# 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 = PVCI − PVCO

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

Sales consideration = 35000 — (I)

(-) WDV/B.V = 29663

Capital Gain = 5337

Tax @ 30% 1601 — (II)

Terminal Value 33399

(i-ii)

## ③ Calculation of NPV (Imp)

| | YEAR | P.V.F (10%) | Amount | P.V. |
|---|---|---|---|---|
| (A) Cash Outflows | | | | |
| Cost of Machine | 0 | 1.000 | 125000 | 125000 |
| (A) | | | | 125000 |
| (B) Cash Inflows | | | | |
| 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 | 0.691 | 18716 | 11623 |
| Terminal Value (w.N.2) | 5 | 0.691 | 33399 | 20641 |
| (B) | | | | 159357 |
| NPV (B - A) | | | | 34357 |

## ④ PI

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

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

$$= 1.275$$

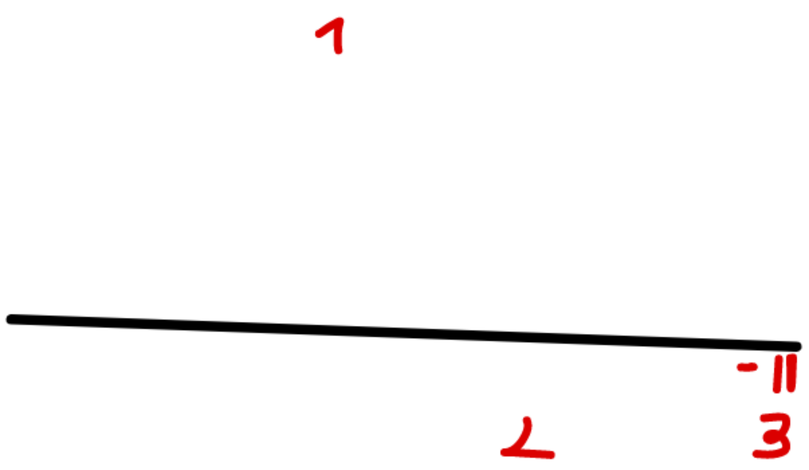
## ② Accounting Rate of Return

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

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

## ① Calculation of PBP (125000)

| YEAR | CFAT | Cum CFAT |
|---|---|---|
| 1 | 43325 | 43325 |
| 2 | 36431 | 79756 |
| 3 | 48323 | 128079 |




Hence PBP = 2 YEAR + $\left(\frac{1}{48323} \times 45244\right)$

= 2.94 YEARS

Eg 2

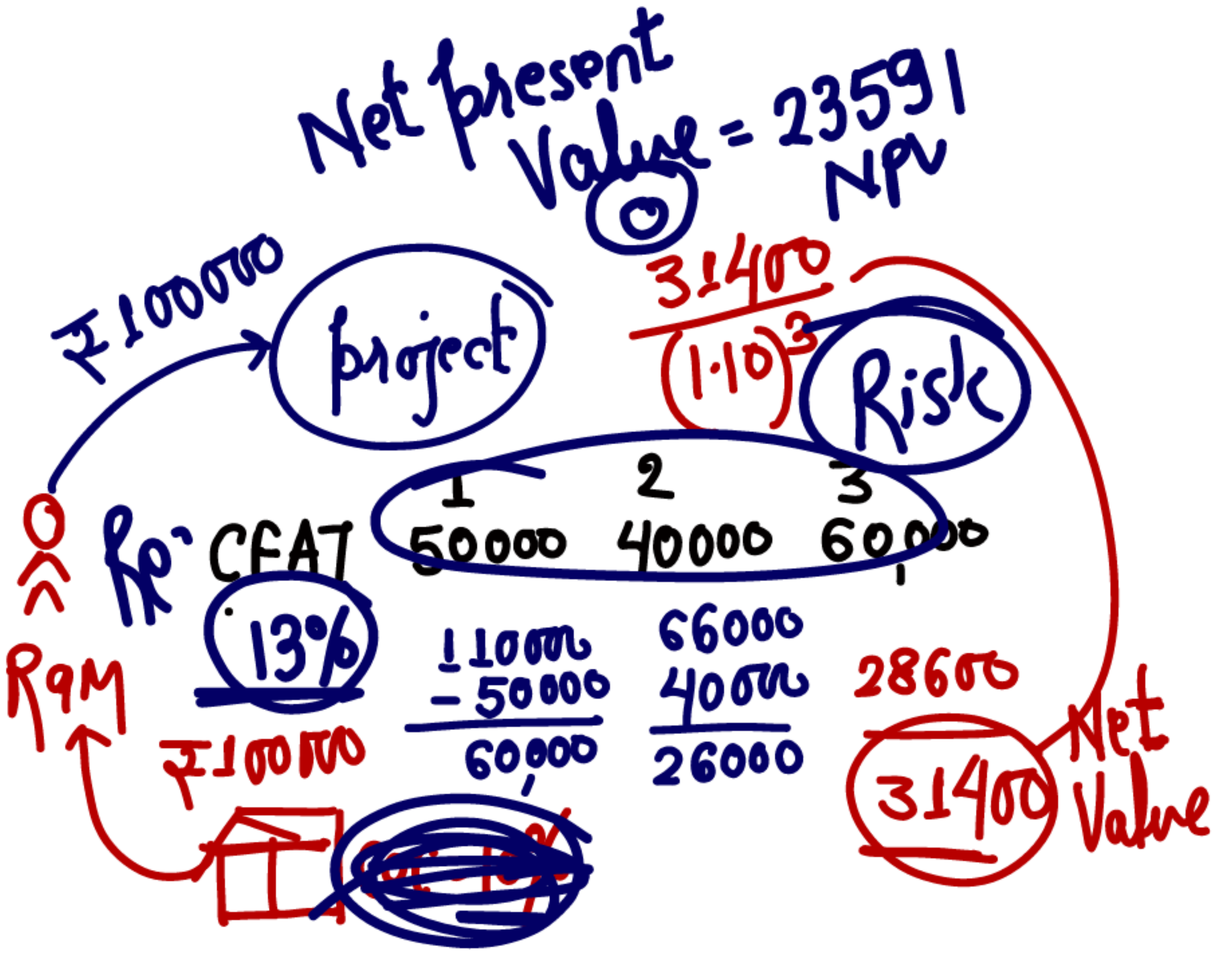
Cost of project = ₹ 100000

| | | |
|---|---|---|
| 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**

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

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

**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 | 5 YEARS | 8 YEARS |
| Running cost | 25000 P.A. | 20000 P.A. |
| Salvage | 10000 | 15000 |

COC = 15%

Which Machine should be purchased?

## Calculation of PVCO

**project A**

$$PVCO = 100000 + (25000 \times 3.352) - (10000 \times 0.497)$$

$$= 178830$$

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

**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 = PVCI

IRR is a rate at which PVCI = PVCO or NPV = 0 or PI = 1

**Let assume Disc. Rate 10%**

$$NPV = PVCI - PVCO$$

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

$$= 14400$$

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

Eg 1

Selling price per unit = ₹50

| YEAR | units |
|---|---|
| 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

| YEAR | CF |
|---|---|
| 1 | 55000 |
| 2 | 60500 |
| 3 | 66550 |

Eg 2

| YEAR | RCF |
|---|---|
| 1 | 60000 |
| 2 | 70000 |
| 3 | 50000 |

Inflation Rate = 5% p.a.

NCF = ?

| YEAR | NCF |
|---|---|
| 1 | 63000 |
| 2 | 77175 |
| 3 | 57881 |

Eg 3

| YEAR | NCF |
|---|---|
| 1 | 80000 |
| 2 | 60000 |
| 3 | 40000 |

Inflation Rate = 5% p.a.

Calculate RCF

RCF

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

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

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

Eg 4

| YEAR | RCF |
|---|---|
| 1 | 32000 |
| 2 | 40000 |
| 3 | 25000 |

Inflation Rate

| | |
|---|---|
| 1 | 10% |
| 2 | 9% |
| 3 | 12% |

Calculate NCF

NCF

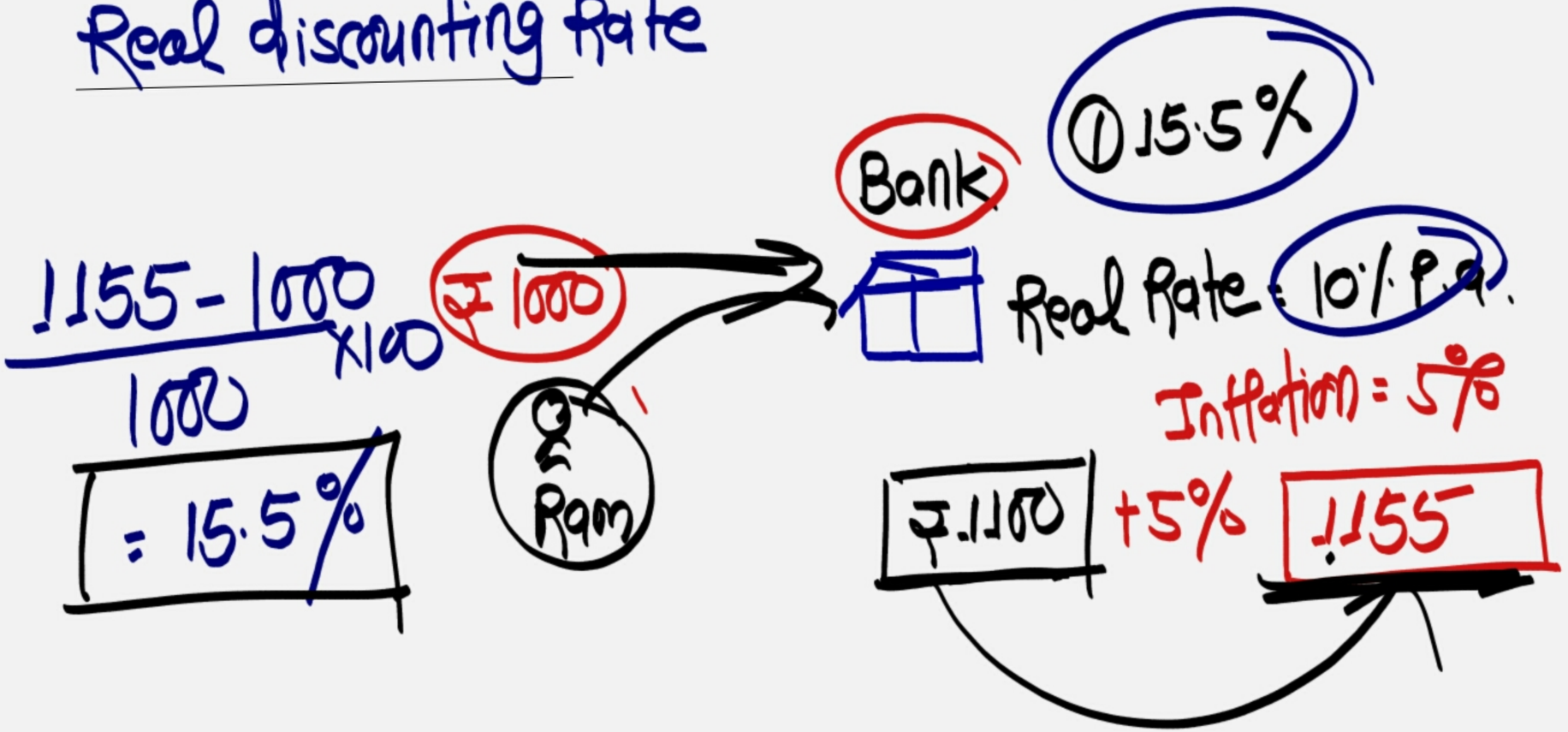
1 YEAR $32000(1.10) = 35200$

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

Eg 1

RDR : 17%

Inflation Rate: 4%

NDR = ?

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

Eg 2

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

$$NPV = \frac{70000}{(1.10)^1} + \frac{50000}{(1.10)^2} + \frac{40000}{(1.10)^3} - 100000$$

$$= 35011$$

$$NPV = (70000 \times 0.909) + (50000 \times 0.826) + (40000 \times 0.751) - 100000$$

$$= 34970$$

② Suppose Inflation Rate 5% p.a.

