aligned}$$

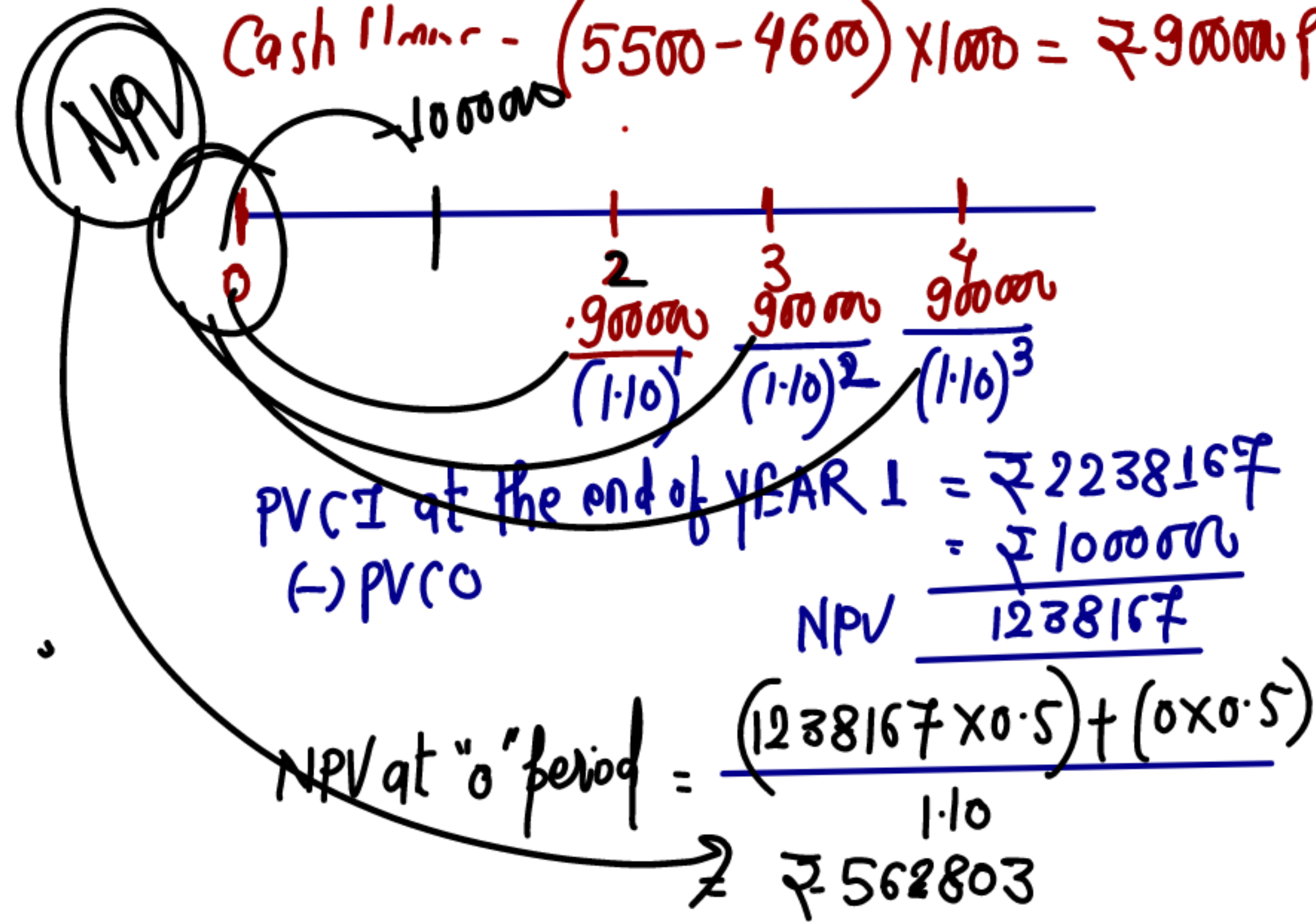
Delay 1 YEAR



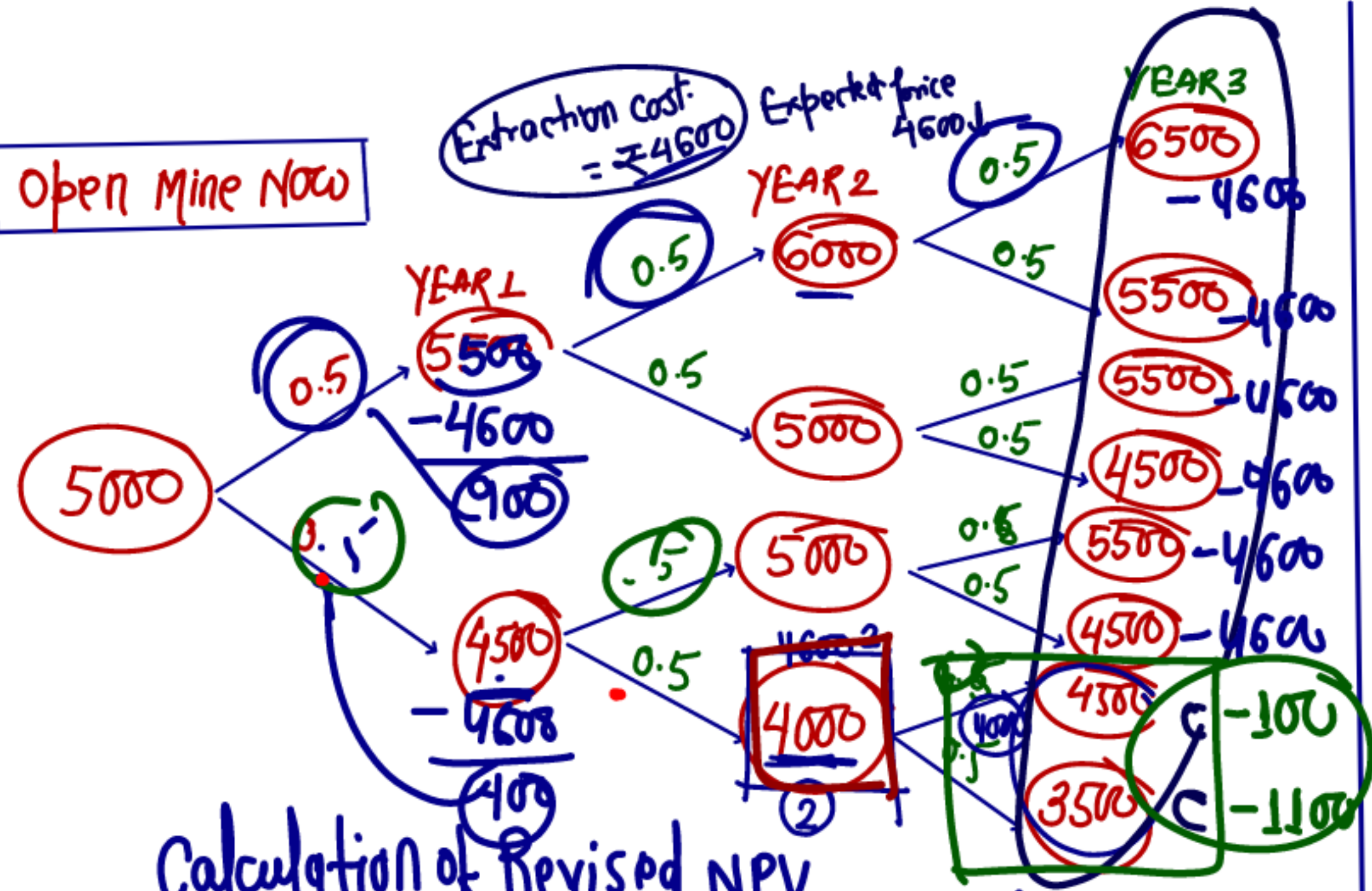
Calculation of Expected price

$$\begin{array}{l} \text{YEAR 2} \quad (6000 + 5000) \times 0.5 = 5500 \\ \text{YEAR 3} \quad \quad \quad \quad \quad \quad \quad = 5500 \\ \text{YEAR 4} \quad \quad \quad \quad \quad \quad \quad = 5500 \end{array}$$

$$\text{Cash flow} - (5500 - 4600) \times 1000 = ₹ 900000 \text{ p.a.}$$



Open Mine Now



Calculation of Revised NPV
if we shut down Gold Mine when price is ₹4000

$$\text{Value of abandonment} = \frac{[0.125(-100-1100)] \times 1000}{(1.10)^3}$$

$$= 112698$$

$$-5260 + 112698 = 107438$$

YEAR 1	YEAR 2	YEAR 3
5000	5000	
-4600	-4600	
<u>400</u>	<u>400</u>	
<u>× 1000</u>	<u>× 1000</u>	
₹400000	400000	550000

