- Reference Books:
-> Damodar Adhikari
-> Santosh kumar Shrestha

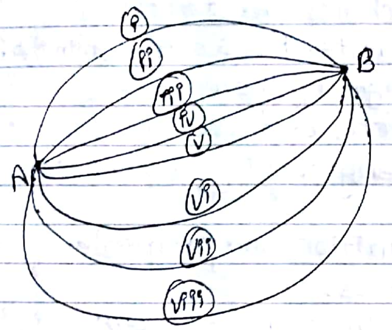
Chapter-1 (4 marks)
Introduction to Engineering Economics (4)

(A) -> Origin of Engineering Economics:
- Design, Construction and operation of machines and structures
- Limited Resources ; unlimited wants
- Mgmt. of these scarce resources
- Focus on these scarce resources wilds engineering to economics.

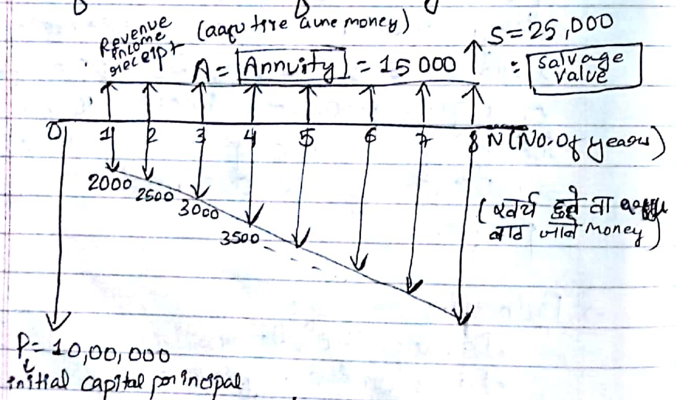
(B) Definition and principles of Engineering Economics:
-> Engineering economics is the application of economic techniques to the evaluation of design and engineering alternatives.
-> Its role is to access the appropriateness of a given project estimate its value, and justify from an engineering standpoint.
-> Minimizing the cost / maximizing the profit.

-> Principles are of:
- Develop the Alternatives.
- Focus on the differences.

- Use a Consistent viewpoint
- Use a Common unit of measure
- Consider all relevant criteria
- Make uncertainty explicit
- Revisit your decision.



Cashflow and Cashflow Diagram:



$i = 10\%$ per year
= interest rate

* Role of Engineers in decision making:
(UC DIE SI)
-> Understand problem, Define Objective
-> Collect Relevant information
-> Define alternatives
-> Identify basic criteria
-> Evaluate
-> Select
-> Implement and monitor results

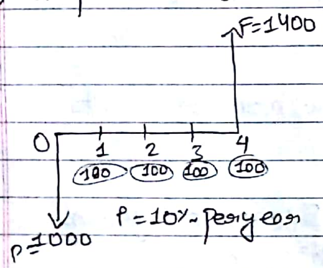
* Economic System:
-> Capitalistic Economic system.
-> pure socialistic system
-> Combination of both.

Chapter-2. (6marks)

* Interest and Time Value of money:
→ Value of money increases with time. Today's one rupee worth more than tomorrow's one rupee which is known as time value of money.

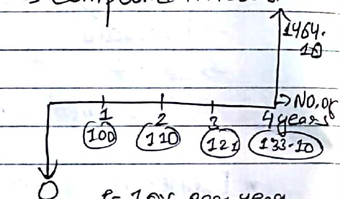
* Interest and types:

a) Simple interest



$i = 10\%$ per year

b) Compound interest



$i = 10\%$ per year

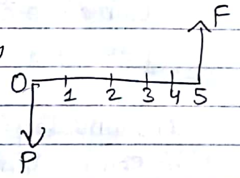
Simple interest (I)
$= P \times i \times N$
$= 1000 \times 0.10 \times 4$
$= 400$

$F = P + I$
$= 1400$

or, $F = P(1+i)^N$
$= 1000(1+0.10)^4$
$= 1464.10$

* Nominal and effective interest rate:

Interest rate $= 12\%$ per year



$$i_{eff} = \left(1+\frac{r}{m}\right)^m - 1$$

where,
r = nominal interest rate
i_{eff} = effective interest rate
m = compounding period.

The basic annual rate of interest quoted by a financial institution is known as nominal interest rate. Denoted by (r).

The actual rate of interest earned during a year is known as effective interest rate.

Denoted by i or i_{eff}.

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Q) Find the effective interest rate when normal rate of interest is 18% per year and Compounding is.

a) Annually $m=1$
b) Semi-Annually $m=2$
c) Monthly $m=12$
d) Weekly $m=52$
e) Daily $m=365$
f) Continuously $m=\infty$

$$i_{eff} = \left(1+\frac{r}{m}\right)^m - 1$$

a) $m=1$ $=0.18$
b) $m=2$ $=0.1881$
c) $m=12$ $=0.1956$
d) $m=52$ $=0.1968$
e) $m=365$ $=0.197$
f) $m=\infty$ $=e^r-1$
$=0.1972$

$$e^r = \lim_{m\to\infty}\left(1+\frac{x}{m}\right)^m = e^x$$

$i_{eff}=0.18$, Compounding monthly then,

$$\left(1+\frac{r}{m}\right)^m - 1 = 0.18$$

$$\left(1+\frac{r}{12}\right)^{12} - 1 = 0.18$$

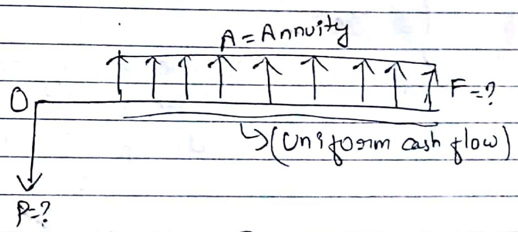
$$\left(1+\frac{r}{12}\right) = (1+0.18)^{1/12}$$

$$\frac{r}{12} = (1+0.18)^{1/12} - 1 = 0.0138 \text{ (per month)}$$

$\therefore r = 0.166$ (per year)

Basic inherent formulas for different cash flows:

a) Uniform Cashflow:

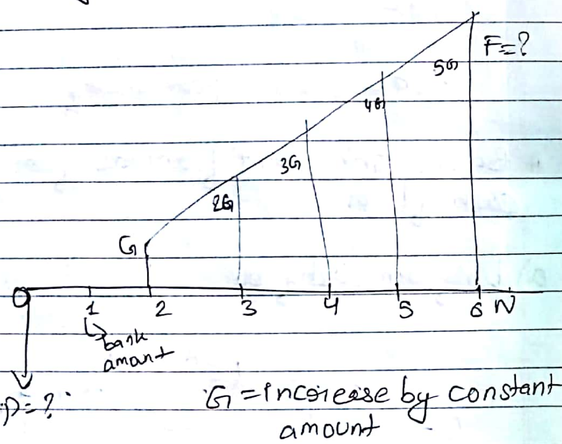


$$P = \left[\frac{(1+i)^N - 1}{i(1+i)^N}\right] \times A$$ → or if P is known, then $$A = \left[\frac{i(1+i)^N}{(1+i)^N - 1}\right] \times P$$