Calculate NPV using NCF & NDR

1 Nominal Cash flows

| YEAR | NCF |
|---|---|
| 1 | ₹3500 |
| 2 | 55125 |
| 3 | 46305 |

② NDR

$NDR = (1.10 \times 1.05) - 1$

$= 15.5\%$ p.a.

$$NPV = \frac{₹3500}{(1.155)^1} + \frac{55125}{(1.155)^2} + \frac{46305}{(1.155)^3} - 100000 = \boxed{35011}$$

$NPV = (₹3500 \times 0.866) + (55125 \times 0.750)$

$+ (46305 \times 0.649) - 100000 = 3504₹$

10% RDR $\quad \frac{0.909}{(1.05)} \quad \frac{0.826}{(1.10)^2} \quad 0.75₹$

Eg

| YEAR | NCf |
|---|---|
| 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 | $0.704/(1.05)^3 = 0.608$ |

$NPV = (40000 \times 0.848) + (30000 \times 0.718) + (25000 \times 0.608) - 50000$

$= 20660$

**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.

## N.N.I Calculation of NDR

$$NDR = [(1.10)(1.05)] - 1$$

$$= 15.5\%$$

# Calculation of NPV

(NCF & NDR) (Calculation)

| | 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%. 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 | 413060 |
| Tax @ 35% - (II) | 14000 | 108836 | 144571 |
| CFAT (i-ii) | 526000 | 702124 | 768489 |
| (x) PVF (14%) | 0.877 | 0.769 | 0.675 |
| PVCI | 461302 | 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 × 0.909) + (12000 × 0.826) + (8000 × 0.751) : 25010

② NCF & NDR

| | | |
|---|---|---|
| NCF | 1 | 10000 × 1.09 = 10900 |
| | 2 | 12000 × 1.09 × 1.10 = 14388 |
| | 3 | 8000 × 1.09 × 1.10 × 1.08 = 10359 |

NDR (factor)

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

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

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

PVCI : (10900 × 0.834) + (14388 × 0.689) + (10359 × 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%) (NDR) | 12% |

Calculation CFAT (RCF)

| | | |
|---|---|---|
| Revenue = | | 30000 |
| (-) Cost = | | 10000 |
| CFBT | (I) | 20000 |
| (-) Dep ($\frac{40000}{4}$) | | 10000 |
| PBT | | 10000 |
| Tax @ 50% | (II) | 5000 |
| CFAT (I-II) | | 15000 |

RDR

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

$$= 1.818\%$$

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

$$= (15000 \times 3.824) - 40000$$

$$= 17360$$

**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.

| 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:

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

# 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

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

Step 2 Calculate standard deviation

$$\sigma x = \sqrt{\Sigma (x - \bar{x})^2 p}$$

Step 3 = Calculate coefficient of variation

$$C.V. = \frac{\sigma}{\bar{X}}$$ [High C.V. means High Risk]

Eg

| Economy | Prob. | NPV |
|---|---|---|
| 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.

| p | x | P(x) | $(x-\bar{x})$ | $(x-\bar{x})^2 p$ |
|---|---|---|---|---|
| 0.7 | 400 | 280 | 98 | 6722.80 |
| 0.2 | 100 | 20 | -202 | 8160.80 |
| 0.1 | 20 | 2 | -282 | 7952.40 |
| | | $\bar{x}$ = 302 | | Variance: 22836 |

Expected NPV = 302

standard deviation: $\sqrt{22836}$

= 151

TYK6

**Question: 13**

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.

| | A | B |
|---|---|---|
| Expected NPV | 9000 | 9000 |
| S.D. | 4450 | 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 Co-efficient of variation

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

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

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

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) | $(x-\bar{x})$ | $(x-\bar{x})^2P$ |
|---|---|---|---|---|
| 0.2 | 15000 | 3000 | 6000 | ₹200000 |
| 0.3 | 12000 | 3600 | 3000 | 270000 |
| 0.3 | 6000 | 1800 | -3000 | 270000 |
| 0.2 | 3000 | 600 | -6000 | ₹200000 |
| | $\bar{x}$ = | 9000 | Variance = | 1980000 |

$\sigma_x = \sqrt{1980000}$

$= ₹4450$

| P | y | P(y) | $(y-\bar{y})$ | $(y-\bar{y})^2P$ |
|---|---|---|---|---|
| 0.1 | 15000 | 1500 | 6000 | 3600000 |
| 0.4 | 12000 | 4800 | 3000 | 3600000 |
| 0.4 | 6000 | 2400 | -3000 | 3600000 |
| 0.1 | 3000 | 300 | -6000 | 3600000 |
| | | $\bar{y}$ = 9000 | | 14400000 |

Expected NPV = 9000

$\sigma_y = \sqrt{14400000}$

$= 3795$

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 × 0.3) + (400 × 0.5)
+ (100 × 0.2) = ₹ 310 p.a.

Expected NPV = PVCI - PVCO
= (310 × PVAf, 10%, 5)
− 1000
= (310 × 3.791) − 1000
= 175.143

## ③ S.D. in NPV [Logical]

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

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

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

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

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

$= 430.57$

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

$$\sigma x = \sqrt{(300-310)^2 \times 0.3 + (400-310)^2 0.5 + (100-310)^2 \times 0.2}$$

$$= 113.58$$

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:

| | | Cash Flow (₹) | |
|---|---|---|---|
| Situation | Probabilities | 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.

① Calculation of Expected NPV

Project A

Expected cf = (600000 × 0.3) + (400000 × 0.4) + (200000 × 0.3)

= 400000 p.a.

Expected NPV = (400000 × PVAf, 7%, 5) − 500000

= (400000 × 4.100) − 500000

= 1140000

Project B

Expected NPV = 400000

$\sigma_B$ = 77459

# 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(000) | 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 |
| S.D. | 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 |

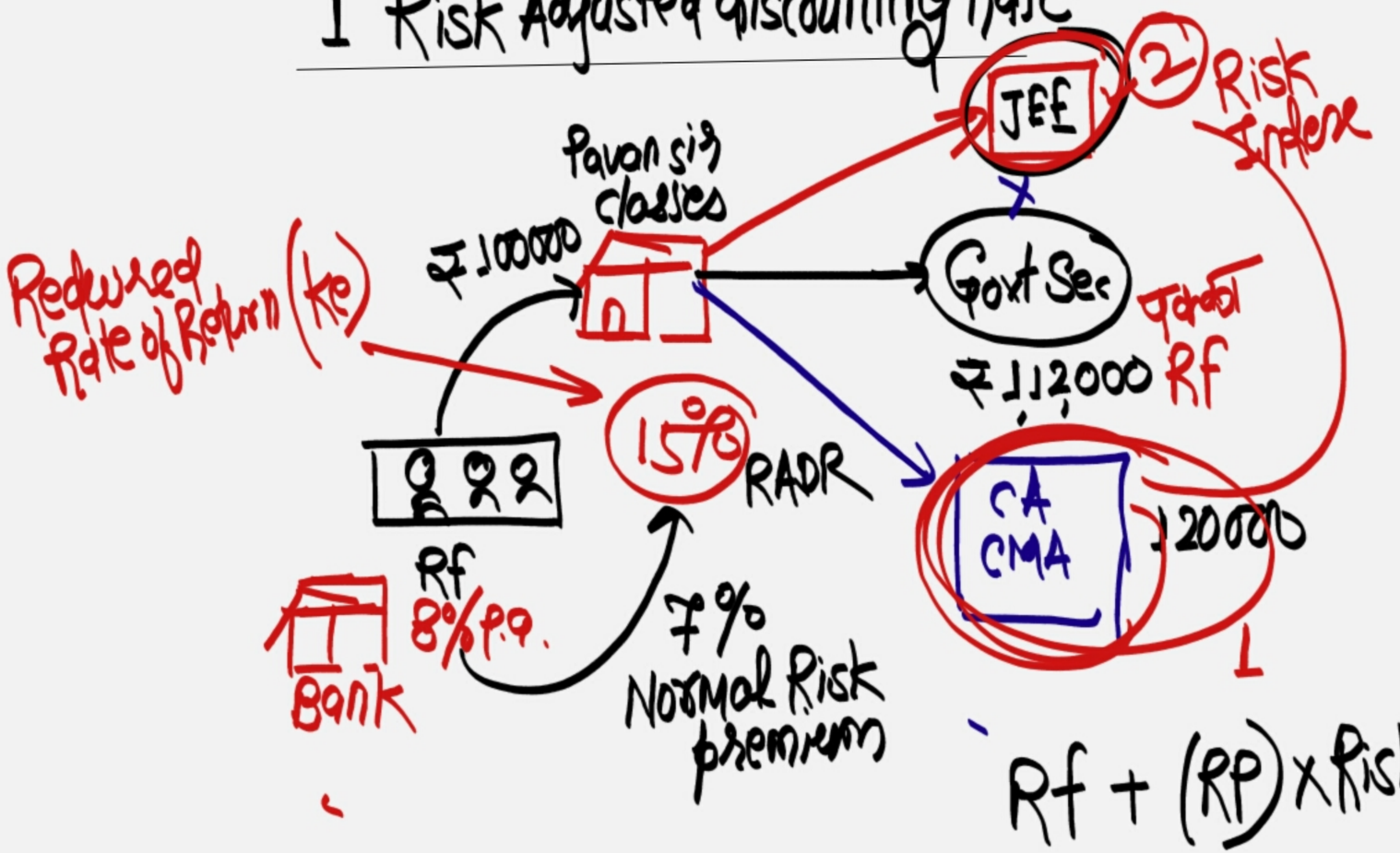

Calculate the expected net present value of the project using 10 per cent discount rate if the Initial Investment of the project is ₹ 10,000.

# 2. Conventional Techniques

① Risk Adjusted Discounting Rate (RADR)

② Certainty Equivalent

# 1 Risk Adjusted discounting Rate




Rf + (RP) x Risk Inflow

Following Steps are applied to Calculate NPV in RADR Method

Rf + RP
C.V
RI

① Calculate RADR

- RADR = Rf + Risk premium (Same Business)
- RADR = Rf + (Risk premium) x Risk Index (other Business)
- RADR depends on C.V.
  [Higher C.V. then 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 |

H.W

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 |

**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- | | | |
| Year 1 | 6,00,000 | 6,00,000 | 4,00,000 |
| Year 2 | 6,00,000 | 4,00,000 | 6,00,000 |
| Year 3 | 6,00,000 | 5,00,000 | 8,00,000 |
| Year 4 | 6,00,000 | 2,00,000 | 12,00,000 |
| Risk Index | 1.80 | 1.00 | 0.60 |

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

$$RADR = Rf + (Ke - Rf)\,Risk\ Index$$

$A = 10 + (15-10)\,1.80$

$= 19\%$

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

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

# Calculation of NPV

NPV = PVCI − PVCO

PI (19%) = (600000 × PVAf, 19%, 4) − 1500000

= (600000 × 2.639) − 1500000

= ₹83400

PII (15%) = (600000 × 0.870) + (400000 × 0.756) + (500000 × 0.657) + (200000 × 0.572) − 1100000 = 167200

PIII ⇒ 213800

Project III is the best due to the highest NPV.