YEAR 3

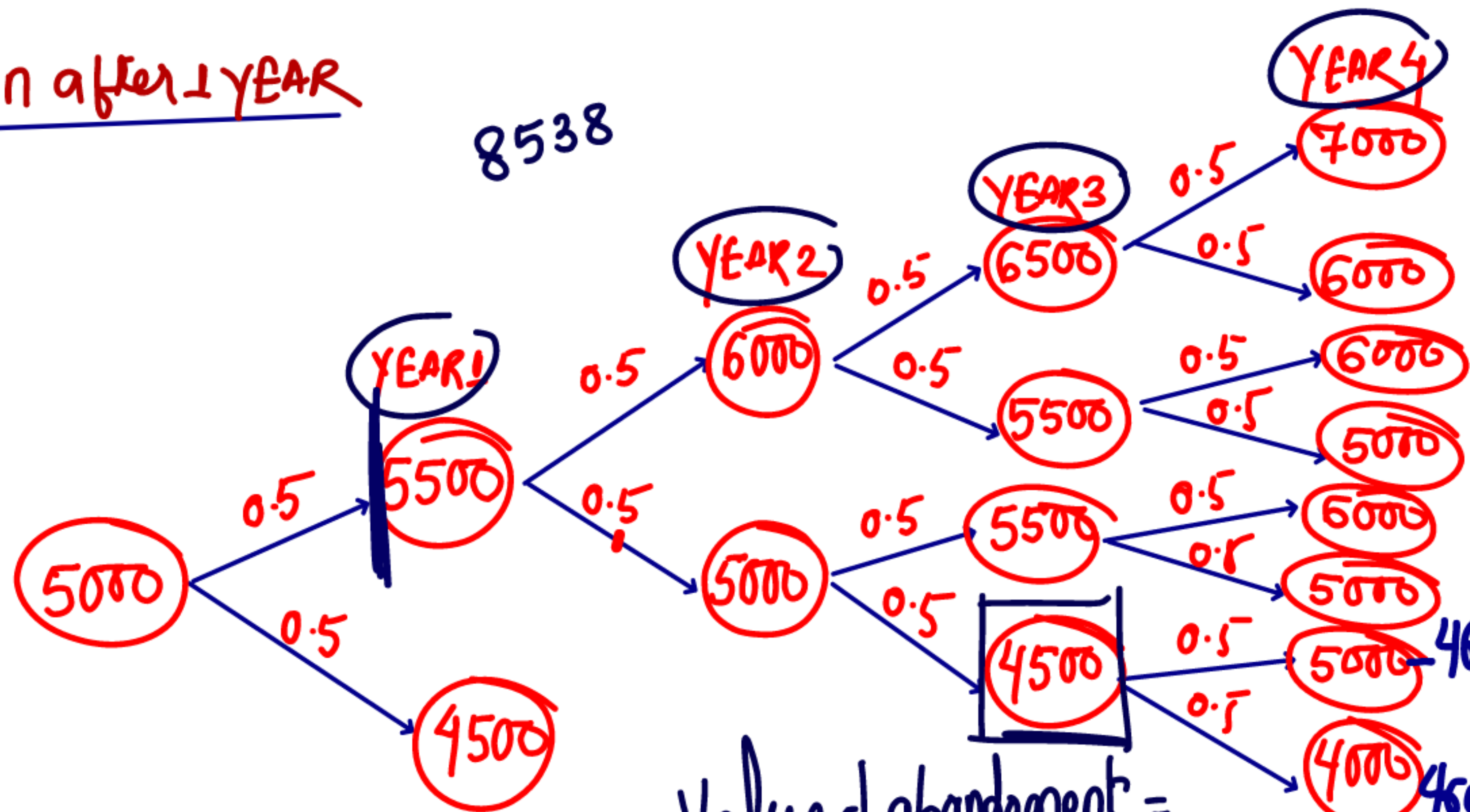
$$\text{NPV} = \frac{400000}{(1.10)^1} + \frac{400000}{(1.10)^2} + \frac{550000}{(1.10)^3} - 1000000 = ₹107438$$

Value of Abandonment = 107438 + 5260 = 112698

-5260

Open after 1 YEAR

8538



Value of abandonment

$$\frac{0.125 (400 - 600) \times 1000}{(1.10)^3}$$

YEAR 1 End

$$18782.87 \times 0.5$$

1.10

$$= ₹ 8538$$

Value of abandonment =
Revised NPV =

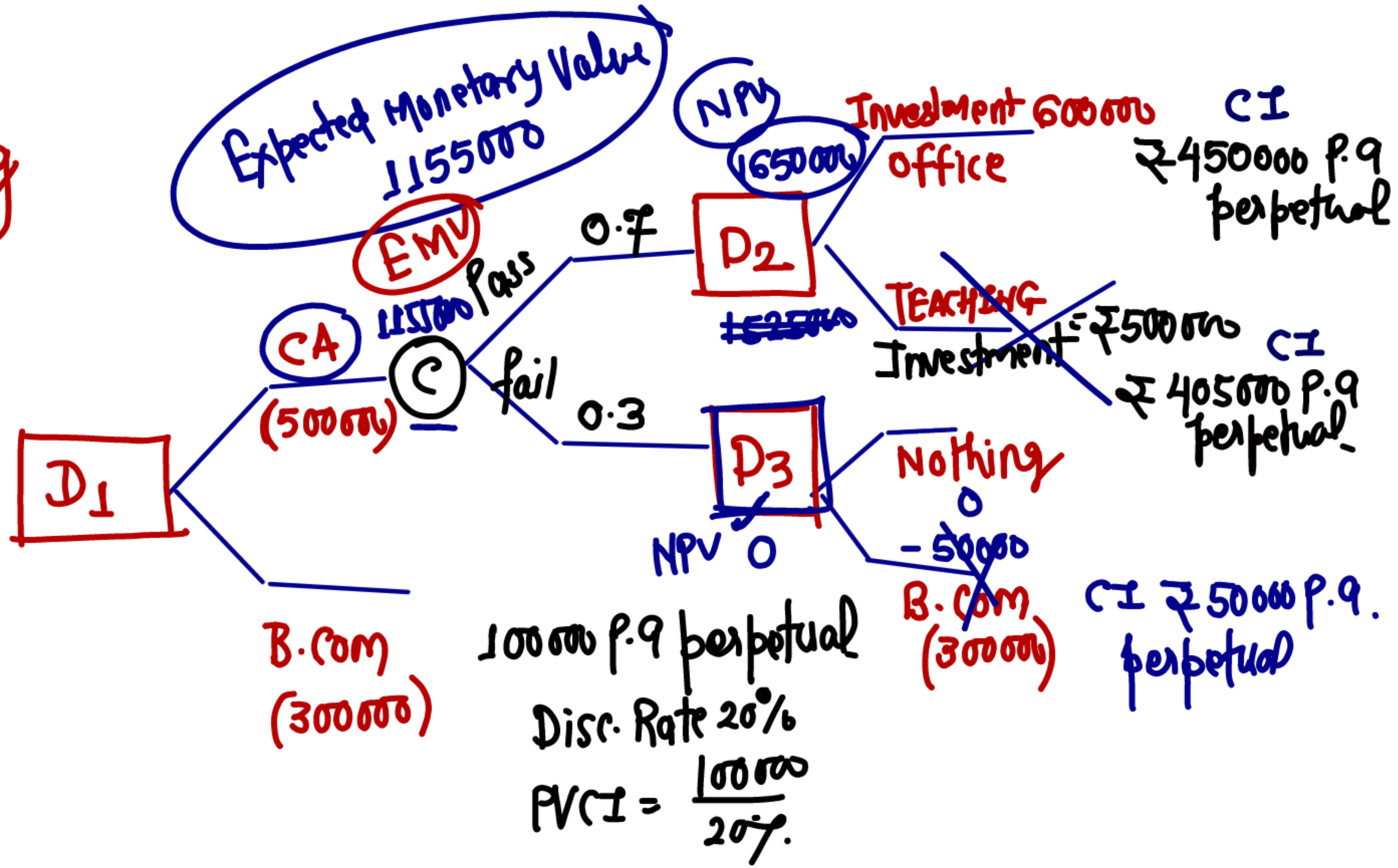
NPV

$$4600 = \boxed{400}$$

$$4600 = 562803$$

$$4600 = \boxed{-600}$$

Eg



• At decision point D₂ (Node D₂)

There are two options

option 1 Office NPV = $\frac{450000}{20\%} - 600000 = ₹ 1650000$

option 2 TEACHING NPV = $\frac{405000}{20\%} - 500000 = ₹ 1525000$

At this point, office is better due to higher NPV

• At decision point D₃ (Node D₃)

option 1 Do Nothing NPV = 0

option 2 B.Com $\left(\frac{50000}{20\%} - 300000 \right) = -50000$

Do Nothing is better.