$F = \left[\frac{(1+i)^N - 1}{i}\right] \times A$ → or. if F is known;

then $A = \left[\frac{i}{(1+i)^N - 1}\right] \times F$

b) linear gradient series:



G = increase by constant amount

↳ always start with 2nd year

↳

present value

$P = G\left[\frac{(1+i)^N - 1 - Ni}{i^2(1+i)^N}\right]$

annuity

$A = G\left[\frac{1}{i} - \frac{N}{(1+i)^N - 1}\right]$

Future Value

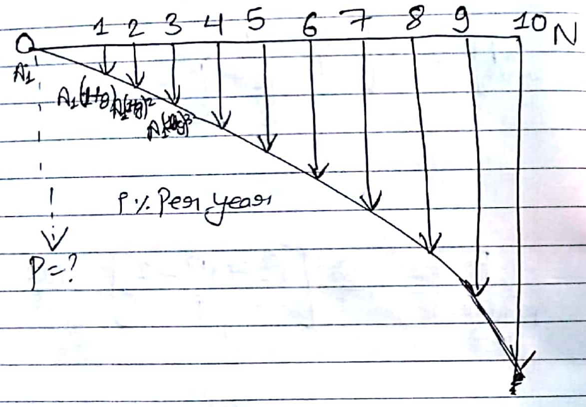
$F = \frac{G}{i}\left[\frac{(1+i)^N - 1}{i}\right] - \frac{NG}{i}$

annuity → equally pay

↳ arko year dekhinsuru.

c) # Geometric Gradient Series:

- Cash flows that increases or decrease over time by a constant percentage.

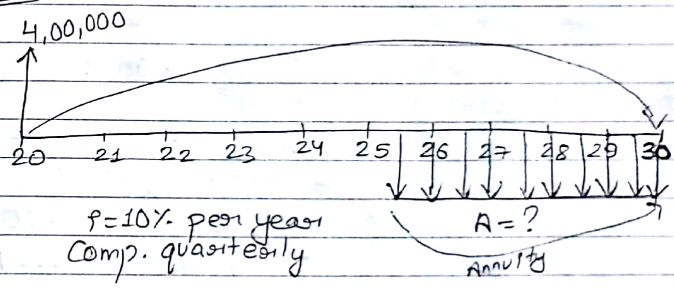


$$P = \frac{A_1}{i-g}\left[1-\left(\frac{1+g}{1+i}\right)^N\right] \rightarrow \text{for } i \neq g$$

$$= \frac{NA_1}{1+i} \rightarrow \text{for } i = g$$

Q) A man age of 30 years now had borrowed Rs. 4,00,000 from bank for his further studies at the age of 20 years. The bank charged interest rate of 10% per year compounded quaterly. He wishes to pay that loan from last 10th semi-annual way with equal installment basis and now he has just cleared the loan. What amount did he pay in each installment?

⇒ soln



Given, i = 10% per year quarterly.

$$i_{effective} = \left(1+\frac{r}{m}\right)^m - 1$$

$$= \left(1+\frac{0.10}{4}\right)^4 - 1$$

$$= 0.1038 = 10.38\%$$

And,
again, determine $i_{semi\text{-}annual}$ because the payment installment is on semi-annual way.

Hence,

$$i_{eff} = \left(1+\frac{r}{m}\right)^m - 1$$

$$\text{or, } 0.1038 = \left(1+\frac{r}{m}\right)^2 - 1$$

$$\text{or, } \frac{r}{m} = i_{semi} = (1+0.1038)^{1/2} - 1$$
$$= 0.0506$$
$$= 5.06\%$$

Now; Future Amount at the age of 30

$$= P(1+i_{eff})^N$$
$$= 4,00,000\ (1+0.1038)^{10}$$
$$= Rs.\ 1073900.114$$

Now, Future amount of Payment Annuity (A) is;

$$F = A \times \left[\frac{(1+i_{semi})^N - 1}{i_{semi}}\right]$$

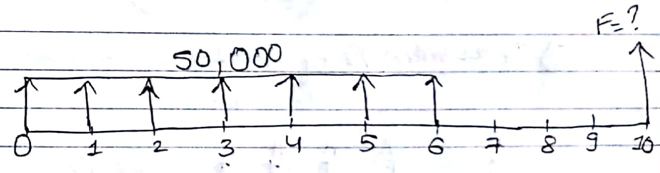
$$= A \times \left[\frac{(1+0.0506)^{10} - 1}{0.0506}\right]$$
$$= A \times 12.61$$

equating both future, Amounts;
We get;

$$A = \frac{10,73,900.114}{12.61}$$
$$= 85162.57$$

Q) You deposited Rs. 50,000 in the beginning of each year for 7 years, how much money will be in your account at the end of 10th year when rate of interest is 6%. Compounded quarterly.

⇒ Soln



$i = 6\%$ Compounded quarterly

$$i_{effective} = \left(1+\frac{r}{m}\right)^m - 1$$

$$= \left(1+\frac{0.06}{4}\right)^4 - 1$$

$$= 0.0614$$

$$F_6 = A \times \left[\frac{(1+i_{eff})^N - 1}{i_{eff}}\right]$$

$$= 50,000\left[\frac{(1+0.0614)^7 - 1}{0.0614}\right]$$

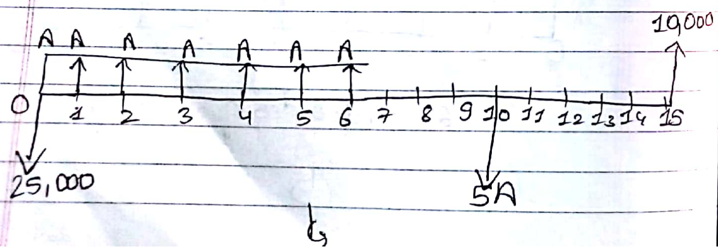
$$= 3.59 \times 10^{10}$$

$$F_{10} = F_6(1+i_{eff})^4$$

$$= 3.59 \times 10^{10}(1+0.0614)^4$$

$$= 4.55 \times 10^{10}$$

Q) Determine A of $i = 15\%$ per year



⇒ soln

Present Value of positive cash flows;