**Question 23**

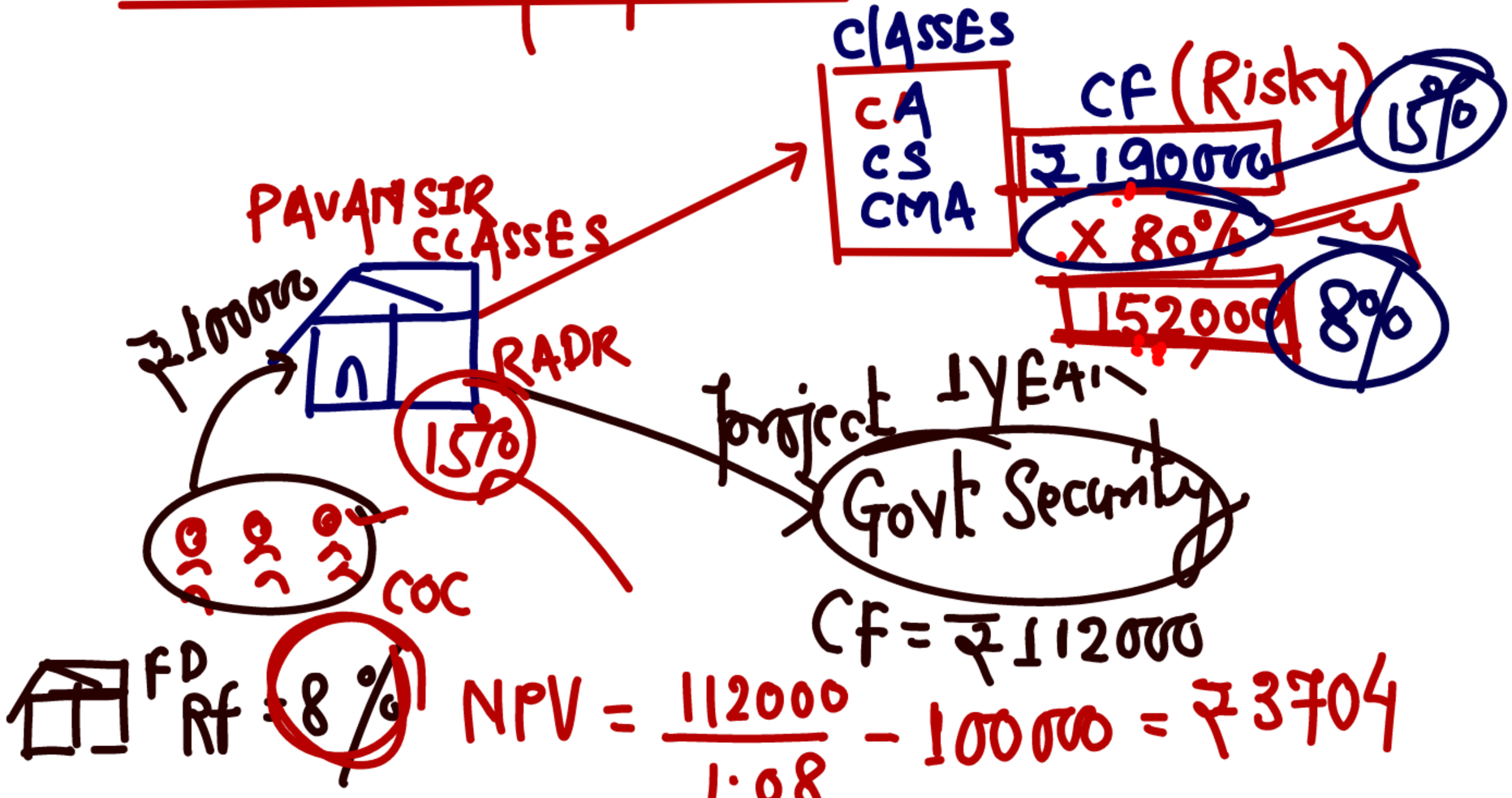
An enterprise is investing ₹ 100 lakhs in a project. The risk-free rate of return is 7%. Risk premium expected by the Management is 7%. The life of the project is 5 years. Following are the cash flows that are estimated over the life of the project:

H.W

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

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.

Risk free Cash flows = Expected Cash Flows × C.E.

Step 2 Calculate NPV using Rf 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 |
| | | | | PVCI | 150428 |
| | | | | (-) PVCO | 120000 |
| | | | | NPV | 30428 |

**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:

| Project M | | | Project N | |
|---|---|---|---|---|
| Year-end | 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 |

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 |

# 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

| | |
|---|---|
| COP = | 42.16% |
| CFAT = | 29.66% |
| life = | 34.80% |
| COC = | 154.30% |

इसमे ज्यादा change नही किया जा सकता

# 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 at which NPV should be "0"

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

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

$$\text{Sensitivity in CFAT} = \frac{45000 - 31664}{45000} \times 100$$

$$= 29.66\%$$

**FORMULA**

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

## 3. Life of project

Assume life of project be 4 YEARS

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

(PVAF, 16%, 4)

Life 3 YEAR

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

(PVAF, 16%, 3)

Interpolation

| | |
|---|---|
| 4 YEARS | 22650 → 22650 ≙ NPV |
| 3 YEARS | (8085) |
| 1 YEAR | 30735 |

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

$= 3.26 \text{ YEARS}.$

## Discounting PBP (120000)

(10%)

| YEAR | PVCFAT | CumCFAT |
|---|---|---|
| 1 | 40909 | 40909 |
| 2 | 37190 | 78099 |
| 3 | 33809 | 111908 |
| 4 | 30736 | |
| 5 | 27941 | |

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

$= 3.26 \text{ YEARS}.$

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

## ④ Sensitivity in CoC

Discounting Rate at which NPV = 0

| | NPV |
|---|---|
| 10% | 50595 |
| 20% | 14577 |
| 25% | 1018 |
| 28% | (6060) |

| | |
|---|---|
| 25% | 1018 |
| 28% | (6060) |
| 3% | 7078 |

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

$$= 25.43\%$$

25.60%

26.37% — 25.85%

1018 → 1018

0

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

$$= 154.30\%$$

## 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 × 80% = 36000

NPV = (36000 × 3.791) − 120000 = 16476

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

Most critical factor is CFAT

## ③ life of project (20% ↓)

life 5YEAR − 20% = 4YEARS

NPV = (45000 × 3.170) − 120000 = 22650

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

Cost of project = 47.44%

## ④ Cost of Capital 10% (20%↑) = 12%

NPV = (45000 × 3.605) − 120000 = 42225

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

# 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 carryout about such factor before accepting the project.

**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:

| | |
|---|---|
| Initial Project Cost (₹) | 1,20,000 |
| Annual Cash Inflow (₹) | 45,000 |
| Project Life (Years) | 4 |
| Cost of Capital | 10% |

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

(Page No. 42)

**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.

(Page No. 43)

TYK9

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

Calculation of NPV 55.26

NPV = PVCI − PVCO

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

$11 = 20 \times \left[\frac{20000}{(1.10)^1} + \frac{30000}{(1.10)^2} + \frac{30000}{(1.10)^3}\right] - 1000000$

$20 \times 65514.65 - 1000000 = 310293$

16

## 1 Sensitivity in selling price per unit

### 1st Approach

Selling price ₹60 (10%↓) = ₹54

NPV = −82795

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

### 2nd Approach

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

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

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

Change in CPU = ₹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

$$20x - 1000000 = 0$$

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

$$\text{Sensitivity} = \frac{65514.657 - 50000}{65514.657} \times 100 = 23.68\%$$

## (ii) Sensitivity in unit cost

**1st Approach**

Unit cost = ₹40 (10% ↑) = ₹44

NPV = ₹48234

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

**2nd Approach**

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

**Alternative**

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

$$20 \times 6.5515x = 1000000$$

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

20000 30000 30000

| YEAR | Units | | |
|---|---|---|---|
| 1 | $(2 \times 7631.84)$ | = 15263.68 | 20000 |
| 2 | $(3 \times 7631.84)$ | = 22895.52 | 30000 |
| 3 | $(3 \times 7631.84)$ | = 22895.52 | 30000 |
| | | 61054.72 | |

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

# (d) Sensitivity in Initial Outlays

## Approach 1

Initial Outlays = 1000000 (10% ↑) = ₹ 1100000

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)

| YEAR | PV of CF | Cum PV of |
|---|---|---|
| 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 नही और last में जाकर फँस गए)

Project life (33.33% ↓)

3 YEARS − 33.33%

= 2 YEARS

$$NPV = 363636 + 495868 - 1000000$$

$$= -140496$$

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

$$= 145.28\%$$

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

4:31 —

**Question: 33**

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 |
| 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 |

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

(Page No. 46)

**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 |
| 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 |

*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

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

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

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 |

S.P. 200
VC = 60
FC = 100000

CF = 57500

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

W.N.1 COC

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

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

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

W.N.2 Selling price per unit

$$\text{Selling price} = \frac{₹60}{30\%}$$

$$= ₹200$$

IRR is a rate at which .

PVCI = PVCO

PVCO (Cost of project) = Annual CFAT × PVAf (IRR)

PVCI = Annual CFAT × $PVAf_{(COC)}$

① Initial Investment

Initial Investment = Annual Cash flows × $PVAf^{16\%}_{(IRR)}$

= 57500 × 3.274 = ₹ 188255

② NPV = PVCI - PVCO

= (57500 × PVAf, 10%, 5) - 188255 = ₹ 29727.50

## ③ Annual fixed Cost

fixed cost sensitivity is 7.8416%

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

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

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

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

$$\text{PV of FC} = \text{Annual FC} \times \text{PVAf (coc)}$$

$$379106 = x \times 3.791$$

$$x = ₹100000$$

## (iv) Estimated Annual units of Sales

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

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

## (v) BEP

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

**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

$(30-16.50)(200000\times3.605)-(1000000\times3.605)-5000000$

$13.50\times721000-3605000-5000000$

$= ₹\ 1128500$

## (a) Sensitivity in Selling price

$x\times721000-3605000-5000000=0$

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

$\text{Sensitivity in Selling price}=\frac{13.50-11.93}{30}\times100$

$=5.23\%$

## (b) Sensitivity in Sales Volume

$$13.50X - 3605000 - 5000000 = 0$$

$$X = 637407.41$$

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

$$= 11.59\%$$

## (c) Sensitivity in VC per unit

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

## (d) Calculation of NPV

Poor = $(13.50 \times 175000 \times 3.605) - 3605000 - 5000000$

$= -88188$

Normal (200000 units) = NPV = 1128500

Good NPV = 2345188

| NPV | probability |
|---|---|
| -88188 | 30% |
| 1128500 | 60% |
| 2345188 | 10% |

Expected NPV = $(-88188 \times 30\%) + (1128500 \times 60\%) + (2345188 \times 10\%)$

= ₹ 885163

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:*

| 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% |

*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:*

*(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)*

(ii) Worst Outcomes

NPV = −14728

prob. = 0.08 or 8%

Expected (−14728 × 0.08)

(iii) Best Outcomes

NPV = 24100

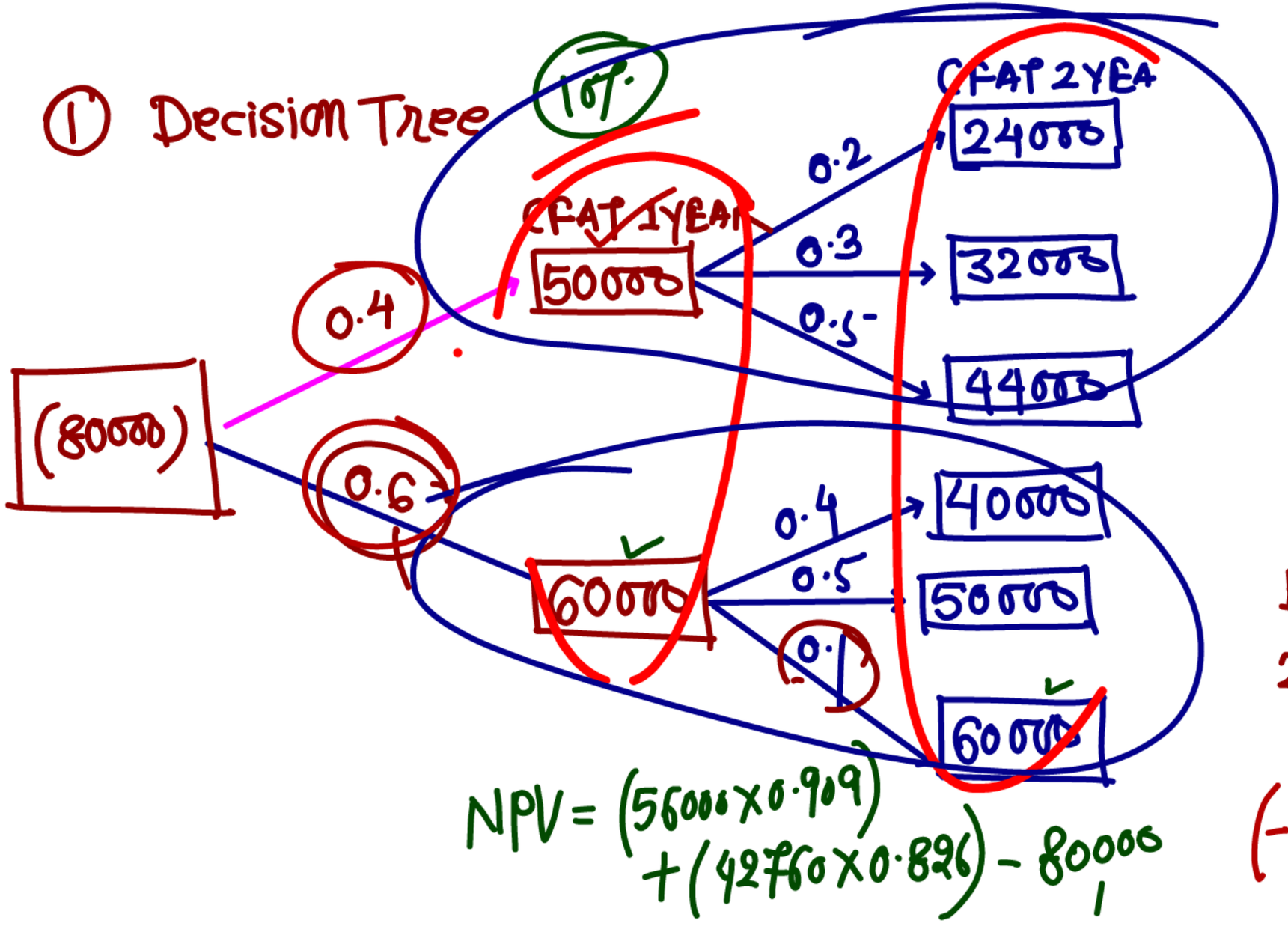
prob. = 0.06

Expected (24100 × 0.06) = 1446

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

(v) What is the prob. of Negative NPV =

# ① Decision Tree




NPV = (56000 × 0.909) + (42760 × 0.826) − 80000

PATH 1

1 50,000 × 0.909

2 36400 × 0.826

− 80000 = (4484)