Expected Monetary Value [EMV] at point c

$$\begin{aligned} \text{EMV} &= (1650000 \times 0.7) + (0 \times 0.3) \\ &= ₹ 1155000 \end{aligned}$$

At decision point D₁

option 1 CA NPV = $1155000 - 500000 = 655000$

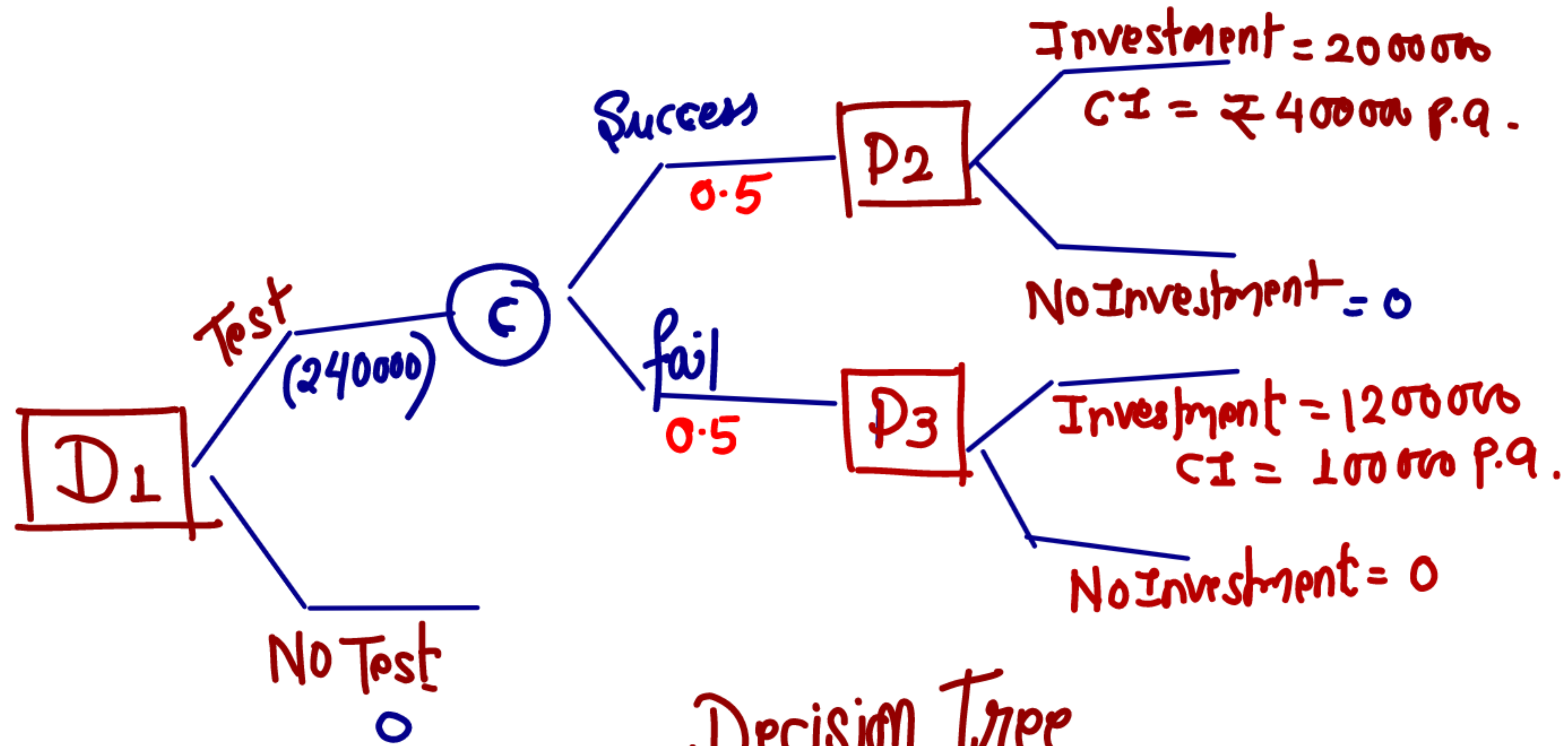
option 2 B.COM NPV = $\frac{1000000}{20\%} - 300000 = 2000000$

CA is better due to higher NPV

Question: 30

SM Test

L & R Limited wishes to develop new virus-cleaner software. The cost of the pilot project would be ₹2,40,000. Presently, the chances of the product being successfully launched on a commercial scale are rated at 50%. In case it does succeed, L&R can invest a sum of ₹20 lacs to market the product. Such an effort can generate perpetually, an annual net after tax cash income of ₹4 lacs. Even if the commercial launch fails, they can make an investment of a smaller amount of ₹12 lacs with the hope of gaining perpetually a sum of ₹1 lac. Evaluate the proposal, adopting decision tree approach. The discount rate is 10%.



Evaluation

At decision point D₂

option 1 If Investment $NPV = \frac{400000}{10\%} - 2000000 = 2000000$

option 2 No Investment $NPV = 0$

Investment is better due to higher NPV

At decision point 3

option 1 Investment $NPV = \frac{1000000}{10\%} - 1200000 = -200000$

option 2 No Investment $NPV = 0$

No Investment is better

Calculation of EMV at point C

$$(2000000 \times 0.5) + (0 \times 0.5) = 1000000$$

At decision point D₁

option 1 Testing

$$NPV = (1000000 - 240000) \\ = ₹ 760000$$

option 2 No Testing
 $NPV = 0$

Testing is better due to higher NPV

PART III Replacement Decision

30% 900

Eg

B.V. = ₹ 60000 Market Value of old = ₹ 63000

CFAT = 45000 p.a

10 YEARS

160000
- 52100
97900

Cost of Machine = 100000
life = 10 years
Salvage = 0
Dep = SLM

Salvage Value of old = 2000

CFAT = 72000 p.a.

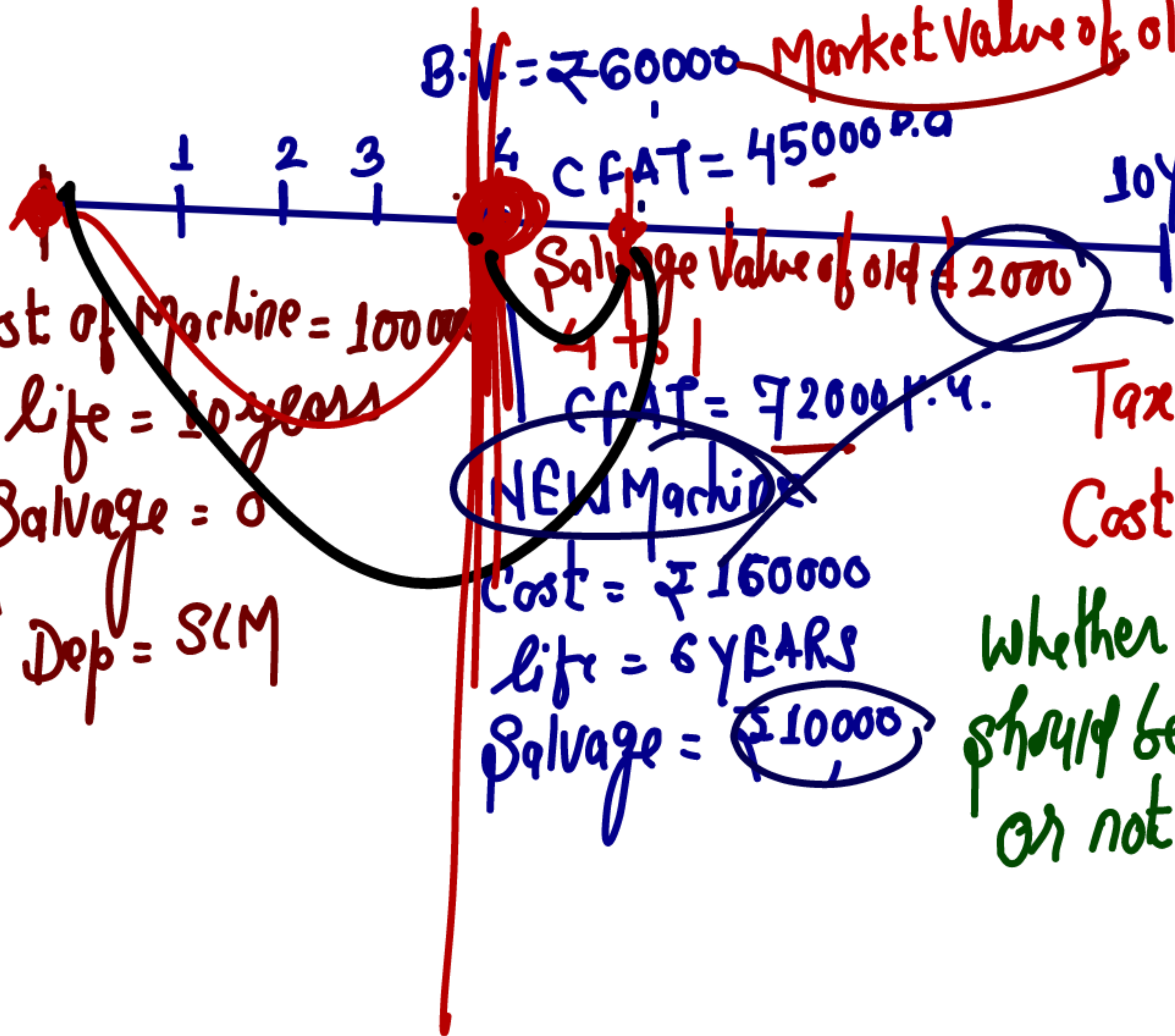
Tax Rate = 30%
Cost of Capital = 10%

NEW Machine

Cost = ₹ 160000
life = 6 YEARS
Salvage = ₹ 10000

Whether old machine should be replaced or not?