$$P_{positive} = A + A \times \left[\frac{(1+i)^N - 1}{i(1+i)^N}\right] + 10,000(1+i)^{-N}$$

$$= A + A \times \left[\frac{(1+0.15)^6 - 1}{0.15(1+0.15)^6}\right] + 10,000(1+0.15)^{-15}$$

$$= A + A \times 3.785 + 10,000 \times 0.1229$$

Also,

Present Value of negative cash flows;

$$= 25000 + 5A \times (1+i)^{-N}$$

$$= 25000 + 5A \times (1+0.15)^{-10}$$

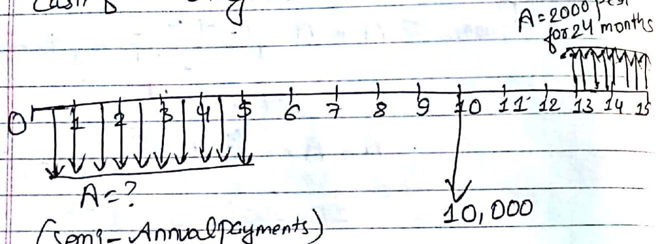
$$= 25000 + 1.236A$$

equating both; we get;

$$25000 + 1.236A = A + 3.785A + 1.229$$

$$\Rightarrow A = 6698$$

Q) Determine the Semi-annual payments for the 1st 5 years in the following Cash flow Diagram.



[i = 12% per year Compounded weekly]

→ soln

Effective interest rate per year

$(i_{eff}) = \left(1+\frac{r}{m}\right)^m - 1$

$= \left(1+\frac{0.12}{52}\right)^{52} - 1$

$= 0.1273$

$= 12.73\%$

Now; Semi-annual interest rate:-

$i_{eff} = \left(1+\frac{r}{m}\right)^m - 1$

Or, $0.1273 = (1+i_{semi})^2 - 1$

Or, $i_{semi} = (1.1273)^{1/2} - 1$

$= 0.0617 = 6.17\%$

And monthly interest rate:

$0.1273 = (1+i_{monthly})^{12} - 1$

Or, $i_{monthly} = (1.1273)^{1/12} - 1$

$= 0.0100$

$= 1\%$

Now; Present Value of positive Cash flow

$= A \times \left[\frac{(1+i_m)^N - 1}{i_m(1+i_m)^N}\right] \times (1+i_{eff})^{-13}$

$= 2000 \times \left[\frac{(1+0.010)^{24} - 1}{0.010(1+0.010)^{24}}\right] \times (1+0.1273)^{-13}$

$= Rs.\ 8948.29$

Again;
Present Value of Cash Outflows:

$$= A \times \left[\frac{(1+i_{semi})^N - 1}{i_{semi}(1+i_{semi})^N}\right] + 10,000 \times (1+i_{eff})^{-N}$$

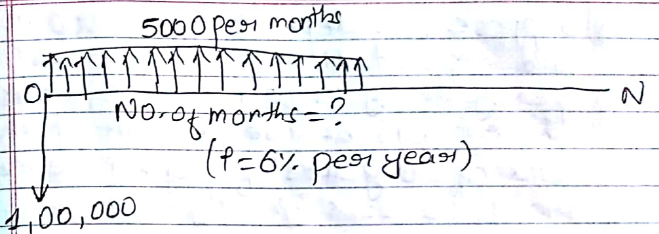
$$= A \times \left[\frac{(1+0.0617)^{10} - 1}{0.0617(1+0.0617)^{10}}\right] + 10,000(1+0.1273)^{-10}$$

$$= A \times 7.301 + 3017.205$$

Equating outflow and inflow,

$$A = Rs.\ 812.355$$

Q) If you deposit Rs. 1,00,000 in a bank account which gives 6% interest per year. How many times would you draw Rs. 5000 per month with that money.



⇒ Soln

$$i_{monthly} = (1 + i_{eff})^{1/m} - 1$$
$$= (1+0.06)^{1/12} - 1$$
$$= 0.00486$$

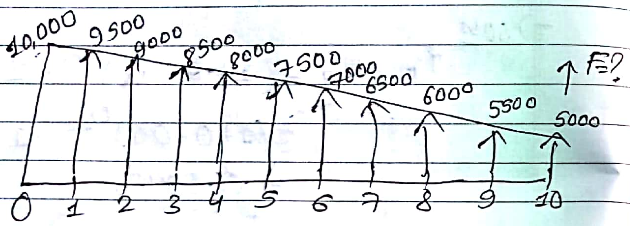
Now, we have;

$$P = A \times \left[\frac{(1+i_m)^N - 1}{i_m(1+i_m)^N}\right]$$

$$\Rightarrow 100000 = 5000 \times \left[\frac{(1+0.00486)^N - 1}{0.00486(1+0.00486)^N}\right]$$

$$\therefore N = 21.091 \text{ months.}$$

Q) Suppose you deposit Rs. 10,000 now and deposit amount is decreasing per year by Rs. 500 for 10 years. What will be the amount at the end of 10 years if bank interest rate is 12% yearly?

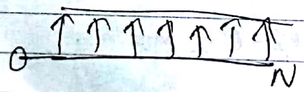


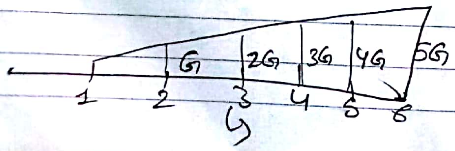
($i = 12\%$ yearly)

⇒ Soln

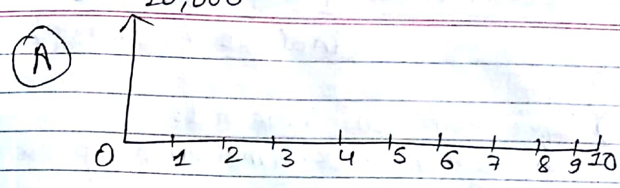
Given;

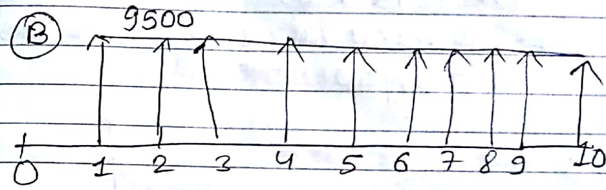
$i = 12\%$ per year compounded yearly.

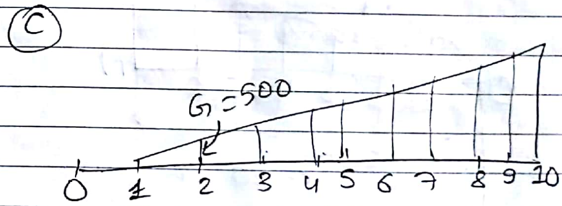




Annuity ma next year bata badhxa.