PATH 2

1 60000 × 0.909

2 47000 × 0.826

− 80000 = 13362

(−4484 × 0.4) + (13362 × 0.6)

# Calculation of Expected NPV

| Scenario | NPV = PVCI - PVCO | NPV | Joint prob. | NPV x J.P. |
|---|---|---|---|---|
| 1 | (50000 x 0.909) + (24000 x 0.826) - 80000 = | (14726) | 0.08 | (1178) |
| 2 | (50000 x 0.909) + (32000 x 0.826) - 80000 = | (8118) | 0.12 | (974) |
| 3 | (50000 x 6.909) + (44000 x 0.826) - 80000 = | 1794 | 0.20 | 359 |
| 4 | (60000 x 0.909) + (40000 x 0.826) - 80000 = | 7580 | 0.24 | 1819 |
| 5 | (60000 x 0.909) + (50000 x 0.826) - 80000 = | 15840 | 0.30 | 4752 |
| 6 | (60000 x 0.909) + (60000 x 0.826) - 80000 = | 24100 | 0.06 | 1446 |
| | | | | 0.20 |
| | | Expected NPV = | | 6224 |

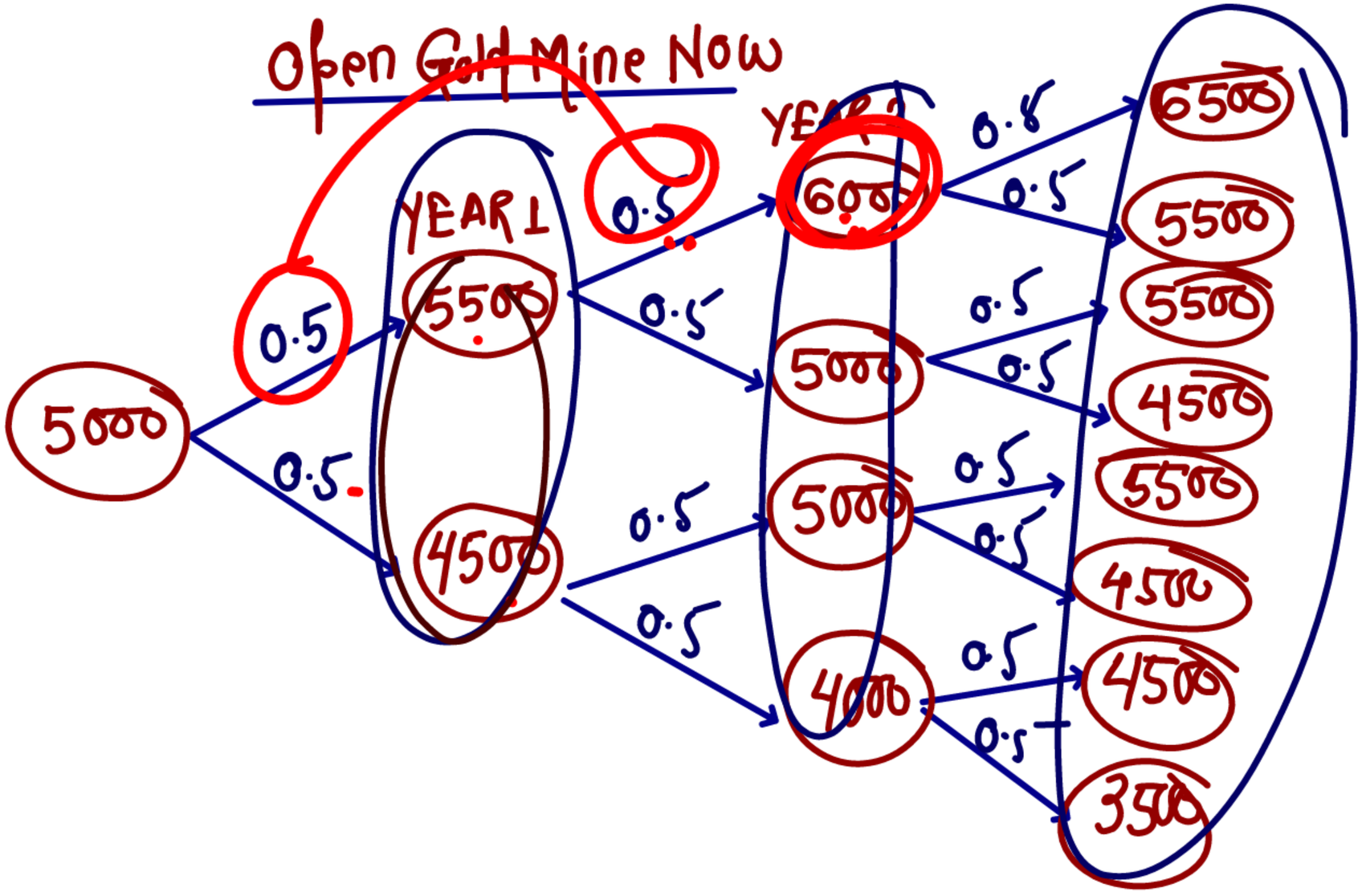
## Question – 27

*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
5000
0.5
0.5
YEAR 1
5500
4500
0.5
0.5
0.5
0.5
6000
5000
5000
4000
0.5
0.5
0.5
0.5
0.5
0.5
6500
5500
5500
4500
5500
4500
4500
3500

## Expected price of Gold

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

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

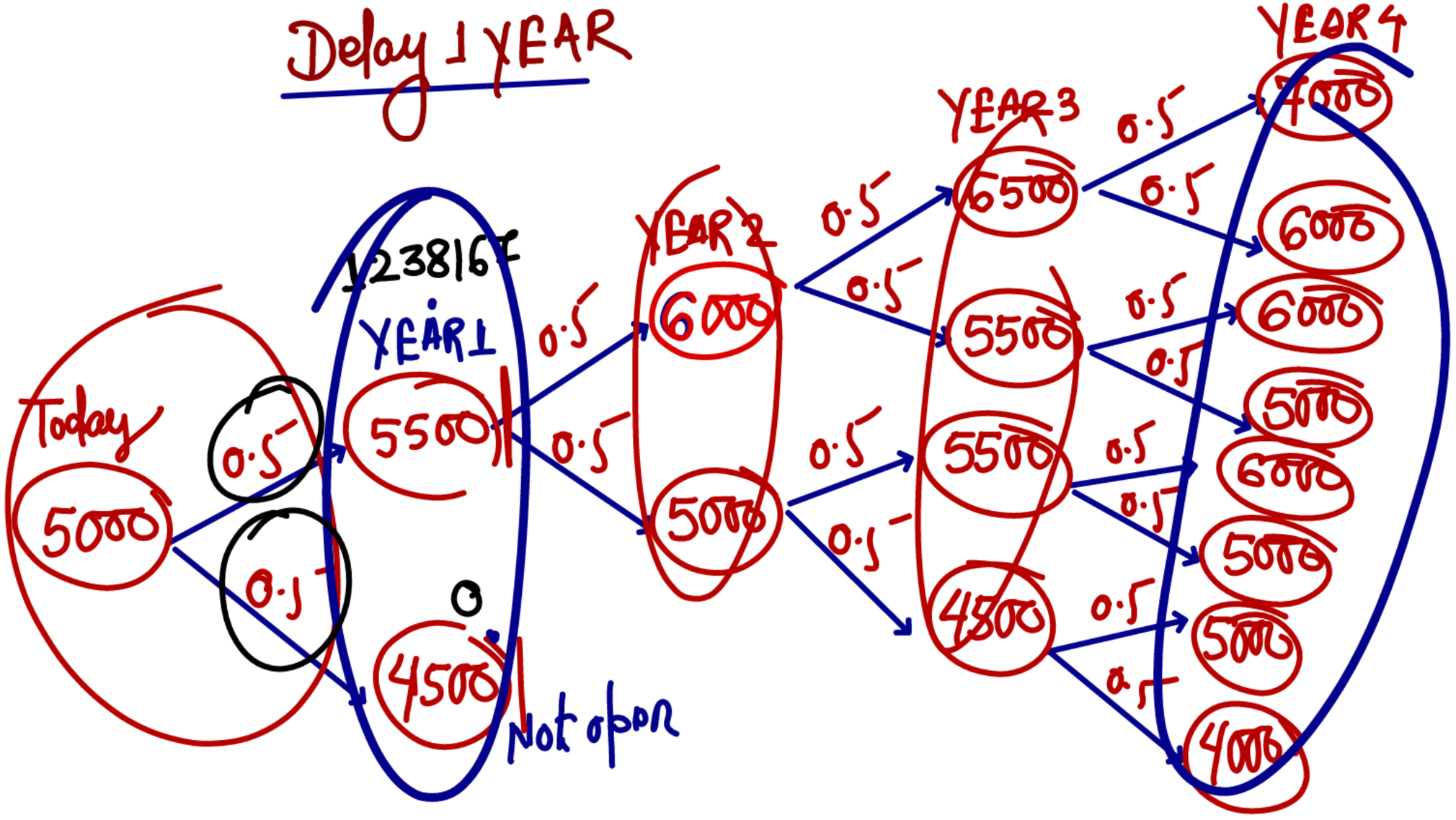
YEAR 3 = $\times (0.5)^3$ = ₹ 5000

## Calculation of NPV

| | |
|---|---|
| Gold price | ₹ 5000 |
| (-) Extration cost | ₹ 4600 |
| Cash Inflow | ₹ 400 per ounce |
| (x) Quantity | 1000 / 400000 |

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

$$= (5260)$$


Delay 1 YEAR
Today
5000
0.5
0.5
YEAR1
5500
4500
Not open
123816F
0.5
0.5
YEAR2
6000
5000
0.5
0.5
0.5
0.5
YEAR3
6500
5500
5500
4500
0.5
0.5
0.5
0.5
0.5
0.5
YEAR4
7000
6000
6000
5000
6000
5000
5000
4000

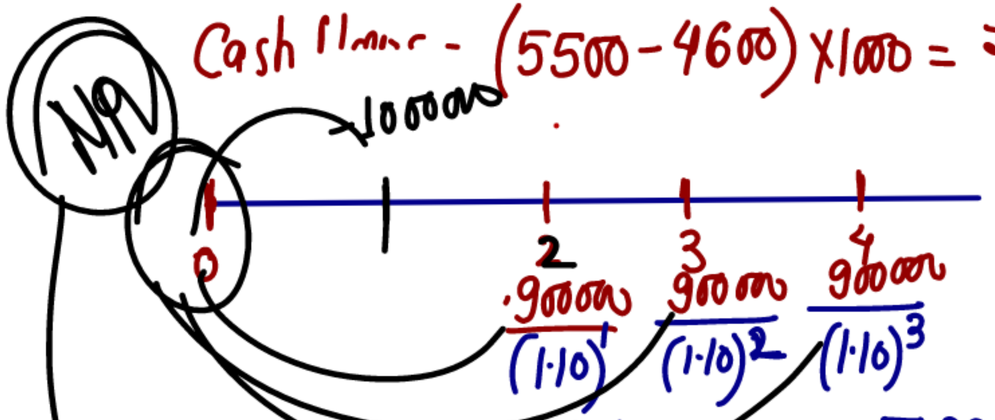
# Calculation of Expected price

YEAR 2 $(6000+5000)\times 0.5 = 5500$

YEAR 3 $= 5500$

YEAR 4 $= 5500$

Cash flows - $(5500-4600)\times 1000 = ₹ 900000$ p.a.