63000
- 900
62100



Statement showing Calculation of NPV

	YEAR	PVF (10%)	Amount	P.V.
<u>(A) Incremental Cash Outflow</u>				
Cost of New Machine	0	1.000	160000	160000
Sale of old Machine (Net of Tax) (W.N!) (A)	0	1.000	(62100)	(62100)
				<u>97900</u>
<u>(B) Incremental Cash Inflow</u>				
Incremental CFAT (72000 - 45000)	1-6	4.355	27000	117585
Incremental Terminal Value (10000 - 2000) (B)	6	0.564	8000	4512
				<u>122097</u>
				<u>24197</u>

Machine should be replaced, due to positive NPV

W.N.1 Sale of old Machine

Sales Consideration = ₹ 63,000 - (i)

(-) Book Value = ₹ 60,000

Capital Gain = ₹ 3,000

Tax @ 30% = ₹ 900 - (ii)

Sales Consideration
(Net of Tax) ₹ 62,100 (i-ii)

Question: 11

SM

12

A Company named Roby's cube decided to replace the existing Computer system of their organization. Original cost of old system was ₹ 25,000 and it was installed 5 years ago. Current market value of old system is ₹ 5,000. Depreciation of the old system was charged with life of 10 years with Estimated Salvage value as Nil. Depreciation of the new system will be charged with life over 5 years. Present cost of the new system is ₹ 50,000. Estimated Salvage value of the new system is ₹ 1,000. Estimated cost savings with new system is ₹ 5,000 per year. Increase in sales with new system is assumed at 10% per year based on original total sales of ₹ 10,00,00. Company follows straight line method of depreciation. Cost of capital of the company is 10% whereas tax rate is 30%.

(Page No. 17)

W.N. 1 Sale of old machine

Sales consideration = 5000 - (I)
(-) B.V. of old machine =
[25000 - (25000 x 5)] 12500
Capital loss 7500
Tax savings @ 30% 2250 - (II)
Net consideration 7250
(i+ii)

Q.N. 2 Incremental CFAT

Savings in cost = ₹ 5000
Increase in Revenue = ₹ 10000
(₹ 100000 × 10%)
Incremental CFBT ₹ 15000 — (i)

(-) Incremental Dep.
 $\left[\left(\frac{50000 - 10000}{5} \right) - 2500 \right]$ ₹ 7300
Incremental PBT 7700
Tax @ 30% 2310 — (ii)
Incremental CFAT 12690 (i-ii)

Calculation of NPV

	YEAR	PVF (10%)	Amt	P.V.
<u>(A) Incremental C.O.</u>				
Cost of New Machine	0	1.000	50000	50000
Sale of old Machine (W.N-L)	0	1.000	(7250)	(7250)
				<u>42750</u>
<u>(B) Incremental CI</u>				
Incremental CFAT	1-5	3.791	12690	48108
Incremental P.V.	5	0.621	1000	621
				<u>48729</u>
NPV				<u>5079</u>

Question: 05

A company has an old machine having book value zero - which can be sold for ₹ 50,000. The company is thinking to choose one from following two alternatives:

- (i) To incur additional cost of ₹ 10,00,000 to upgrade the old existing machine.
- (ii) To replace old machine with a new machine costing ₹ 20,00,000 plus installation cost ₹ 50,000.

Both above proposals envisage useful life to be five years with salvage value to be nil.

The expected after tax profits for the above three alternatives are as under :

Year	Old existing Machine (₹)	Upgraded Machine (₹)	New Machine (₹)
1	5,00,000	5,50,000	6,00,000
2	5,40,000	5,90,000	6,40,000
3	5,80,000	6,10,000	6,90,000
4	6,20,000	6,50,000	7,40,000
5	6,60,000	7,00,000	8,00,000

The tax rate is 40 per cent.

The company follows straight line method of depreciation. Assume cost of capital to be 15 per cent.

P.V.F. of 15%, 5 = 0.870, 0.756, 0.658, 0.572 and 0.497. You are required to advise the company as to which alternative is to be adopted.

Option 1 Upgraded Machine

Calculation of NPV

	1	2	3	4	5
Upgrade PAT	550000	590000	610000	650000	700000
(+) Dep	200000	200000	200000	200000	200000
CFAT	750000	790000	810000	850000	900000
(-) CFAT (old)	500000	540000	580000	620000	660000
Incremental CFAT	250000	250000	230000	230000	240000
(x) PVF	0.870	0.756	0.658	0.572	0.497

PVCI = 808680

(-) PVCO = 1000000

NPV = (191320)

NEW Machine

	1	2	3	4	5
New Machine PAT	600000	640000	690000	740000	800000
(+) Dep $\left[\frac{2050000}{5} \right]$	410000	410000	410000	410000	410000
CFAT	1010000	1050000	1100000	1150000	1210000
(-) CFAT of old	500000	540000	580000	620000	660000
Incremental CFAT	510000	510000	520000	530000	550000
(x) PVF	0.870	0.756	0.658	0.572	0.497

Sale of old Machine

Sale Consideration =	50000
(-) B.V.	0
Cap. Gain	50000
Tax @ 40%	20000
	30000

PVCI = 1747930

(-) PV(0) $\frac{2020000}{(272070)}$
 NPV $\frac{(2050000 - 30000)}{(272070)}$

Since NPV is Negative in both option, hence old machine without upgradation is better

TYK 24

Question: 07

Company X is forced to choose between two machines A and B. The two machines are designed differently but have identical capacity and do exactly the same job. Machine A costs ₹1,50,000 and will last for 3 years. It costs ₹40,000 per year to run. Machine B is an 'economy' model costing only ₹1,00,000, but will last only for 2 years, and costs ₹60,000 per year to run. These are real cash flows. The costs are forecasted in rupees of constant purchasing power. Ignore tax. Opportunity cost of capital is 10 per cent. Which machine company X should buy?

(Page No. 12)

Calculation of EAPVCO

Machine A

$$PVCO = 150000 + (40000 \times 2.487)$$
$$= 294474$$

$$EAPVCO = \frac{PVCO}{PVAf} = \frac{249480}{2.487} = 100314$$

EPVCO lower Accept

Machine B

$$PVCO = 100000 + (60000 \times 1.735)$$

$$EAPVCO = \frac{204100}{1.735} = 117637$$

Q3

Question: 03

ABC Chemicals is evaluating two alternative systems for waste disposal, System A and System B, which have lives of 6 years and 4 years respectively. The initial investment outlay and annual operating costs for the two systems are expected to be as follows:

	System A	System B
Initial Investment Outlay	₹ 5 million	₹ 4 million
Annual Operating Costs	₹ 1.5 million	₹ 1.6 million
Salvage value	₹ 1 million	₹ 0.5 million

If the hurdle rate is 15%, which system should ABC Chemicals choose?

H/W

The PVIF @ 15% for the six years are as below:

Year	1	2	3	4	5	6
PVIF	0.8696	0.7561	0.6575	0.5718	0.4972	0.4323



Replacement decision

Whenever old machine is in working condition, but new machine with better technology is available in market.

In this situation, decision is taken whether old machine should be replaced or not? Such decision is taken on the basis of incremental cash flows.

TYK 26

Question: 09

A machine used on a production line must be replaced at least every four years. Costs incurred to run the machine according to its age are:

Age of the Machine (years)					
	0	1	2	3	4
Purchase price (in ₹)	60,000				
Maintenance (in ₹)		16,000	18,000	20,000	20,000
Repair (in ₹)		0	4,000	8,000	16,000
Scrap Value (in ₹)		32,000	24,000	16,000	8,000

Future replacement will be with identical machine with same cost. Revenue is unaffected by the age of the machine. Ignoring inflation and tax, determine the optimum replacement cycle. PV factors of the cost of capital of 15% for the respective four years are 0.8696, 0.7561, 0.6575 and 0.5718.

Statement showing PVCO

	YEAR	PVP.	EVERY YEAR		2 YEARS		3 YEARS		4 YEARS	
			Amt	P.V.	Amt	P.V.	Amt	P.V.	Amt	P.V.
Cost Maintenance & Repair	0	1.000	60000	60000	60000	60000	60000	60000	60000	60000
	1	0.8696	16000	13914	16000	13914	16000	13914	16000	13914
	2	0.7561	-	-	22000	16634	22000	16634	22000	16634
	3	0.6575	-	-	-	-	28000	18410	28000	18410
	4	0.5718	-	-	-	-	-	-	36000	20585
Salvage	1	0.8696	(32000)	(27827)	-	-	-	-	-	-
	2	0.7561	-	-	(24000)	(18146)	-	-	-	-
	3	0.6575	-	-	-	-	(16000)	(10520)	-	-
	4	0.5718	-	-	-	-	-	-	(8000)	(4574)
				46087	72462	98438	124969			
				0.8696	1.6257	2.2832	2.858			
				₹ 52998	₹ 44536	43114	43772			

PVCO
÷ PVAF

EAPVCO

optimal Replacement cycle is 3 YEARS due to
Lower PVCO

~~Q12~~ I/13

Question: 12

X Ltd. is a taxi operator. Each taxi cost to company ₹4,00,000 and has a useful life of 3 years. The taxi's operating cost for each of 3 years and salvage value at the end of year is as follows:

	Year 1	Year 2	Year 3
Operating Cost	₹ 1,80,000	₹ 2,10,000	₹ 2,38,000
Resale Value	₹ 2,80,000	₹ 2,30,000	₹ 1,68,000

You are required to determine the optimal replacement period of taxi if cost of capital of X Ltd. is 10%.