(A + B − C)

$F_A = 10,000(1+i)^N$

$F_B = 9500\left[\frac{(1+i)^N - 1}{i}\right]$

$F_C = \frac{G}{i}\left[\frac{(1+i)^N - 1}{i}\right] - \frac{NG}{i}$

$\therefore F_A + F_B - F_C$ //

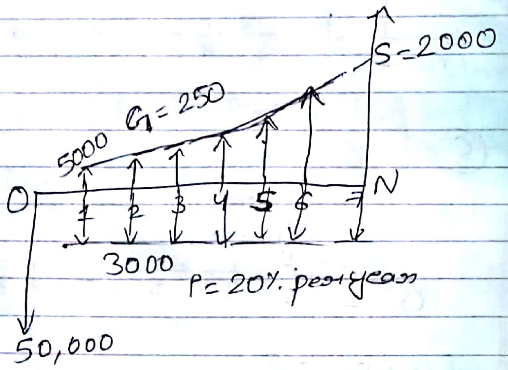
Chp-3.

Basic Methodologies of Engineering Economic Analysis. (12 marks)

1) Equivalent worth method:

a) Present worth method / Net present value (NPV) method:

→ Equivalent values of all the cash flows at the year zero (0).

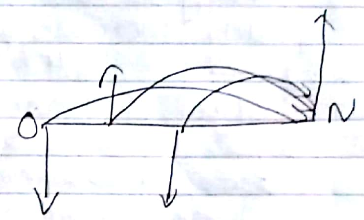


$$NPV(20\%) = -50,000 + 5000 \times \left[\frac{(1+i)^N - 1}{i(1+i)^N}\right] + G\left[\frac{(1+i)^N - 1 - Ni}{i^2(1+i)^N}\right] + 2000(1+i)^{-N} - 3000 \times \left(\frac{(1+i)^N - 1}{i(1+i)^N}\right)$$

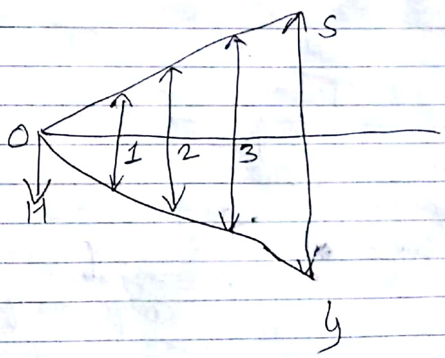
$NPV(20\%) = Rs. \ldots$

+ve = Accept
-ve = Reject
zero = Remain indifferent.

b) Net Future Worth:

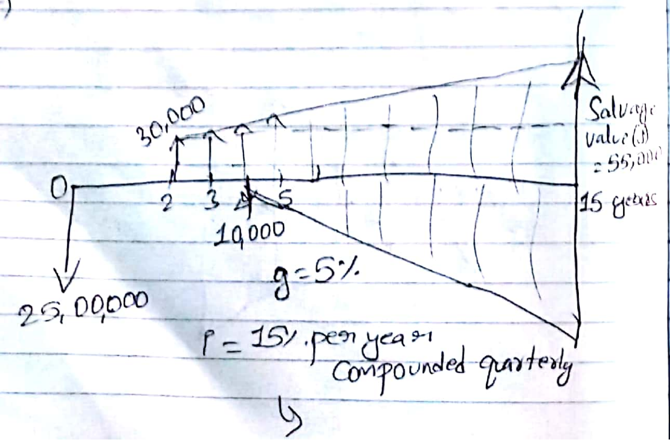


c) Net Annual Worth:



Q) A person invests Rs. 25,00,000 now. The annual income is Rs. 30,000 at the end of second year and it increases by a constant amount of Rs. 1500 thereafter for 15 years. The expenditure begins from the end of 4th year with an amount of Rs 10,000 and increases by a constant % by 5% thereafter for 15 years. The final salvage value at the end of 15th year is 55,000. Using interest rate of 15% per year compounded quaterly. Determine the net present value.

=)



$r = 15\%$ per year compounded quarterly

Net Present Value:-

Effective interest rate $(r_{eff}) = \left(1+\frac{r}{m}\right)^m - 1$

$= \left(1+\frac{0.15}{4}\right)^4 - 1$

$= 0.1586$

Now, Net Present Value

$$NPV = -25,00,000 + 30000 \times \left[\frac{(1+r)^N - 1}{r(1+r)^N}\right] \times (1+r)^{-1} + G\left[\frac{(1+r)^N - 1 - Nr}{r^2(1+r)^N}\right] \times (1+r)^{-1} + 55,000(1+r)^{-15} - \frac{10,000}{r-g}\left[1 - \left(\frac{1+g}{1+r}\right)^N\right] \times (1+r)^{-3}$$

$$= -25,00,000 + 30,000\left[\frac{(1+0.1586)^{14} - 1}{0.1586(1+0.1586)^{14}}\right] \times (1+0.1586)^{-1} + G\left[\frac{(1+0.1586)^{14} - 1 - 14\times 0.1586}{(0.1586)^2(1+0.1586)^{14}}\right] \times (1+r)^{-1} + 55000(1+r)^{-15}$$

$$= \frac{10000}{0.1586-0.05}\left[1-\left(\frac{1+0.05}{1+0.1586}\right)^{12}\right] \times (1+0.1586)^{-3}$$

= Rs. 2653920.27

+ve,

∴ accept.

2) PayBack Period Method:

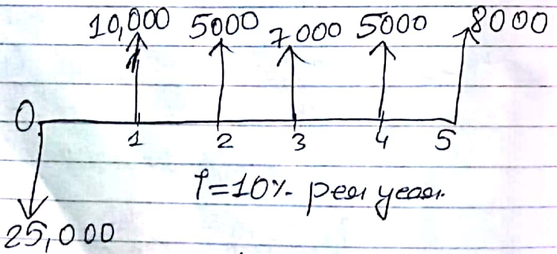
-> PayBack period is the total time required to recover the initial investment in any project.

-> It is expressed in terms of years.

-> Types:- a) Simple payback period.

b) Discounted payback period.