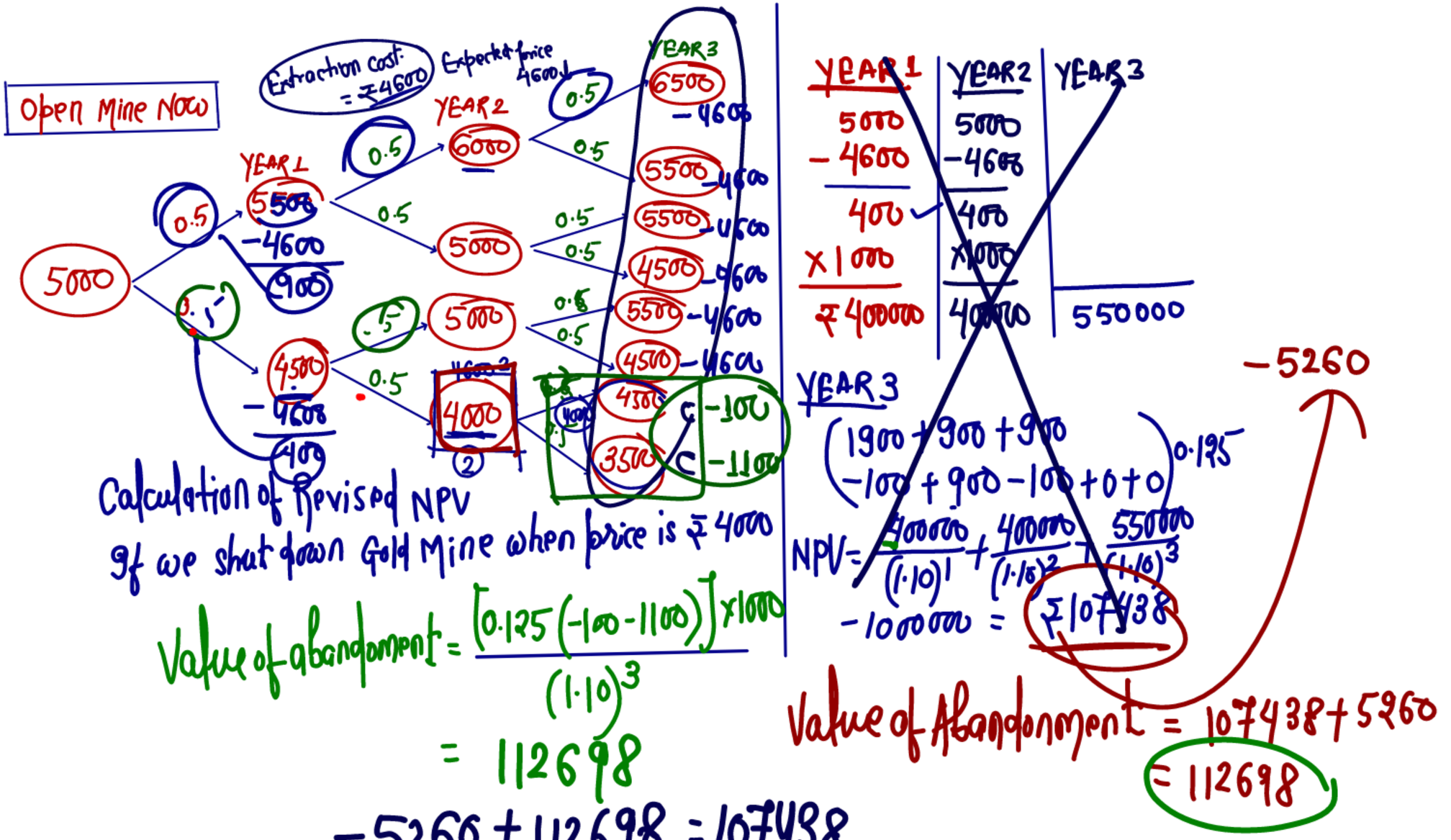

PVCI at the end of YEAR 1 $= ₹ 2238167$

(-) PVCO $= ₹ 1000000$

NPV $1238167$

NPV at "0" period $= \frac{(1238167\times 0.5)+(0\times 0.5)}{1.10}$

$= ₹ 562803$




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

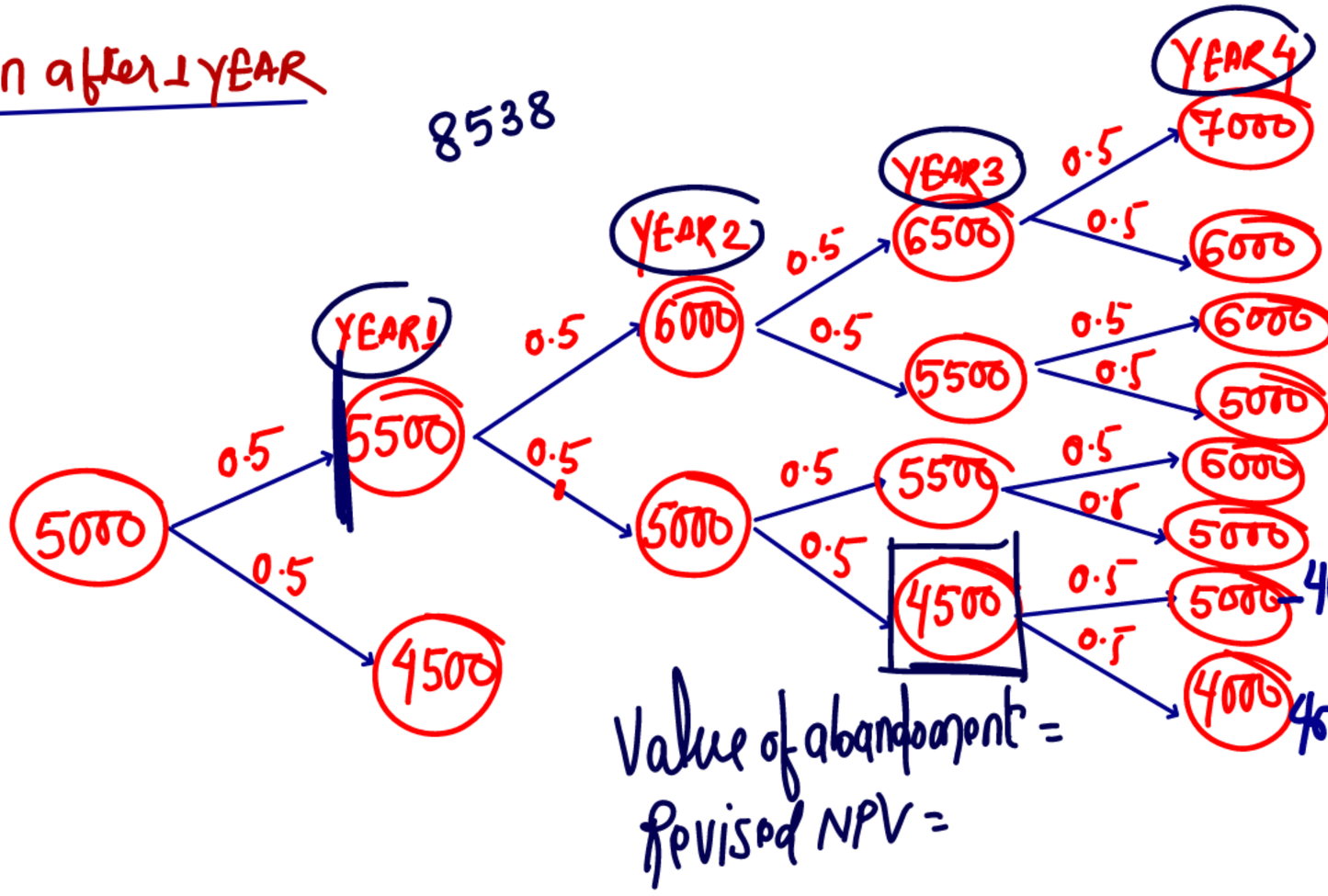
$$\text{Value of abandonment} = \frac{[0.125(-100-1100)]\times 1000}{(1.10)^3}$$

$$= 112698$$

$$-5260 + 112698 = 107438$$

Open after 1 YEAR

8538




Value of abandonment =

Revised NPV =

Value of abandonment

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

YEAR 1 End

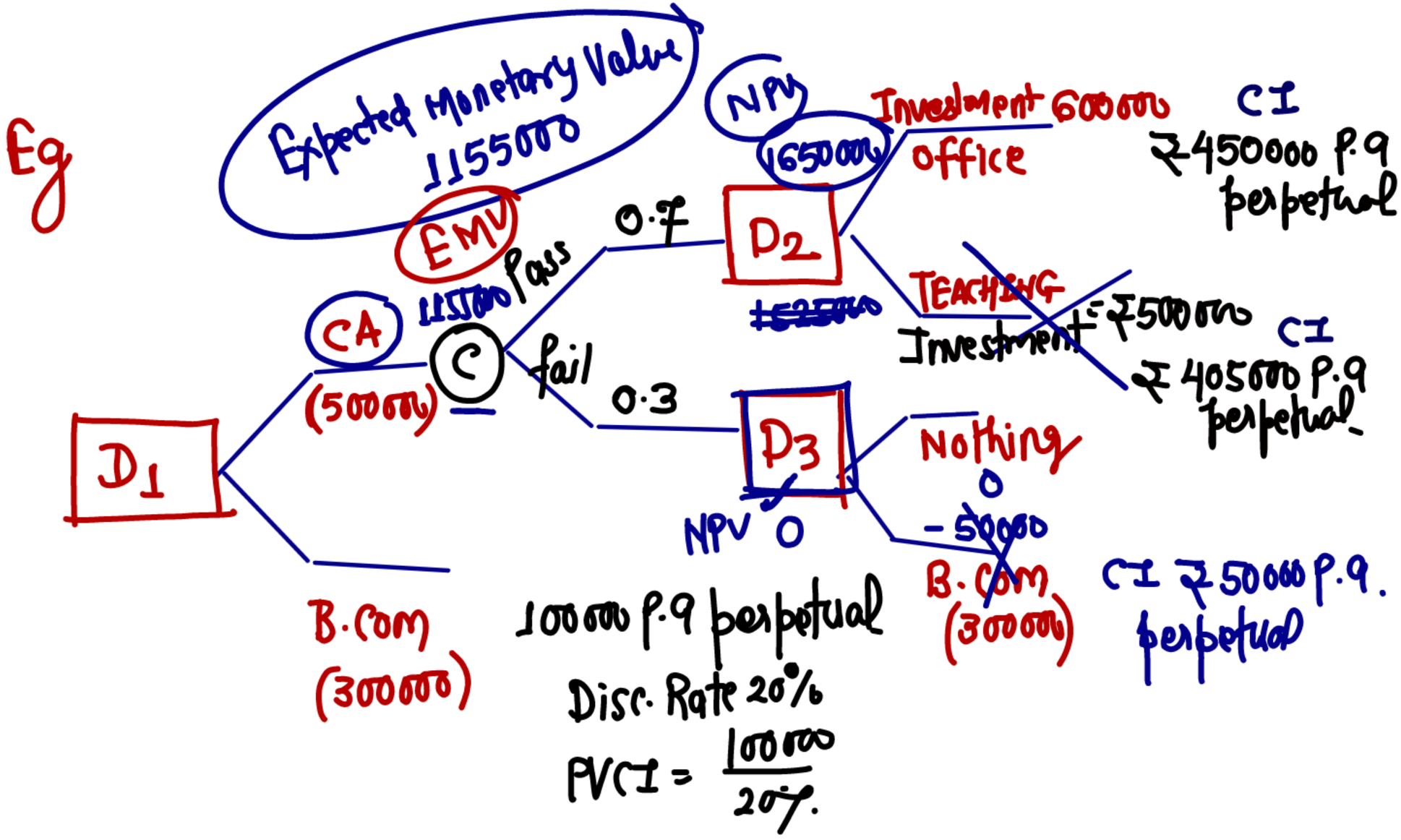
$$\frac{18782.87\times 0.5^{-}}{1.10}$$

$= ₹8538$

4600 = 4000

NPV = 562803

4500 = -600


Eg
Expected Monetary Value
1155000
EMV
1155000
CA
(500000)
Pass
0.7
fail
0.3
D1
D2
D3
NPV
1650000
Investment 600000
office
CI
₹450000 P.9
perpetual
TEACHING
Investment ₹500000
CI
₹405000 P.9
perpetual
Nothing
0
-50000
NPV 0
B.Com
(300000)
B.Com
(300000)
100000 P.9 perpetual
Disc. Rate 20%
PVCI = 100000/20%
CI ₹50000 P.9.
perpetual

- At decision point $D_2$ (Node $D_2$)

There are two option

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 $D_3$ (Node $D_3$)