Statement showing Calculation of PVCO

	YEAR	PVf (10%)	Replace Every Year		2 YEARS		3 YEARS	
			Amt	P.V.	Amt	P.V.	Amt	P.V.
Cost operating cost	0	1.000	400000	400000	400000	400000	400000	400000
	1	0.909	180000	163620	180000	163620	180000	163620
	2	0.826	—	—	210000	173460	210000	173460
	3	0.751	—	—	—	—	238000	178738
Salvage	1	0.909	(280000)	(254520)	—	—	—	—
	2	0.826	—	—	(230000)	(189980)	—	—
	3	0.751	—	—	—	—	(168000)	(126168)
PVCO					547100		789650	
÷ PVAf			309100 0.909		1.735		9.486	
EAPVCO			340044		315331		317639	



Question: 10

Trouble Free Solutions (TFS) is an authorized service center of a reputed domestic air conditioner manufacturing company. All complaints/service related matters of Air conditioner are attended by this service center. The service center employs a large number of mechanics, each of whom is provided with a motor bike to attend the complaints. Each mechanic travels approximately 40,000 kms per annum. TFS decides to continue its present policy of always buying a new bike for its mechanics but wonders whether the present policy of replacing the bike every three year is optimal or not. It is of believe that as new models are entering into market on yearly basis, it wishes to consider whether a replacement of either one year or two years would be better option than present three year period. The fleet of bike is due for replacement shortly in near future.

The purchase price of latest model bike is ₹ 55,000. Resale value of used bike at current prices in market is as follows:

Period	₹
1 Year old	35,000
2 Year old	21,000
3 Year old	9,000

Running and Maintenance expenses (excluding depreciation) are as follows:

Year	Road Insurance etc. (₹)	Taxes	Petrol Maintenance (₹)	Repair etc.
1		3,000		30,000
2		3,000		35,000
3		3,000		43,000

Using opportunity cost of capital as 10% you are required to determine optimal replacement period of bike.

TYK 25

Question: 08

Company Y is operating an elderly machine that is expected to produce a net cash inflow of ₹ 40,000 in the coming year and ₹ 40,000 next year. Current salvage value is ₹ 80,000 and next year's value is ₹ 70,000. The machine can be replaced now with a new machine, which costs ₹ 1,50,000, but is much more efficient and will provide a cash inflow of ₹ 80,000 a year for 3 years. Company Y wants to know whether it should replace the equipment now or wait a year with the clear understanding that the new machine is the best of the available alternatives and that it in turn be replaced at the optimal point. Ignore tax. Take opportunity cost of capital as 10 per cent. Advise with reasons.

(Page No. 13)

Statement showing calculation of NPV

ICAI

	YEAR	PVF (10%)	Replace Now		Replace one YEAR	
			Amt	P.V.	Amt	P.V.
<u>Cash Outflows</u>						
Cost of New Machine	0	1.000	150000	150000	-	-
	1	0.909	-	-	150000	136350
Sale of old machine	0	1.000	(80000)	(80000)	-	-
	1	0.909	-	-	(70000)	(63630)
				<u>70000</u>		<u>72720</u>
<u>Cash Inflows</u>						
CFAT	1-3	2.487	80000	198960	-	-
	1	0.909	-	-	40000	36360
	2-4	2.261	-	-	80000	180880
				<u>198960</u>		<u>217240</u>
				<u>128960</u>		<u>144520</u>

(A)

(B)

NPV(B-A)

Exam में ऐसे ही करना है

Machine should be replaced in YEAR 1 due to higher NPV

Question: 06

SM TYK 22 Imp

A & Co. is contemplating whether to replace an existing machine or to spend money on overhauling it. A & Co. currently pays no taxes. The replacement machine costs ₹ 90,000 now and requires maintenance of ₹ 10,000 at the end of every year for eight years. At the end of eight years it would have a salvage value of ₹ 20,000 and would be sold. The existing machine requires increasing amounts of maintenance each year and its salvage value falls each year as follows:

Year	Maintenance (₹)	Salvage (₹)
Present	0	40,000 ✓
1	10,000 ✓	25,000
2	20,000 ✓	15,000 ✓
3	30,000	10,000
4	40,000	0

The opportunity cost of capital for A & Co. is 15%.

Required:

When should the company replace the machine?

(Notes: Present value of an annuity of Re. 1 per period for 8 years at interest rate of 15% : 4.4873; present value of Re. 1 to be received after 8 years at interest rate of 15% : 0.3269).

New Machine

Cost of New Machine = ₹ 90,000

(+) P.V. of Maintenance cost =
(₹ 10,000 × 4.4873) = ₹ 44,873

(-) P.V. of Salvage
(₹ 20,000 × 0.3269) = (6,538)

Cost

₹ 128,335

Equivalent cost = $\frac{128335}{4.4873}$

= 28,600

	YEAR	PVF (15%)	NOW		1 YEAR		2 YEAR		3 YEAR		4 YEAR	
			Amt	P.V.	Amt	P.V.	Amt	P.V.	Amt	P.V.	Amt	P.V.
EAC Net of Salvage	0	1.000	11400	11400	-	-	-	-	-	-	-	-
	1	0.870	-	-	(3000)	(3132)	-	-	-	-	-	-
	2	0.756	-	-	-	-	(18600)	(10282)	-	-	-	-
	3	0.658	-	-	-	-	-	-	(18600)	(12239)	-	-
	4	0.572	-	-	-	-	-	-	-	-	(28600)	(16359)
Maintenance cost	1	0.870	-	-	(10000)	(8700)	(10000)	(8700)	(10000)	(8700)	(10000)	(8700)
	2	0.756	-	-	-	-	(20000)	(15120)	(20000)	(15120)	(20000)	(15120)
	3	0.658	-	-	-	-	-	-	(20000)	(19740)	(30000)	(19740)
	4	0.572	-	-	-	-	-	-	-	-	(40000)	(22880)
					11400	(11832)	(39102)	(55799)	(82799)			

Question: 01

A manufacturing unit engaged in the production of automobile parts is considering a proposal of purchasing one of the two plants, details of which are given below:

Particulars	Plant A	Plant B
Cost	₹ 20,00,000	₹ 38,00,000
Installation charges	₹ 4,00,000	₹ 2,00,000
Life	20 years	15 years
Scrap value after full life	₹ 4,00,000	₹ 4,00,000
Output per minute (units)	200	400

The annual costs of the two plants are as follows:

Particulars	Plant A	Plant B
Running hours per annum	2,500	2,500
Costs: (In ₹)	(In ₹)	(In ₹)
Wages	1,00,000	1,40,000
Indirect materials	4,80,000	6,00,000
Repairs	80,000	1,00,000
Power	2,40,000	2,80,000
Fixed Costs	60,000	80,000

Will it be advantageous to buy Plant A or Plant B? Substantiate your answer with the help of comparative unit cost of the plants. Assume interest on capital at 10 percent. Make other relevant assumptions:

Note: 10 percent interest tables

	20 Years	15 Years
Present value of ₹ 1	0.1486	0.2394
Annuity of ₹ 1 (capital recovery factor with 10% interest)	0.1175	0.1315

Calculation of Capital charge p.u.

	A	B
Cost	2400000	4000000
(-) P.V. of Salvage	(4000000×0.1486) <u>(59440)</u>	(4000000×0.2394) <u>(95760)</u>
Cost	2340560	3904240
(x) Capital Recovery	<u>0.1175</u>	<u>0.1315</u>
Capital charge	275016	513468
(+) Operational Exp. p.u.	<u>960000</u>	<u>1200000</u>
Total cost	1235016	1713468
÷ No. of units	3000000	6000000
Cost per unit	0.04117	0.02856

15 YEARS

Project
200 Cr.

Equity

Loan @ 15%

₹ 50 Cr.

₹ 150 Cr.

Revenue = ₹ 50 Cr.

Exp. = ₹ 10 Cr.

Question: 02

XYZ Ltd., an infrastructure company is evaluating a proposal to build, operate and transfer a section of 35 kms. of road at a project cost of ₹ 200 crores to be financed as follows:

Equity Shares Capital ₹ 50 crores, loans at the rate of interest of 15% p.a. from financial institutions ₹ 150 crores. The Project after completion will be opened to traffic and a toll will be collected for a period of 15 years from the vehicles using the road. The company is also required to maintain the road during the above 15 years and after the completion of that period, it will be handed over to the Highway authorities at zero value. It is estimated that the toll revenue will be ₹ 50 crores per annum and the annual toll collection expenses including maintenance of the roads will amount to 5% of the project cost. The company is allowed to write off the total cost of the project in 15 years on a straight line basis. For Corporate Incometax purposes the company is allowed to take depreciation @ 10% on WDV basis. The financial institutions are agreeable for the repayment of the loan in 15 equal annual installments - consisting of principal and interest.

Calculate Project IRR and Equity IRR. Ignore Corporate taxation.

Explain the difference in Project IRR and Equity IRR.

Calculation of CFAT

Revenue = ₹ 50 Cr.

(-) Exp. = ₹ 10 Cr.

CFAT = ₹ 40 Cr.