:)



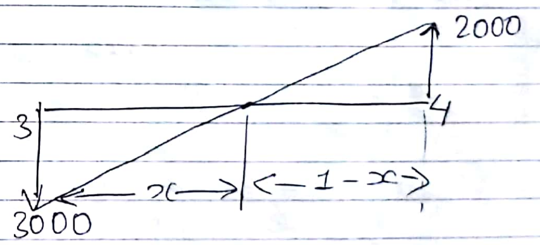
a) Simple payback period:

EOY	Cashflow	Cummulative Cashflow
0	-25,000	-25,000
1	10,000	-15,000
2	5000	-10,000
3	7000	-3,000
4	5000	2000
5	8000	10,000

-> zero

Here, positive value yr-4 = 2000

negative value yr-3 = -3000



$$\frac{x}{3000} = \frac{1-x}{2000}$$

~~Solve~~ $\frac{x}{3} = \frac{1-x}{2}$

$\therefore x = 0.6$

∴ Simple payback period = 3 + 0.6
= 3.6 yrs.

b) Discounted Payback Period:

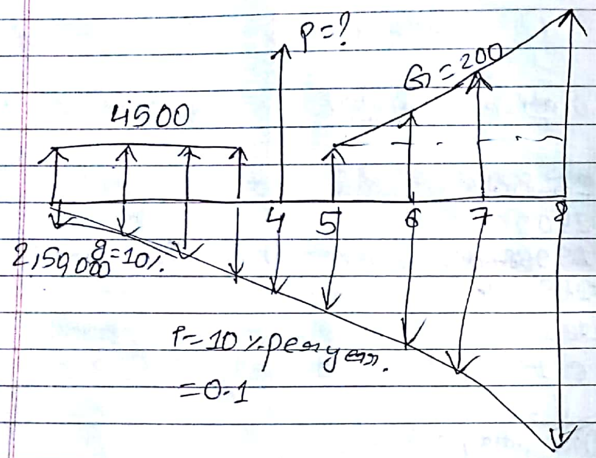
EOY	Cashflow	Commulative Cashflow	Discounted Cashflow	Commulative Cash flow.
0	−25,000	−25,000	−25,000	−25,000
1	10,000	−15,000	$10000(1+i)^{-1} = 909.09$	−24090
2	5000	−10,000	$5000(1+i)^{-2} = 4132.23$	−19958.68
3	7000	−3,000	$7000(1+i)^{-3} = 5259.26$	−14699.48
4	5000	2000 (0)	$5000(1+i)^{-4} = 3415.06$	−11284.42
5	8000	10,000	$(8000)(1+i)^{-5} = 4967.37$	−6317.05

$i = 10\%$.

Discounted payback period > Simple.

Assignment.

Q. Determine Value of P.



$i = 10\%$ per year
$= 0.1$

$\Rightarrow$ Cash inflow at 0 year:

$$4500 + \left[\frac{(1+0.1)^3 - 1}{0.1(1+0.1)^3}\right] \times 4500 +$$

$$P(1+0.1)^{-4} + 5000\left[\frac{(1+0.1)^4 - 1}{0.1(1+0.1)^4}\right] \times \left[\frac{(1+0.1)^4 - 1}{0.1(1+0.1)^4}\right]$$

$$+ 200\left[\frac{(1+0.1)^5 - 1 - 5\times 0.1}{0.1^2(1+0.1)^5}\right] \times (1+0.1)^{-3}$$

$$\cancel{\times \left[\frac{(1+0.1)^4 - 1}{0.1(1+0.1)^4}\right]}$$

$= 27547.2 + 0.683P$

Cash outflow,

$$= 2500000 + \left[\frac{(1+0.1)^8 - 1}{0.1(1+0.1)^8}\right] \times 25000$$

$$+ \frac{8 \times 25000}{1+0.1}$$

$= 1765549.7$

Cash inflow = Cash outflow.

i.e. $27547.2 + 0.683P = 1765549.7$

$\therefore P = \text{Rs. } 2544659.59$

3) Rate of Return Method:

a) Internal Rate of Return (IRR) method

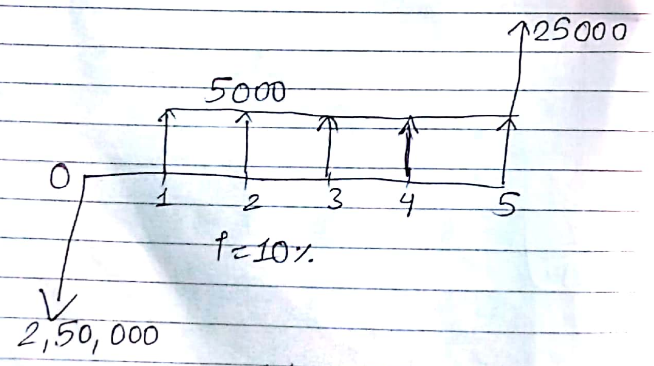
b) External Rate of Return (ERR) method

a) Internal Rate of Return (IRR) :

-> It is the interest rate charged in the unrecovered project balance of the investment such that when the project terminates, the unrecovered balance is zero (0).

-> The investment has zero net present value at this interest rate.

-> Investment Balance Diagram.



MARR (Minimum attractive rate of return)

$$NPV = -2{,}50{,}000 + 5000 \times \left[\frac{(1+i)^N - 1}{i(1+i)^N}\right] + 25000\,(1+i)^{-N}$$

$$= -250000 + 5000 \times \left[\frac{(1+0.10)^5 - 1}{0.10(1+0.10)^5}\right] + 25000\,(1+0.10)^{-5}$$

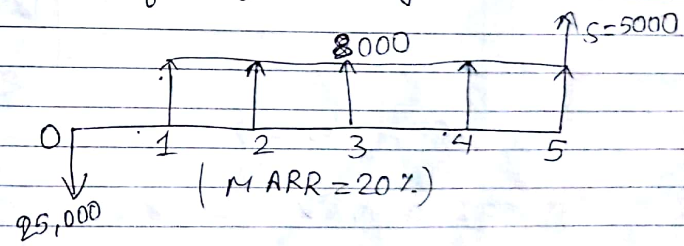
= Rs.

Q) Compute the IRR of the following project also show the unrecovered investment balance in the graphical and tabular form. Initial investment = Rs. 25,000.