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

$$EMV = (1650000 \times 0.7) + (0 \times 0.3)$$

$$= ₹\ 1155000$$

## At decision point D1

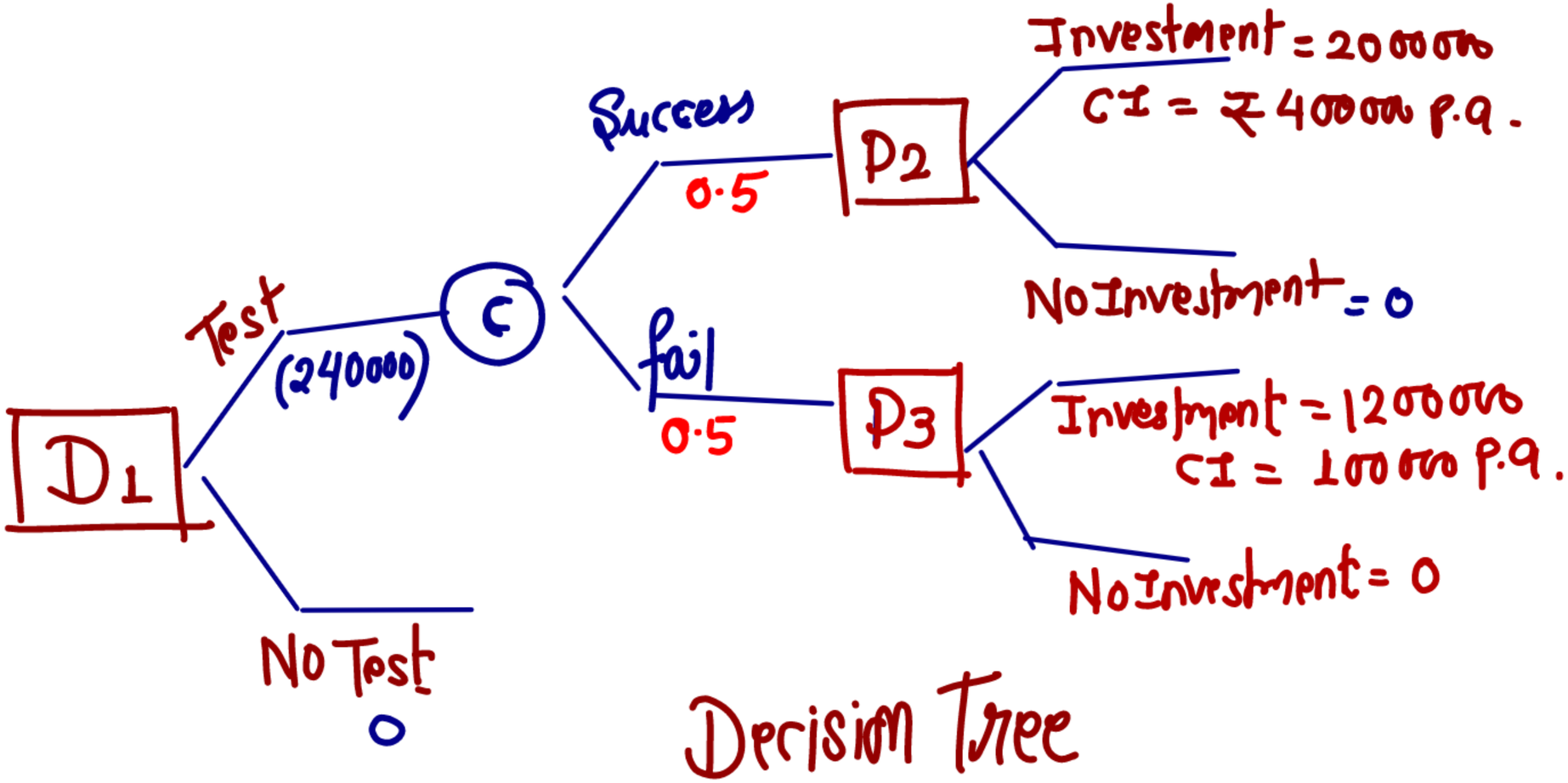
option 1 CA NPV = 1155000 - 500000 = 655000

option 2 B.Com NPV = $\frac{100000}{20\%}$ - 300000 = 200000

CA is better due to higher NPV

**Question: 30**

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%.




Decision Tree

# Evaluation

- **At decision point $D_2$**

  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 = $\frac{-100000}{10\%} - 1200000 = -2000000$

  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 $D_1$**

option 1 Testing

NPV = (1000000 − 240000)

= ₹ 760000

option 2 No Testing

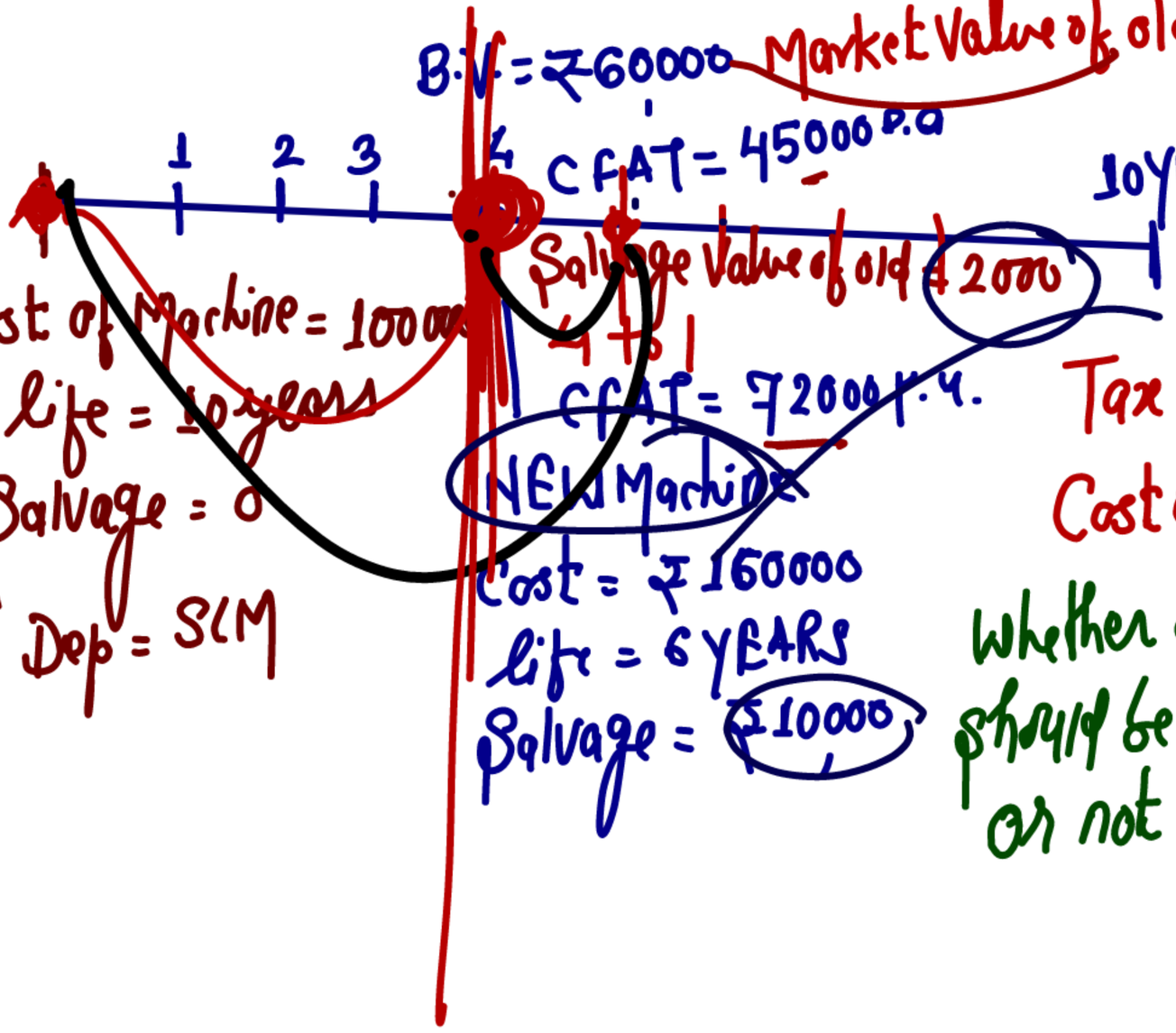
NPV = 0

Testing is better due to Higher NPV

# PART III Replacement Decision

3000 900

Eg




160000
− 62100
97900

63000
− 900
62100

Tax Rate = 30%

Cost of Capital = 10%.

Whether old machine should be replaced or not?

# Statement showing Calculation of NPV

| | YEAR | PVf (10%) | Amount | P.V. |
|---|---|---|---|---|
| (A) Incremental Cash outflow | | | | |
| Cost of New Machine | 0 | 1.000 | 160000 | 160000 |
| Sale of old Machine (Net of Tax) (W.N.1) | 0 | 1.000 | (62100) | (62100) |
| (A) | | | | 97900 |
| (B) Incremental Cash Inflows | | | | |
| Incremental CFAT (72000 - 45000) | 1-6 | 4.355 | 27000 | 117585 |
| Incremental Terminal Value (10000 - 2000) | 6 | 0.564 | 8000 | 4512 |
| (B) | | | | 122097 |
| NPV (B-A) | | | | 24197 |

Machine should be replaced, due to positive NPV

## W.N.1 Sale of old Machine

| | | |
|---|---|---|
| Sales Consideration | = | ₹ 63000 — (I) |
| (-) Book Value | = | ₹ 60000 |
| Capital Gain | = | ₹ 3000 |
| Tax @ 30% | = | ₹ 900 — (II) |
| Sales consideration (Net of Tax) | | ₹ 62100 (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 – (2500×5)] | 12500 |
| Capital Loss | 7500 |
| Tax Savings @ 30% | 2250 – (II) |
| Net consideration (i+ii) | 7250 |

# W.N. 2 Incremental CFAT

| | | |
|---|---|---|
| Savings in cost | = | ₹ 5000 |
| Increase in Revenue (₹ 100000 × 10%.) | = | ₹ 10000 |
| Incremental CFBT | | ₹ 15000 — (I) |
| (-) Incremental Dep. $\left[\left(\frac{50000-1000}{5}\right)-2500\right]$ | | ₹ 7300 |
| Incremental PBT | | 7700 |
| Tax @ 30% | | 2310 — (II) |
| Incremental CFAT | | 12690 (i-ii) |

# Calculation of NPV

| | YEAR | PVf (10%) | Amt | P.V. |
|---|---|---|---|---|
| (A) Incremental C.O. | | | | |
| Cost of New Machine | 0 | 1.000 | 50000 | 50000 |
| Sale of old Machine (w.N-1) | 0 | 1.000 | (7250) | (7250) |
| | | | | 42750 |
| (B) Incremental CI | | | | |
| Incremental CFAT | 1-5 | 3.791 | 12690 | 48108 |
| Incremental T.V. | 5 | 0.621 | 1000 | 621 |
| | | | | 48729 |
| NPV | | | | 5979 |

**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 (2050000/5) | 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 |

PVCI = 1747930

(-) PVCO (2050000 - 30000) 2020000

NPV (272070)

Sale of old Machine

Sale Consideration = 50000

(-) B.V. 0

Cap. Gain 50000

Tax @ 40% 20000

30000

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

ITYK24

**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 × 2.487)

= 294474

EAPVCO = PVCO / PVAf = 249480 / 2.487 = 100314

EPVCO lower Accept

### Machine B

PVCO = 100000 + (60000 × 1.735)

EAPVCO = 204100 / 1.735 = 117637

**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?

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.*

*(Page No. 14)*

# Statement Showing PVCO

| | YEAR | PVF. | EVERY YEAR | | 2 YEARS | | 3 YEARS | | 4 YEARS | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Amt | P.V. | Amt | P.V. | Amt | P.V. | Amt | P.V. |
| Cost | 0 | 1.000 | 60000 | 60000 | 60000 | 60000 | 60000 | 60000 | 60000 | 60000 |
| Maintenance & Repair | 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 | 0.6571 | - | - | - | - | (16000) | (10520) | - | - |
| | 4 | 0.5718 | - | - | - | - | - | - | (8000) | (4574) |
| PVCO | | | | 46087 | | 72402 | | 98438 | | 124969 |
| ÷ PVAF | | | | 0.8696 | | 1.6257 | | 2.2832 | | 2.858 |
| EAPVCO | | | | ₹52998 | | ₹44536 | | 43114 | | 43772 |

Optimal Replacement cycle is 3 YEARS due to Lower PVCO

**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%.*

(Page No. 18)

# 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 | 0 | 1.000 | 400000 | 400000 | 400000 | 400000 | 400000 | 400000 |
| operating cost | 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 | | | | 309100 | | 547100 | | 789650 |
| ÷ PVAF | | | | 0.909 | | 1.735 | | 2.486 |
| 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 Taxes Insurance etc. (₹)** | **Petrol Repair Maintenance 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. |
| **Cash Outflows** | | | | | | |
| 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) | (63636) |
| (A) | | | | 70000 | | 72720 |
| **Cash Inflows** | | | | | | |
| CFAT | 1-3 | 2.487 | 80000 | 198960 | — | — |
| | 1 | 0.909 | — | — | 40000 | 36360 |
| | 2-4 | 2.261 | — | — | 80000 | 180880 |
| (B) | | | | 198960 | 1 | 217240 |
| NPV (B-A) | | | | 128960 | | 144520 |

Exam में इसे भी करना है

Machine should be replaced in YEAR 1 due to Higher NPV

**Question: 06**

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 =
(₹10000 × 4.4873) = ₹44873

(-) P.V. of Salvage
(₹20000 × 0.3269) = (6538)

Cost ₹128335

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

= 28600

| | 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 | – | – | (3600) | (3132) | – | – | – | – | – | – |
| | 2 | 0.756 | – | – | – | – | (13600) | (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 | – | – | – | – | – | – | (30000) | (19740) | (30000) | (19740) |
| | 4 | 0.572 | – | – | – | – | – | – | – | – | (40000) | (22880) |
| | | | | 11400 | | (11832) | | (39102) | | (55799) | | (89799) |

**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 ₹) |
| 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 | (400000 × 0.1486) (59440) | (400000 × 0.2394) (95760) |
| Cost | 2340560 | 3904240 |
| (x) Capital Recovery | 0.1175 | 0.1315 |
| Capital charge p.a | 275016 | 513468 |
| (+) Operational Exp | 960000 | 1200000 |
| Total cost | 1235016 | 1713408 |
| ÷ No. of units | 3000000 | 6000000 |
| Cost per unit | 0.04117 | 0.02856 |

15 YEARS

Project
200 Cr.