Project Cost = ₹ 200 Cr.

① Calculation of project IRR

At IRR, NPV = 0

Let assume disc. rate 10%

$$NPV = (40 \times 7.606) - 200 = 104.24$$

15%

$$NPV = (40 \times 5.847) - 200 = 33.88$$

20%

$$NPV = (40 \times 4.675) - 200 = (13)$$

Interpolation

15%	—————	33.88	33.88
20%	—————	(13)	
<u>5%</u>		<u>46.88</u>	

$$\begin{aligned} \text{project IRR} &= 15 + \left(\frac{5}{46.88} \times 33.88 \right) \\ &= 18.61\% \end{aligned}$$

② Calculation of Equity IRR

$$\begin{aligned}\text{Equal Annual Installment} &= \frac{\text{Loan Amt}}{\text{PVAF (Rate of Int)}} \\ &= \frac{₹ 150 \text{ Cr.}}{\text{PAAF (15\%, 15yr)}} \\ &= \frac{₹ 150}{5.847} = ₹ 25.654\end{aligned}$$

Cash Flow for Equity

CFAT	40 Cr.
(-) Repayment of debt	25.65
CF for Equity	<u>14.35 Cr.</u>

Cash flows p.a. 14.35 cr.

Cash outflows = ₹ 50 cr.

IRR is a rate at $PVCI = PVCO$

Disc. Rate = 25%

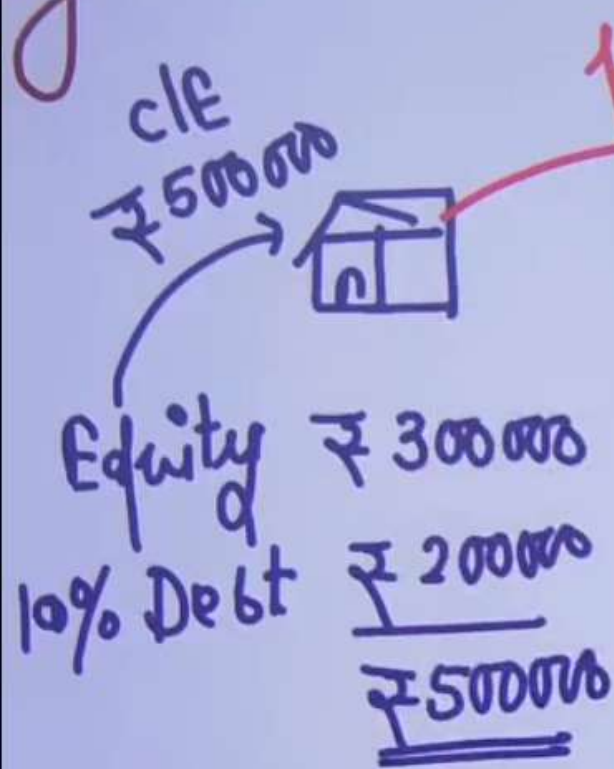
$$NPV = (14.35 \times 3.859) - 50 = 5.377$$

Disc. Rate = 30%

$$NPV = (14.35 \times 3.268) - 50 = (3.104)$$

$$\begin{array}{r}
 25\% \quad \text{---} \quad 5.377 \quad \overset{5.377}{\underset{0}{|}} \\
 30\% \quad \text{---} \quad (3.104) \quad \sim \\
 \hline
 5\% \\
 25 + \left(\frac{5}{8.481} \times 5.377 \right) = 28.17\%
 \end{array}$$

Eg



Assume NO Tax

Calculate

- ① Return on Investment (ROI)
- ② Return on Equity (ROE)

$$ROI = \frac{80,000}{500,000} \times 100 = 16\%$$

$$ROE = \frac{60,000}{300,000} \times 100 = 20\%$$

EBIT 80000

(-) Int 20000

EBT 60000

$$\begin{aligned} \text{ROE} &= \text{ROI} + (\text{ROI} - k_d) \frac{D}{E} \\ &= 16 + (16 - 10) \frac{200000}{300000} \\ &= 20\% \end{aligned}$$

- project IRR just like ROI & it is calculate for Debt & Equity both

$$\text{project IRR} = 18.61\%$$

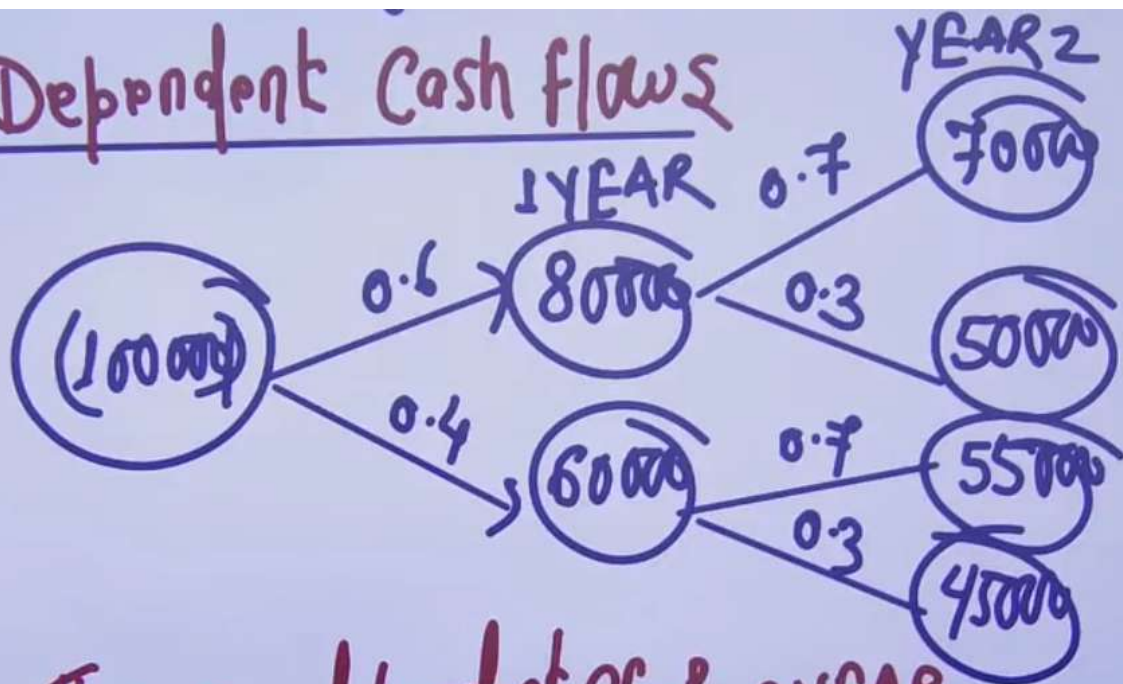
- Equity IRR just like ROE & it is calculated for Equity only

$$\begin{aligned}\text{Equity IRR} &= \text{project IRR} + (\text{project IRR} - k_d) \frac{D}{E} \\ &= 18.61 + (18.61 - 15) \frac{150}{50} \\ &= 29.44\%\end{aligned}$$

HERTZ MODEL & HILLIER MODEL (Imp)

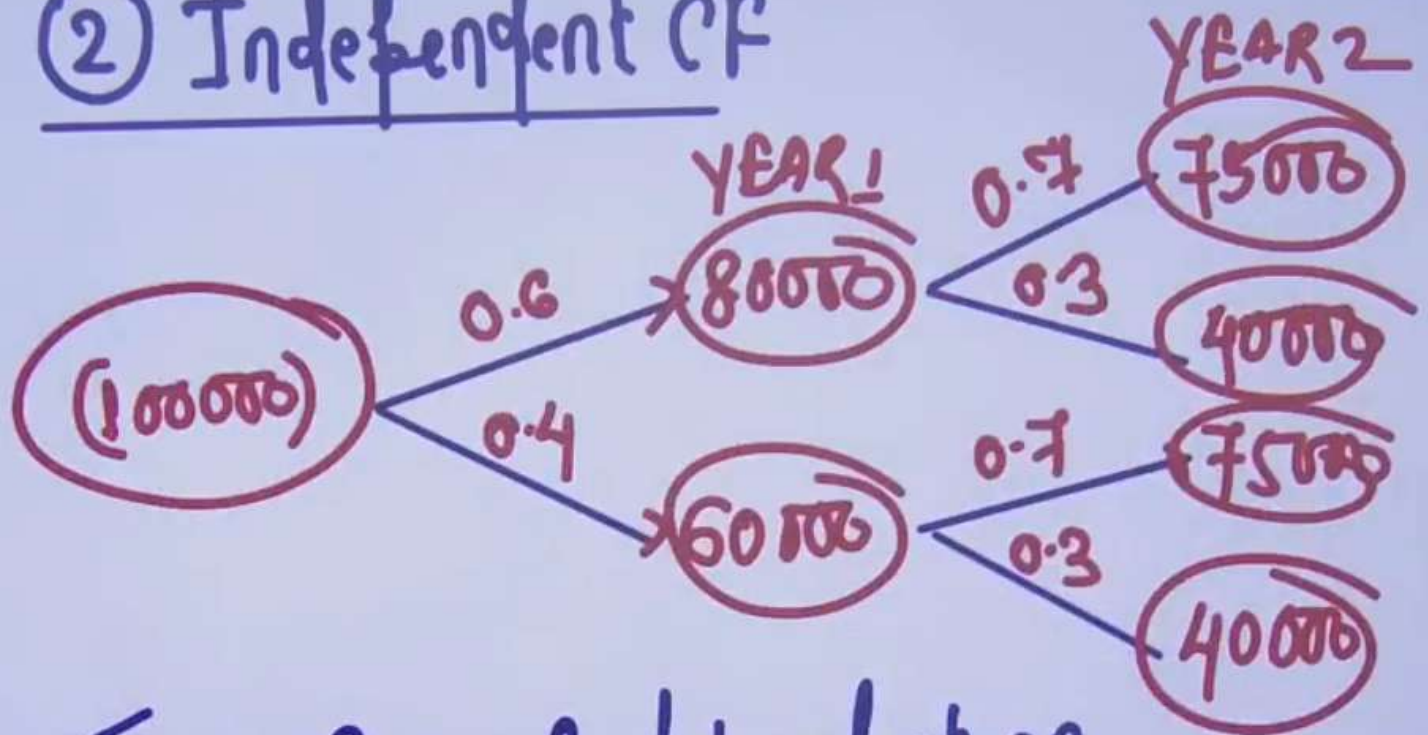
- In this Topic, we calculate standard deviation of NPV.
- There are two types of Cash flows.