Net annual revenue = Rs. 8000

Salvage value (S) = 5000

Useful life = 5 years



4303.124

⇒ soln

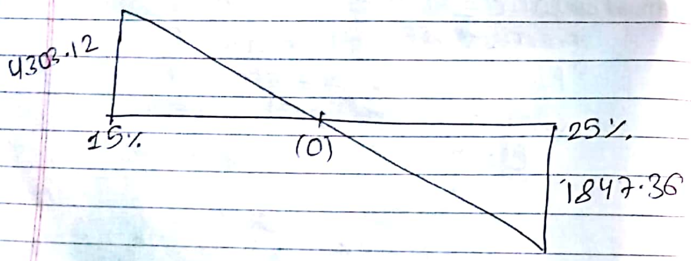
Writing the equation for Net present Value (NPV);

$$NPV(i\%) = -25000 + 8000 \times \left[\frac{(1+i)^5 - 1}{i(1+i)^5}\right] + 5000(1+i)^{-5} \quad \text{--- (i)}$$

Now;

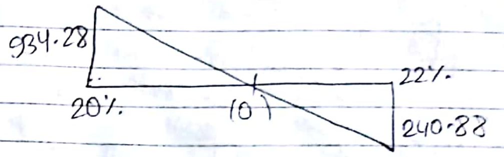
$i = 15\%$, $NPV = 4303.12$

$i = 25\%$, $NPV = \cancel{-3321.92}$ -1847.36



$i = 20\%$, $NPV = 934.28$

$i = 22\%$, $NPV = -240.88$



By interpolation;

$$\frac{x}{934.28} = \frac{2-x}{240.88}$$

Solving;

$x = 1.57$

Hence; $IRR = 21.57\%$

(then to, verify eq^n (i) ma 0 le equate garnu)

Decision Criteria:

IRR > MARR (Ok)

IRR < MARR (Reject)

IRR = MARR (Remain indifferent)

Graphical form:-

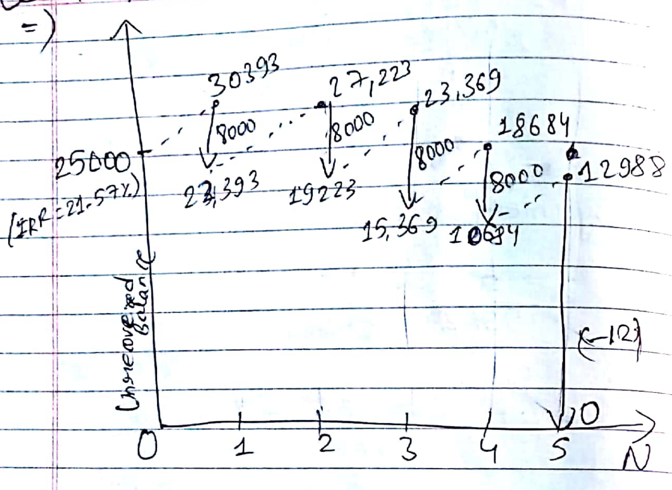


Fig: Unrecovered Balance Diagram.

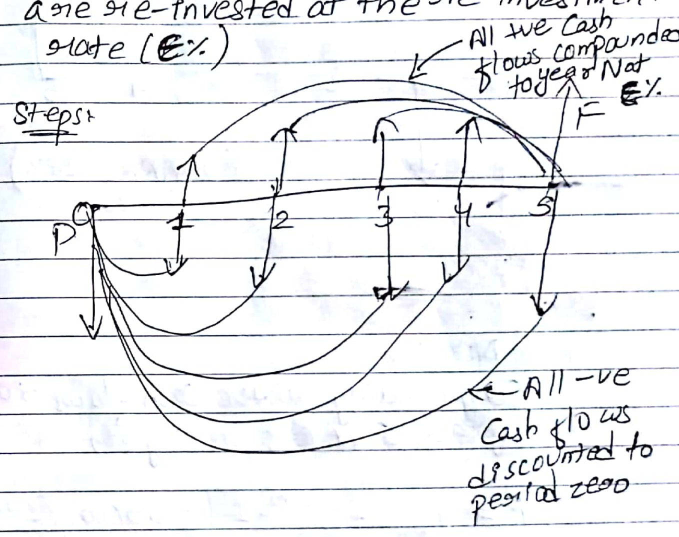
Tabular form:-

EOY	Cash flow	Unrecovered Investment: Beginning of year	Unrecovered Investment: End of year	Net Unrecovered Investment
0	-25000	—	-25000	-25000
1	8000	-25000	-30393	-22393
2	8000	-22393	-27223	-19223
3	8000	-19223	-23369	-15369
4	8000	-15369	-18684	-10,684
5	13000	-10,684	-12988	12 ≃ 0

b) External Rate of Return (ERR) method:

It is the unique rate of return for a project, that assumes net positive cash flows, which represent money not immediately needed by the project are re-invested at the re-investment rate (E%)

Steps:

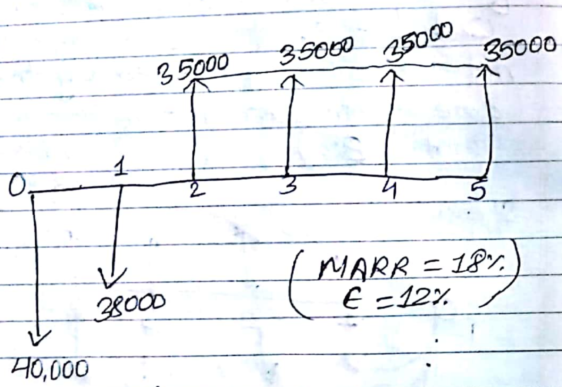


→ ERR is the interest rate that equivalence between the 2 eqn,

$$\boxed{F = P \times (1 + i^*)^N}$$

i^* = External rate of return

Q) Determine external rate of return (ERR) for the following project.



$$\begin{pmatrix} MARR = 18\% \\ \epsilon = 12\% \end{pmatrix}$$

⇒ Soln

Now;

Compounding all +ve cash flows to year 5 at $\epsilon\%$; we get,

$$F = A\left[\frac{(1+i)^N - 1}{i}\right] = 35000 \times \left[\frac{(1+0.12)^4 - 1}{0.12}\right]$$

$$= 167276.48$$

Also;

Discounting all −ve cash flows to ~~year~~ zero; we get,

$$P = 40,000 + 38000(1+\epsilon)^{-1}$$

$$= 40,000 + 38,000(1+0.12)^{-1}$$

$$= 73928.57$$

Establishing the equivalence both two we get;

$$F = P(1+i^*)^N$$

$$\Rightarrow 167276.48 = 73928.57(1+i^*)^5$$

$$\Rightarrow \therefore i^* = 17.74\%$$

$$\left[\begin{array}{l} i^* > MARR - \text{Accept} \\ i^* = MARR - \text{Indifferent} \\ i^* < MAR - \text{Reject} \end{array}\right]$$

4) Cost-Benefit Analysis :- (Benefit Cost Ratio Method):

$$B/C \text{ ratio} = \frac{\text{Eq. worth of benefits}}{\text{Eq. worth of costs}}$$

All costs and benefits are expressed in monetary terms.