Equity ₹50 Cr.

Loan @ 15% ₹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 decides 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) | 46.88 |
| 5% | | |

$$\text{project IRR} = 15 + \left(\frac{5}{46.88} \times 33.88\right)$$

$$= 18.61\%$$

## ② Calculation of Equity IRR

$$\text{Equal Annual Installment} = \frac{\text{Loan Amt}}{\text{PVAf (Rate of Int)}}$$

$$= \frac{₹150 \text{ Cr.}}{\text{PAAF}(15\%, 15\text{yrs})}$$

$$= \frac{₹150}{5.847} = ₹25.654$$

### Cash Flow for Equity

| | |
|---|---|
| CFAT | 40 Cr. |
| (-) Repayment of debt | ₹25.65 |
| CF for Equity | 14.35 Cr. |

Cash flows p.a. 14.35 cr.

Cash outflows = ₹ 50 cr.

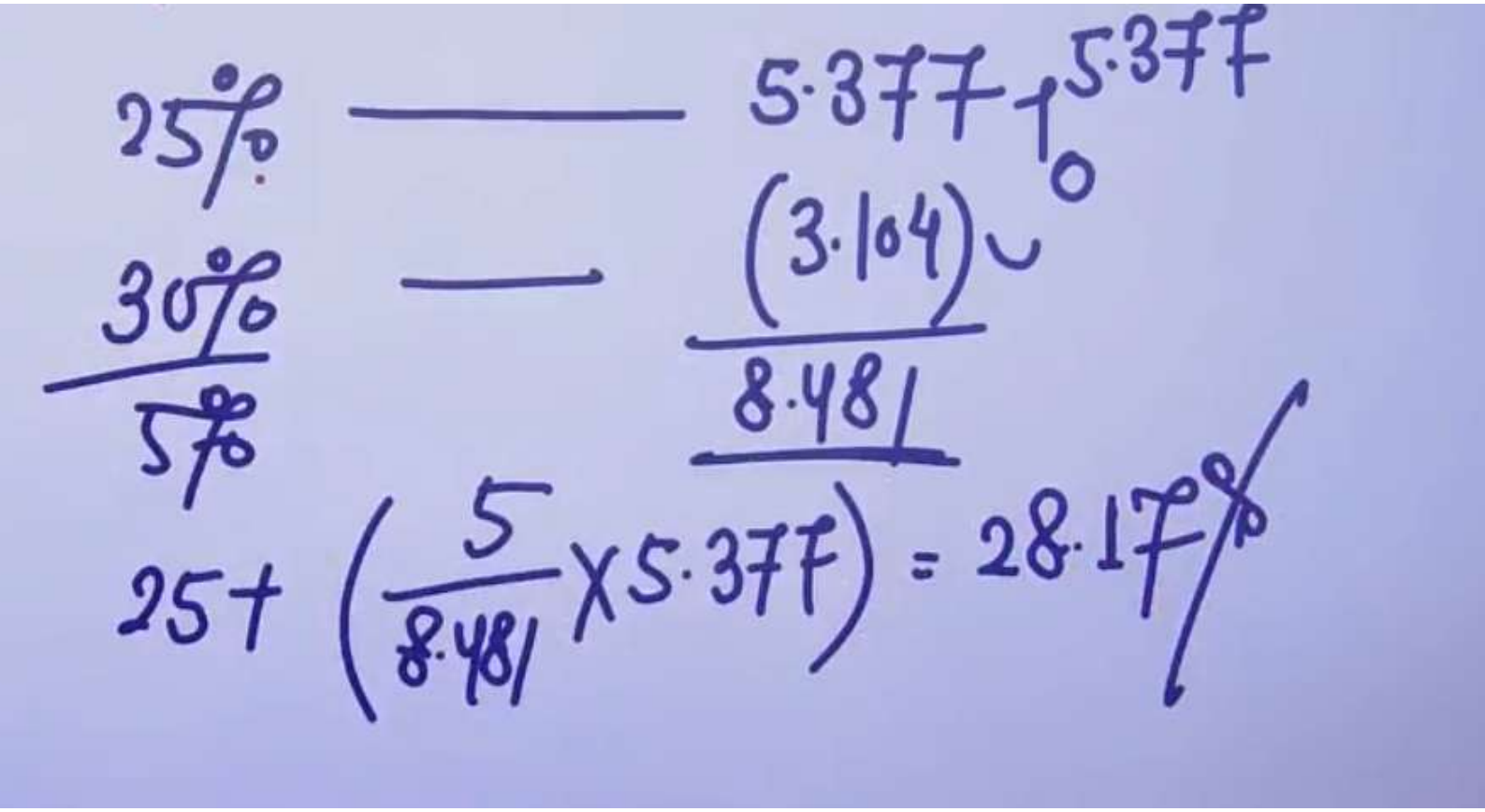
IRR is a rate at PVCI = PVCO

Disc. Rate = 25%

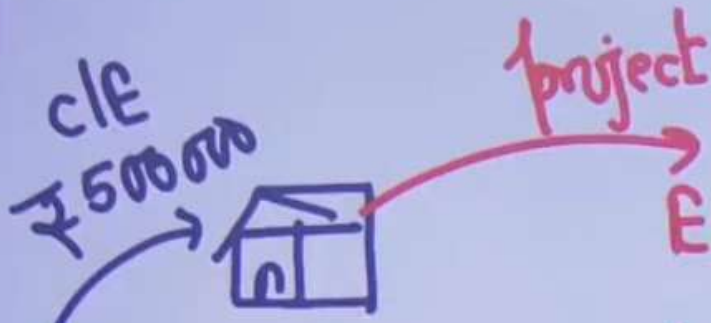
$$NPV = (14.35 \times 3.859) - 50 = 5.377$$

Disc. Rate = 30%

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


25% ——— 5·377
30% ——— (3·104)
5% 8·481
25 + (5/8·481 X 5·377) = 28·17%

Eg




Equity ₹ 300000
10% Debt ₹ 200000
₹ 500000

Assume No Tax.

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

$$ROI = \frac{80000}{500000} \times 100 = 16\%$$

$$ROE \quad \frac{60000}{300000} \times 100 = 20\%$$

| | |
|---|---|
| EBIT | 80000 |
| (-) Int | 20000 |
| EBT | 60000 |

$$ROE = ROI + (ROI - kd)\frac{D}{E}$$

$$= 16 + (16 - 10)\frac{200000}{300000}$$

$$= 20\%$$

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

project IRR = 18.61%

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

$$\text{Equity IRR} = \text{project IRR} + (\text{project IRR} - k_d)\frac{D}{E}$$

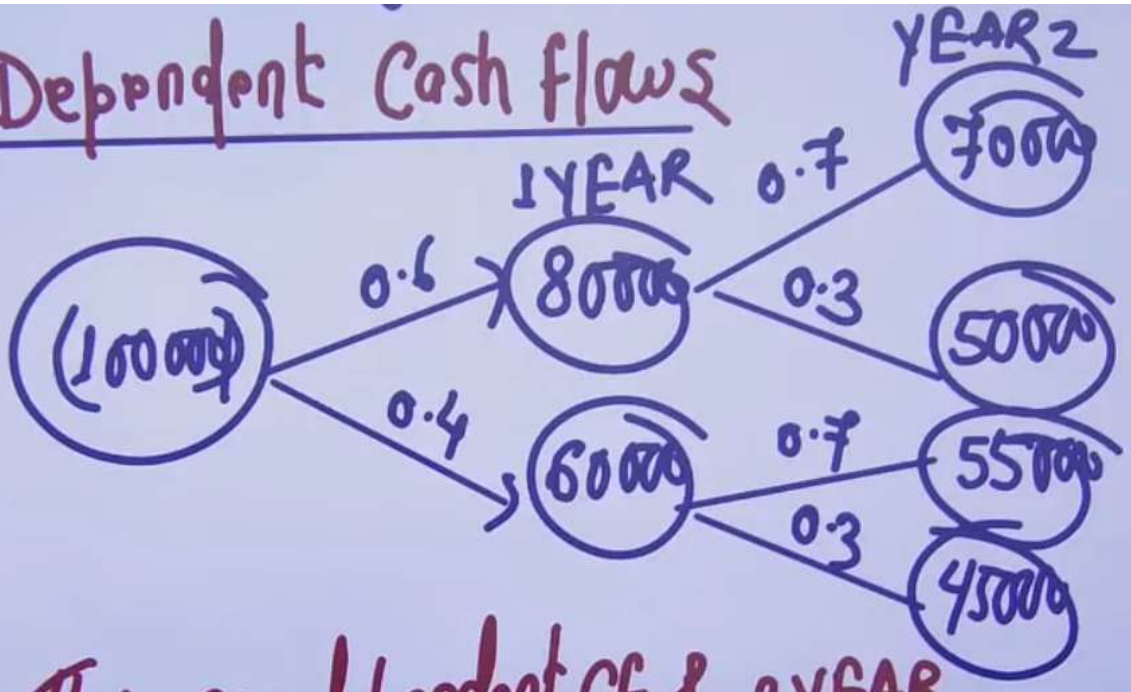
$$= 18.61 + (18.61 - 15)\frac{150}{50}$$

$$= 29.44\%$$

# HERTZ MODEL & HILLIER MODEL (Imp)

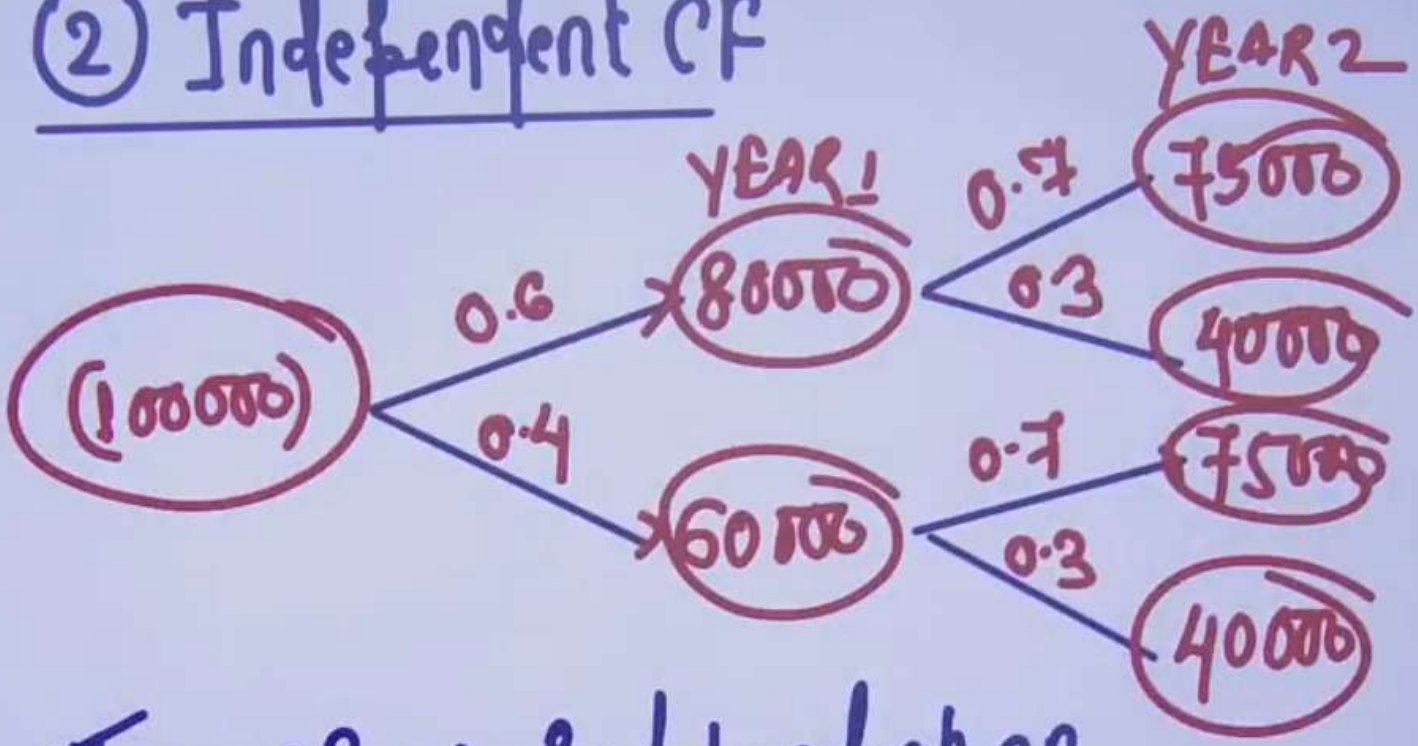
- In this Topic, we calculate standard deviation of NPV.
- There are two types of Cash flows.