(i) Dependent Cash flows

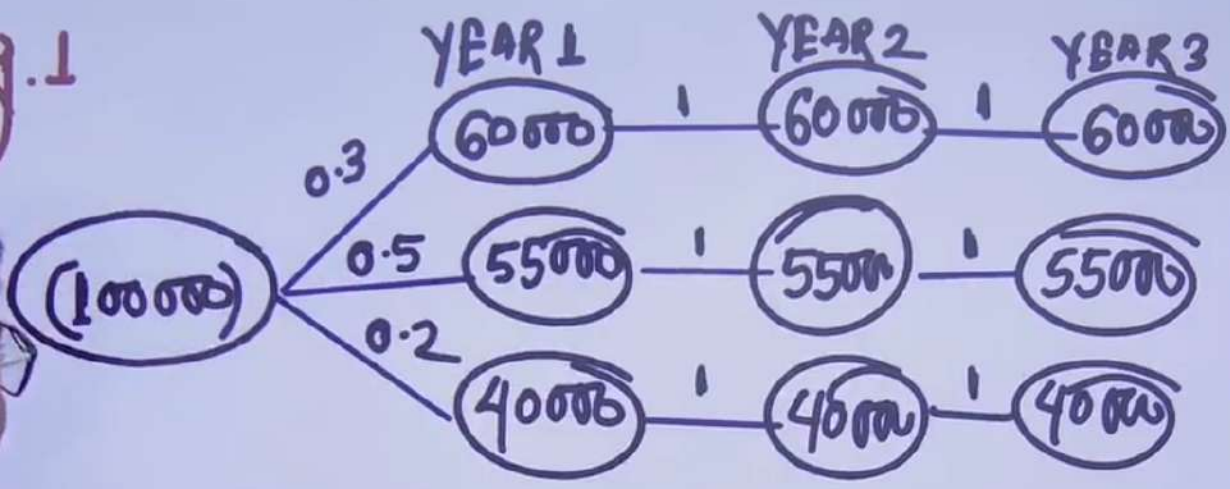


These are dependent CF & 2 YEAR
CF depends on 1st YEAR CF

② Independent CF



These CF are independent CF
because 2nd YEAR CF does not depend
on 1st YEAR CF.



perfectly
dependent
Cash flows

Discounting Rate = 10%

① Calculate NPV

② Calculate standard deviation in NPV

① Expected NPV

NPV

$$\text{Path I} = (60000 \times 2.487) - 100000 = 49220$$

$$\text{Path II} = (55000 \times 2.487) - 100000 = 36785$$

$$\text{Path III} = (40000 \times 2.487) - 100000 = (520)$$

$$\text{Expected NPV} = (49220 \times 0.3) + (36785 \times 0.5) \\ + (-520 \times 0.2) = 33055$$

$$\text{Standard deviation} = \sqrt{(49220 - 33055)^2 \cdot 0.3 + (36785 - 33055)^2 \cdot 0.5 \\ + (-520 - 33055)^2 \cdot 0.2} \\ = 17630$$

HERTZ Model

HERTZ Model is used to calculate standard deviation in NPV when Cash Flows are perfectly dependent

How to calculate

Standard deviation of CF.

$$1 \text{ YEAR} = \sqrt{(60000 - 53500)^2 \cdot 0.3 + (55000 - 53500)^2 \cdot 0.5 + (40000 - 53500)^2 \cdot 0.2} = 7089$$

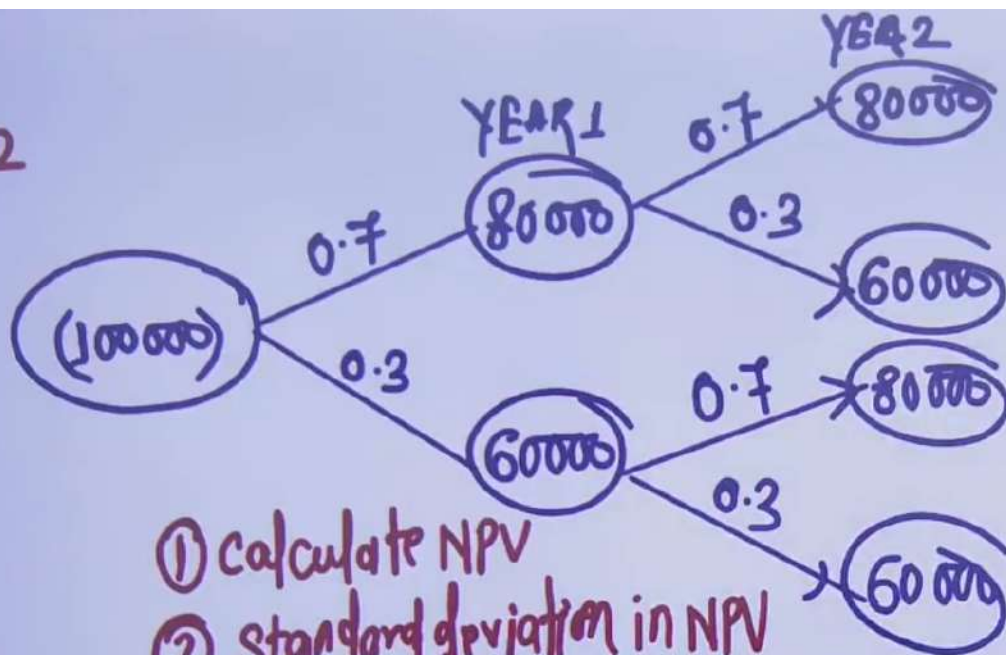
$$2 \text{ YEAR} = 7089$$

$$3 \text{ YEAR} = 7089$$

FORMULA

$$\begin{aligned} \sigma_{NPV} &= \frac{\sigma_{CF_1}}{(1+r)^1} + \frac{\sigma_{CF_2}}{(1+r)^2} + \frac{\sigma_{CF_3}}{(1+r)^3} \\ &= \frac{7089}{(1.10)^1} + \frac{7089}{(1.10)^2} + \frac{7089}{(1.10)^3} = 17630 \end{aligned}$$

Eg. 2



• Independent CF

• Disc. Rate = 10%

- ① calculate NPV
- ② standard deviation in NPV

PATHWISE

		JP
①	80000 38800	0.49
②	22280	0.21
③	20620	0.21
④	4100	0.09

① Expected NPV

$$\text{Expected NPV} = 28390$$

② Standard deviation

$$\begin{aligned} \text{S.D.} &= \sqrt{(38800 - 28390)^2 \cdot 0.49 + (22280 - 28390)^2 \cdot 0.21} \\ &\quad + (20690 - 28390)^2 \cdot 0.21 + (4100 - 28390)^2 \cdot 0.11} \\ &= 11257 \end{aligned}$$

Hillier Model

Hillier Model is used to calculate S.D. of NPV when cash flows are independent.

$$\text{Expected CF YEAR-1} = (80000 \times 0.7) + (60000 \times 0.3) \\ = 74000$$

$$\text{YEAR 2} = (80000 \times 0.49) + (60000 \times 0.21) \\ + (80000 \times 0.21) + (60000 \times 0.09) \\ = 74000$$

$$\sigma_{CF_1} = \sqrt{(80000 - 74000)^2 \cdot 0.7 + (60000 - 74000)^2 \cdot 0.3}$$

$$= 9165$$

$$\sigma_{CF_2} = \sqrt{(80000 - 74000)^2 \cdot 0.49 + (60000 - 74000)^2 \cdot 0.21}$$

$$+ (80000 - 74000)^2 \cdot 0.21 + (60000 - 74000)^2 \cdot 0.21$$

$$= 9165$$

FORMULA

$$\sigma_{NPV} = \sqrt{\frac{\sigma_{CF}^2}{(1+r)^{2 \cdot n}} + \frac{\sigma_{CF}^2}{(1+r)^{2 \cdot n}}}$$

$$= \sqrt{\frac{(9165)^2}{(1.10)^2} + \frac{(9165)^2}{(1.10)^4}} = 11260$$

TYK!