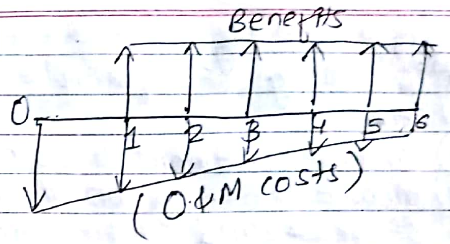
Types of B/C ratio:

a) Conventional B/C ratio
b) ~~Traditional~~ Modified B/C ratio

a) PW formulation:

$$\text{Conventional } (B/C) \text{ ratio} = \frac{PW(\text{Benefits})}{PW(I) - PW(S) + PW(O\&M)}$$

$$\text{Modified } (B/C) \text{ ratio} = \frac{PW(\text{Benefits}) - PW(O\&M)}{PW(I) - PW(S)}$$



FW formulation:

$$\text{Conventional } B/C \text{ ratio} = \frac{FW(\text{Benefits})}{FW(I) - FW(S) + FW(O\&M)}$$

$$\text{Modified } B/C \text{ ratio} = \frac{FW(\text{Benefit}) - FW(O\&M)}{FW(I) - FW(S)}$$

(Similarly AW formulation)

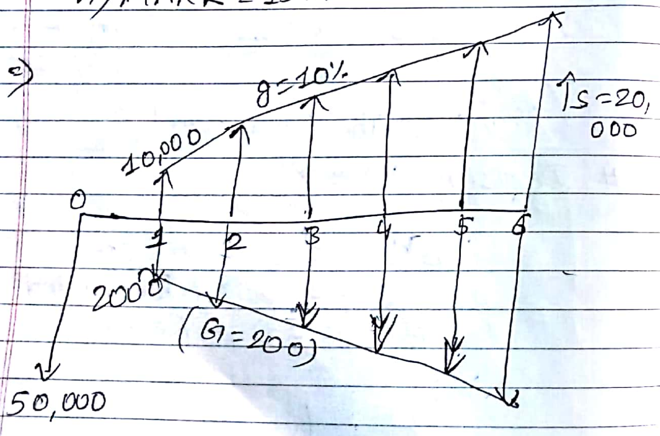
Decision Criteria:

$B/C > 1.0$ – Accept
$B/C = 1.0$ – Remain indifferent
$B/C < 1.0$ – Reject.

V.V.V.V.I * 2

Q) Calculate both types of benefit cost ratio using FW formulation when

i) initial investment is 50,000
ii) income is Rs. 10,000 at the end of 1st year and increasing by 10% per year
iii) Annual expenditure is Rs. 2000 at the end of 1st year and increasing by Rs. 200 per year.
iv) Useful life 6 yrs.
v) Salvage value 20,000.
vi) MARR = 15%.



Future worth of Benefits (FW)

$= PW(\text{Benefits}) \times (1+i)^N$

$= \frac{A_1}{i-g}\left[1-\left(\frac{1+g}{1+i}\right)^N\right] \times (1+i)^N$

$= \frac{10,000}{0.15-0.10}\left[1-\left(\frac{1+0.10}{1+0.15}\right)^6\right] \times (1+0.15)^6$

$= 108299.95$

→ Future worth of Investment FW (I)

$= 50,000(1+i)^N$

$= 50,000(1+0.15)^6$

$= 115653.03$

→ Future worth of Salvage value FW(S)

$= 20,000$

→ Future worth of (O & M) cost;

$FW(O\&M) = 2000\left(\frac{(1+i)^N-1}{i}\right) + \frac{G}{i}\left[\frac{(1+i)^N-1}{i}\right] - \frac{NG}{i}$

$$= 20000 \times \left(\frac{(1+0.15)^6 - 1}{0.15}\right) + \frac{200}{0.15}\left[\frac{(1+0.15)^6 - 1}{0.15}\right] - \frac{6 \times 200}{0.15}$$

$= 21179.128$

Now,

Conventional B/C ratio = 0.926 < 1

Modified B/C ratio = 0.91 < 1

Since B/C ratio < 1; the project is not feasible.

Life Cycle Costing

-> Initial Cost

-> operation and maintainance cost

-> Disposal cost

Financial and Economic Analysis:

Financial	Economic
-> cost and benefits are considered from viewpoint of project entity.	-> Cost and benefits are considered from ~~viewp~~ view of society.
-> Objective is to maximize the profit to the benefit-caries.	-> objective is to the achievement of national objectives.

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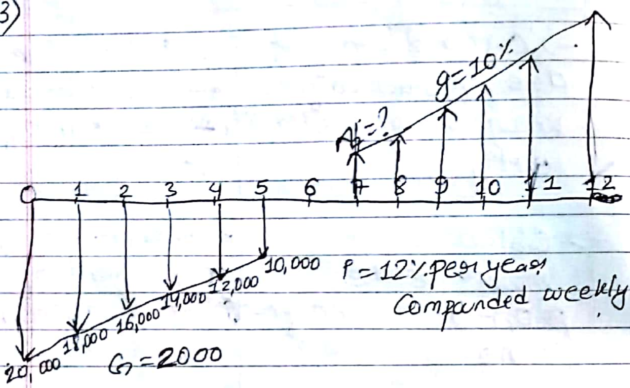
Chapter-8.

Inflation and its effect on project Cash flows.

Q.3)



$i = 12\%$ per year Compounded weekly

$$i_{effective} = \left(1+\frac{r}{m}\right)^m - 1$$

$$= \left(1+\frac{0.12}{52}\right)^{52} - 1$$

$$= 0.1273$$

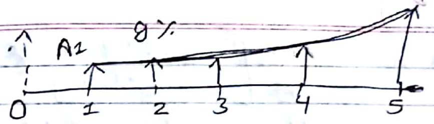
$$= 12.73\%$$

Now;

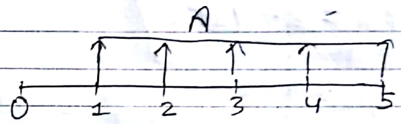
Present Worth of positive Cash flows;

P...

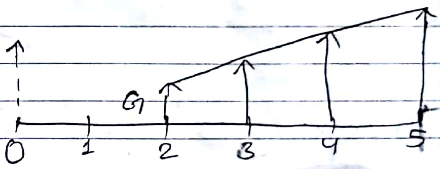
Note:



$$P = \frac{A_1}{i-g}\left[1 - \left(\frac{1+g}{1+i}\right)^N\right]$$



$$P = A \times \left[\frac{(1+i)^N - 1}{i(1+i)^N}\right]$$

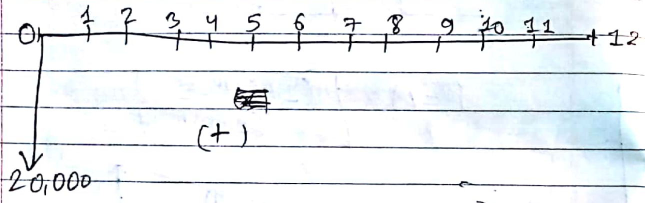


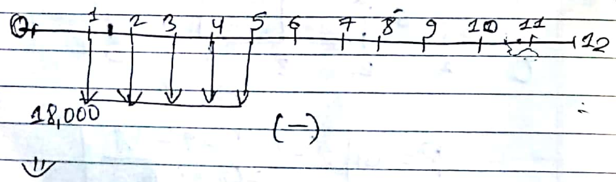
$$P = G\left[\frac{(1+i)^N - 1 - Ni}{i^2(1+i)^N}\right]$$