## (i) Dependent Cash flows

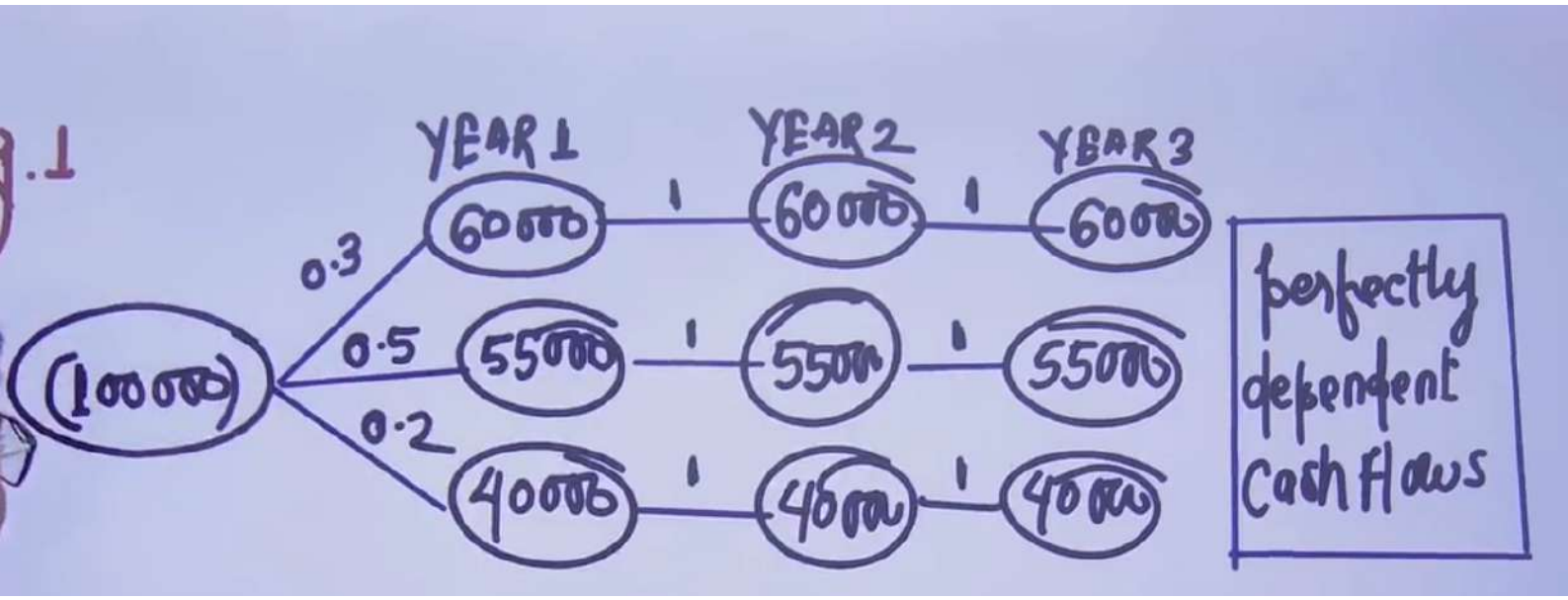



These are dependent CF & 2 YEAR CF depends on 1st YEAR CF

## ② Independent CF




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


YEAR 1
YEAR 2
YEAR 3
(100000)
0.3
0.5
0.2
60000
55000
40000
1
1
1
1
1
1
60000
55000
40000
60000
55000
40000
perfectly dependent Cash Flows

Discounting Rate = 10%

① Calculate NPV

② Calculate standard deviation in NPV

## ① Expected NPV

NPV

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

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

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

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

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

$= 17630$

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

2 YEAR = 7089

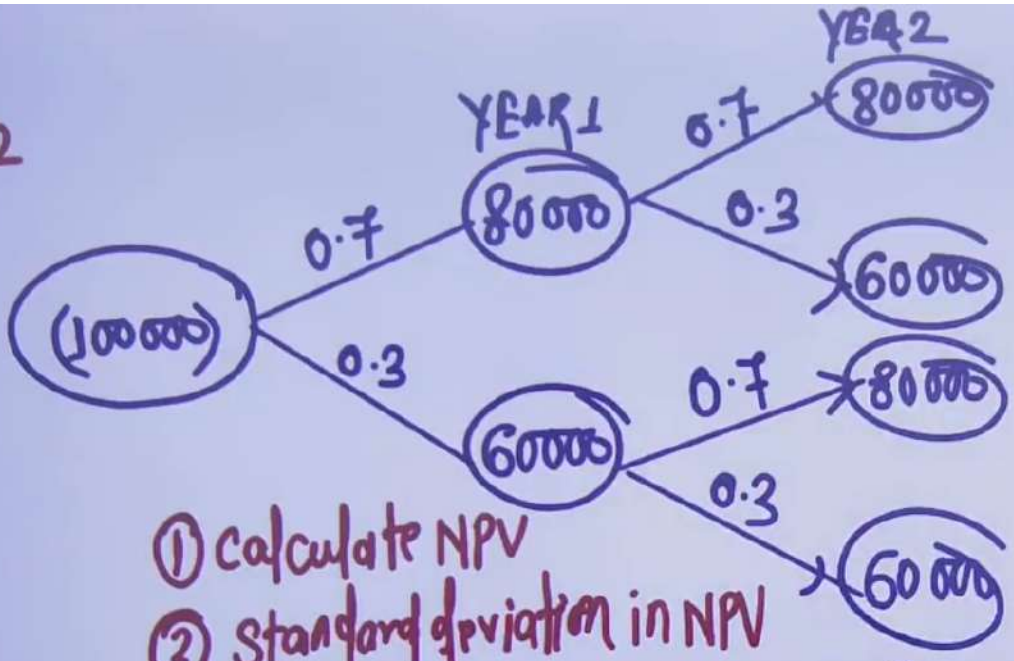
3 YEAR = 7089

## FORMULA

$$\sigma NPV = \frac{\sigma CF_1}{(1+r)^1} + \frac{\sigma CF_2}{(1+1)^2} + \frac{\sigma CF_3}{(1+1)^3}$$

$$= \frac{7089}{(1.10)^1} + \frac{7089}{(1.10)^2} + \frac{7089}{(1.10)^3} = 17630$$

Eg. 2




- Independent Cf
- Disc. Rate = 10%.

① Calculate NPV
② Standard deviation in NPV

PATHWISE

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

## ① Expected NPV

Expected NPV = 28390

## ② Standard deviation

$$S.D. = \sqrt{(38800-28390)^2 0.49 + (22280-28390)^2 0.21 + (20690-28390)^2 0.21 + (4100-28390)^2 0.21}$$

$$= 11257$$

# Hillier Model

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

Expected cf YEAR = 1 $(80000 \times 0.7) + (60000 \times 0.3)$

$= 74000$

YEAR 2 $= (80000 \times 0.49) + (60000 \times 0.21)$

$+ (80000 \times 0.21) + (60000 \times 0.09)$

$= 74000$

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

$$= 9165$$

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

$$= 9165$$

**FORMULA**

$$\sigma_{NPV} = \sqrt{\frac{\sigma_{CF}^2}{(1+1)^2} + \frac{\sigma_{CF}^2}{(1+1)^4}}$$

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

**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)

YEAR 1 = (14 × 0.1) + (18 × 0.2)
+ (25 × 0.4) + (40 × 0.3) = 27

YEAR 2 = (15 × 0.1) + (20 × 0.3)
+ (32 × 0.4) + (45 × 0.2) = 29.30

YEAR 3 = (18 × 0.2) + (25 × 0.5)
+ (35 × 0.2) + (48 × 0.1) = 27.90

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

$$= 24.97$$

## (II) Standard deviation

### Standard deviation of CF

1st YEAR

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

2nd YEAR

$$\sigma_{CF_2} = 9.93$$

3rd YEAR

$$\sigma_{CF_3} = 8.62$$

## HILLIER MODEL

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

$$= 14.87$$

(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.

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

**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

Scenario 1 = $(100000 \times 3.791) + (20000 \times 0.621) - 400000$

= (8480)

Scenario 2 = $(110000 \times 3.791) + (50000 \times 0.621) - 400000$

= 48060

Scenario 3 $(120000 \times 3.791) + (60000 \times 0.621) - 400000$

= 92180

(11) Best NPV = 92180
Worst NPV = (8480)

= 92180

Expected NPV = (-8480 × 0.3) + (48060 × 0.5) + (92180 × 0.2) = 39922

(iii) Probability of Worst Case NPV

Perfectly dependent

Probability = 0.3 [0.3 × 1 × 1 × 1 × 1]

Independent

Probability = $(0.3)^5$ = 0.00243

(iv) Standard deviation in NPV

I हमने NPV calculate कर लिया है Path से

So Hillier या HBRTZ model नहीं लगा रहे हैं

## (iv) Standard deviation in NPV

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

$$= 35807$$

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

## (v) NPV

Since x'd project's C.V. (0.90) is less than Avg C.V.
hence Discounting Rate (RADR) should be

$(10 - 1)\% = 9\%$

Expected cf $= (100000 \times 0.3) + (110000 \times 0.5) + (120000 \times 0.2)$

$= 109000$ p.a.

Expected Salvage Value $= (20000 \times 0.3) + (50000 \times 0.5) + (60000 \times 0.2) = 43000$

Expected NPV $= (109000 \times 3.890) + (43000 \times 0.650) - 400000 = 51960$ (Accepted)

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

YEAR-1 = (30×0.3)+(50×0.4)+(65×0.3)

48.50

YEAR 2 = 41.53

YEAR 3 = 38.5

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

$$= 37.34$$

## Project Y

Expected CF = $(40 \times 0.20) + (45 \times 0.20) + (50 \times 0.3)$

= 45.50 p.a.

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

## (11) Standard deviation [Question Silent - Hillier Model]

**Project x**

**Standard deviation of CF**

1st YEAR $\sigma_{CF_1} = \sqrt{(30-48.50)^2 0.3 + (50-48.50)^2 0.4 + (65-48.50)^2 0.3} = 13.61$

2nd YEAR $\sigma_{CF_2} = \sqrt{(30-41.53)^2 0.3 + (40-41.53)^2 0.4 + (55-41.53)^2 0.3} = 9.76$

3rd YEAR

$CF_3 = 5.94$

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

$$= 15.44$$

# Simulation

Cost of project : ₹ 120000

Discounting Rate = 10%

| CFAT | probability |
|---|---|
| 60000 | 0.3 |
| 40000 | 0.5 |
| 30000 | 0.2 |

| life | prob. |
|---|---|
| 5 | 0.1 |
| 6 | 0.4 |
| 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 & Random No. Range

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

| Life | prob. | Cum. prob. | Range |
|---|---|---|---|
| 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 (10%)

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 |
| 69 | 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 | -10,000 | 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 Utilit

| CF | Utilities | prob. | UXP |
|---|---|---|---|
| 40000 | 60 | 0.5 | 30 |
| 15000 | 40 | 0.3 | 12 |
| -10000 | -20 | 0.2 | -4 |
| | | | 38 |

Expected utility is positive, project should be accepted.