Question: 37

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?

① Expected CF (00 000)

$$\text{YEAR 1} = (14 \times 0.1) + (18 \times 0.2) \\ + (25 \times 0.4) + (40 \times 0.3) = 27$$

$$\text{YEAR 2} = (15 \times 0.1) + (20 \times 0.3) \\ + (32 \times 0.4) + (45 \times 0.2) = 29.30$$

$$\text{YEAR 3} = (18 \times 0.2) + (25 \times 0.5) \\ + (35 \times 0.2) + (48 \times 0.1) = 27.90$$

$$\text{NPV} = \frac{27}{(1.06)^1} + \frac{29.30}{(1.06)^2} + \frac{27.90}{(1.06)^3} - 50 \\ = 24.97$$

⑪ Standard deviation

Standard deviation of CF

$$\frac{\text{1st YEAR}}{\sigma_{CF_1}} = \sqrt{(14-27)^2 \cdot 0.1 + (18-27)^2 \cdot 0.2 + (25-27)^2 \cdot 0.4 + (40-27)^2 \cdot 0.3} = 9.24$$

2nd YEAR

$$\sigma_{CF_2} = 9.93$$

3rd YEAR

$$\sigma_{CF_3} = 8.62$$

HILLIER MODEL

$$\sigma_{NPV} = \frac{(9.24)^2}{(1.06)^2} + \frac{(9.93)^2}{(1.06)^4} + \frac{(8.62)^2}{(1.06)^6}$$
$$= 14.37$$

(iii) Standard deviation is a measurement of risk.
If two projects having same NPV then we select the project having lower S.D.

In case of conflict it means project A having higher NPV & project B having lower S.D then decision is taken on the basis of C.V.

$$C.V. = \frac{\sigma}{\bar{X}} \quad (\text{Lower C.V. means Lower Risk})$$

TYK 7

Question: 40

Following are the estimates of the net cash flows and probability of a new project of M/s X Ltd.:

	Year	P = 0.3	P = 0.5	P = 0.2
Initial investment	0	4,00,000	4,00,000	4,00,000
Estimated net after tax cash inflows per year	1 to 5	1,00,000	1,10,000	1,20,000
Estimated salvage value (after tax)	5	20,000	50,000	60,000

Required rate of return from the project is 10%. Find:

- (i) The expected NPV of the project.
- (ii) The best case and the worst case NPVs.
- (iii) The probability of occurrence of the worst case if the cash flows are perfectly dependent overtime and independent overtime.
- (iv) Standard deviation and coefficient of variation assuming that there are only three streams of cash flow, which are represented by each column of the table with the given probabilities.
- (v) Coefficient of variation of X Ltd. on its average project which is in the range of 0.95 to 1.0. If the coefficient of variation of the project is found to be less risky than average, 100 basis points are deducted from the Company's cost of Capital

Should the project be accepted by X Ltd?

① Expected NPV

$$\begin{aligned}\text{Scenario 1} &= (100000 \times 3.791) + \\ &\quad (20000 \times 0.621) - 400000 \\ &= (8480)\end{aligned}$$

$$\begin{aligned}\text{Scenario 2} &= (110000 \times 3.791) \\ &\quad + (50000 \times 0.621) - 400000 \\ &= 48060\end{aligned}$$

$$\begin{aligned}\text{Scenario 3} &\quad (120000 \times 3.791) \\ &\quad + (60000 \times 0.621) - 400000 \\ &= 92180\end{aligned}$$

$$\begin{aligned} \textcircled{ii} \text{ Best NPV} &= 92180 \\ \text{Worst NPV} &= (8480) \end{aligned} \quad \Bigg| \quad \begin{aligned} \text{Expected NPV} &= (-8480 \times 0.3) + (48060 \times 0.5) \\ &\quad + (92180 \times 0.2) = 39922 \end{aligned}$$

③ probability of Worst Case NPV

perfectly dependent

$$\text{probability}_q = 0.3 \quad [0.3 \times 1 \times 1 \times 1 \times 1]$$

Independent

$$\text{probability}_q = (0.3)^5 = 0.00243$$

(iv) Standard deviation in NPV

। हमने NPV calculate कर लिया है Path से

So Hillier या McBRAT model नहीं लगा रहे
। है]

(iv) Standard deviation in NPV

$$\sigma_{NPV} = \sqrt{(-8480 - 39922)^2 \cdot 0.3 + (48060 - 39922)^2 \cdot 0.5 + (92180 - 39922)^2 \cdot 0.2}$$
$$= 35807$$

$$C.V. = \frac{\sigma}{\bar{X}} = \frac{35807}{39922} = 0.90$$

(V) NPV

Since X41 project's c.v. (0.90) is less than Avg c.v.
hence Discounting Rate (RADR) should be

$$(10 - 1)^{\vee} = 9\%$$

$$\begin{aligned}\text{Expected CF} &= (100000 \times 0.3) + (110000 \times 0.5) + (120000 \times 0.2) \\ &= 109000 \text{ p.a.}\end{aligned}$$

$$\begin{aligned}\text{Expected Salvage Value} &= (20000 \times 0.3) + (50000 \times 0.5) \\ &\quad + (60000 \times 0.2) = 48000\end{aligned}$$

$$\begin{aligned}\text{Expected NPV} &= (109000 \times 3.890) + (48000 \times 0.650) \\ &\quad - 400000 = 51960 \text{ (Accepted)}\end{aligned}$$

TYK 5

Question: 38

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	20	40	55
3	30	40	45

Project Y: Investment (year 0) ₹ 70 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.

Expected NPV

project X

Expected CF

$$\text{YEAR-1} = (30 \times 0.3) + (50 \times 0.4) + (65 \times 0.3) \\ = 48.50$$

$$\text{YEAR 2} = 41.53$$

$$\text{YEAR 3} = 38.5$$

$$\text{NPV} = \frac{48.50}{(1.10)^1} + \frac{41.53}{(1.10)^2} + \frac{38.50}{(1.10)^3} - 70 \\ = 37.39$$

project y

$$\begin{aligned}\text{Expected CF} &= (40 \times 0.20) + (45 \times 0.20) + (50 \times 0.3) \\ &= 45.50 \text{ p.a.}\end{aligned}$$

$$\text{NPV} = (45.50 \times 2.487) - 80 = 43.16$$

② Standard deviation (Question & Tent - Hillier Model)

Project x

Standard deviation of CF

$$\begin{aligned} \text{1st YEAR } \sigma_{CF_1} &= \sqrt{(30-48.50)^2 \cdot 0.3 + (50-48.50)^2 \cdot 0.4 +} \\ &\quad (65-48.50)^2 \cdot 0.3} = 13.61 \end{aligned}$$

$$\begin{aligned} \text{2nd YEAR } \sigma_{CF_2} &= \sqrt{(30-41.53)^2 \cdot 0.3 + (40-41.53)^2 \cdot 0.4} \\ &\quad + (55-41.53)^2 \cdot 0.3} = 9.76 \end{aligned}$$

3rd YEAR

$$\sigma_{cf3} = 5.94$$

$$\sigma_{NPV} = \frac{(13.61)^2}{(1.10)^2} + \frac{(9.76)^2}{(1.10)^4} + \frac{(5.94)^2}{(1.10)^6}$$
$$= 15.44$$

Simulation

Cost of project = ₹ 120000

Discounting rate = 10%

<u>CFAT</u>	<u>probability</u>	<u>life</u>	<u>prob.</u>
60000	0.3	5	0.1
40000	0.5	6	0.4
30000	0.2	7	0.3
		8	0.2

Random No. CF (19), 55, 69, 17, 7
life (30), 45, 99, 81, 12

Step 1 Calculate Cumulative probability of Random No.

Range

<u>CFAT</u>	<u>prob.</u>	<u>Cum. prob.</u>	<u>Range</u>
60000	0.3	0.3	0-29
40000	<u>0.5</u>	0.8	30-79 ←
30000	0.2	1	80-99

<u>Life</u>	<u>prob.</u>	<u>Cum. prob.</u>	<u>Range</u>
5	0.1	0.1	0-9
6	0.4	0.5	10-49
7	0.3	0.8	50-79
8	0.2	1	80-99

Step 2 Calculation of NPV

120000

CF		life		PVAF	NPV
R.N.	CF	R.No.	life		
19	60000	30	6	4.355	141300
55	40000	45	6	4.355	54200
59	40000	99	8	5.335	93400
17	60000	81	8	5.335	200100
7	60000	12	6	4.355	141300
				$\bar{X} =$	126060 $\left[\frac{630300}{5} \right]$

Evaluation of project using utilities

Cash flows	-20000	-10000	0	15000	40000
Utilities	-80	-20	0	40	60

Project A

CF	probability
40000	0.5
15000	0.3
-10000	0.2

Calculate Expected utilities & decide whether project should be accepted?

Calculation of Exp Utility

<u>CF</u>	Utilities	prob.	<u>UXP</u>
40000	60	0.5	30
15000	40	0.3	12
-10000	-20	0.2	-4
			<hr/>
			38
			<hr/>

Expected utility is positive, project should be accepted.