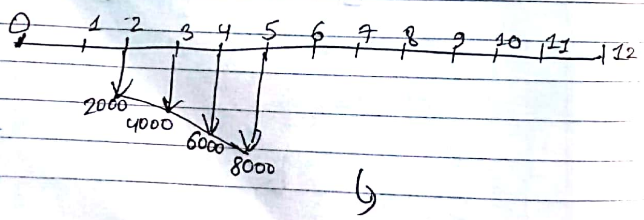
$$P_{positive} = \frac{A_7}{r-g}\left[1-\left(\frac{1+g}{1+i}\right)^N\right](1+i_{eff})^{-N}$$

$$= \frac{A_7}{0.1273-0.10}\left[1-\left(\frac{1+0.10}{1+0.1273}\right)^6\right](1+0.1273)^{-6}$$

$$\boxed{P_{positive} = 2.441 A_7}$$







Neg

Present value of negative cash flows:

$$P_{negative} = 20{,}000 + A\left(\frac{(1+i)^N-1}{i(1+i)^N}\right) - G\left[\frac{(1+i)^N-1-Ni}{i^2(1+i)^N}\right]$$

$$= 20{,}000 + 18000 \times \left[\frac{(1+0.1273)^5-1}{0.1273(1+0.1273)^5}\right] - 2000\left[\frac{(1+0.1273)^5-1-5\times 0.1273}{0.1273^2(1+0.1273)^5}\right]$$

$$= 71253.88209$$

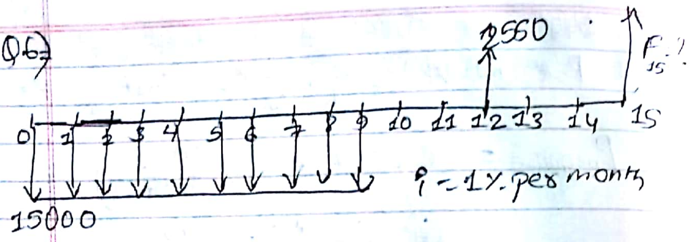
$$P_{pos} = P_{neg}$$

$$2.441 A_7 = 71253.88209$$

$$\therefore A_7 = 29190.447$$

$\frac{r}{m}$ = Interest rate per period

Q6)



i = 1% per month

$$P_{eff} = \left(1+\frac{r}{m}\right)^m - 1$$
$$= (1+0.01)^{12} - 1$$
$$= 0.1268$$

$$F_{15} = 15000 \times \left[\frac{(1+0.1268)^{10} - 1}{0.1268}\right] \times (1+0.1268)^6 - 2550(1+0.1268)^3$$
$$= 553172.65$$

Chapter-8.

1, 2, 3, 8, ... 12

Inflation and its impact on Project Cash flows:

* Inflation:
  - -> Decrease in purchasing power of money overtime.
  - -> Increase in the price of goods and services with time.

* Causes of inflation:
  - -> Increase in money supply.
  - -> Increase in govt. / public expenditure.
  - -> War or any other such social conflict.
  - -> Increase in the production cost with the ~~inflo~~ intention of increasing the profit margin.
  - -> Increase in population.

* Effects of inflation:
  - -> Fixed income group are hit hard.
  - -> Increase in social evils like corruption, black marketing, etc.
  - -> Creates uncertainty in the economy.
  - -> Creates socio-political ~~[illegible]~~ unrests.

→ Redistribution of wealth and economy because rich becomes richer and poor becomes poorer.

~~i=i'~~

\# $\boxed{i = i' + i' \times f + f}$

Where,

i' = inflation free interest rate

f = inflation rate

i = Inflation adjusted interest rate.

Q) Determine the present worth of the following constant cash flows.

$i = 15\%$

$f = 6.5\%$

EOY	Cash flows
0	-50,000
1	1500
2	2500
3	1200
4	1300
5	2200

{ Constant → i'
  Actual → i }

Actual Cash flows = Constant cash flows × $(1+f)^N$

⇒ Determine i':

$i = i' + i' \times f + f$

$i' = \frac{i - f}{(1+f)}$

$= \frac{15 - 6.5}{1 + 6.5}$

$= 0.0798$

$= 7.98\%$

$i - f = i' + i'f$

$i'(1+f)$

$i' = \frac{i - f}{1+f}$

Now,

Present Worth $= -50{,}000 + 1500(1+i')^{-1} + 2500(1+i')^{-2} + 1200(1+i')^{-3} + 1300(1+i')^{-4} + 2200(1+i')^{-5}$

$=$

Thus:

EOY	Constant	Actual
0	-50,000	$-50{,}000(1+f)^0 = -50{,}000$
1	1500	$1500(1+f)^1 =$
2	2500	$2500(1+f)^2 =$
3	1200	$1200(1+f)^3 =$
4	1300	$1300(1+f)^4 =$
5	2200	$2200(1+f)^5 =$

→ P.T.O

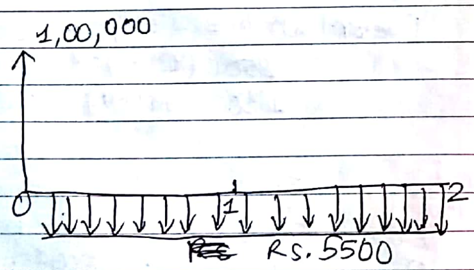
Using Actual Dollar Analysis:

→ First convert all the constant cash-flows into actual cash flows.

i.e. Actual Cashflow = Constant × $(1+f)^N$

Q) Suppose you have borrowed Rs. 1,00,000 from a bank to buy a bike and you have promised to pay Rs. 5550 per month for two years. What is the inflation free interest rate you are supposed to pay if average inflation rate is 0.75% per month?

⇒ $\underline{\underline{\text{soln}}}$



f = 0.75% per month

i' = inflation free interest rate = ?

↳

We have;

P = 1,00,000

A = 5500

$$\therefore P = A\left[\frac{(1+i)^N - 1}{i(1+i)^N}\right]$$

$$\Rightarrow 1,00,000 = 5500 \times \left[\frac{(1+i)^{24} - 1}{i(1+i)^{24}}\right]$$

Solving this for i;

we get $i = i_{monthly} = 0.02352$
$= 2.35\%$

Also, we have;

$$i = i' + i' \times f + f$$

$$\Rightarrow i' = \frac{i - f}{(1+f)}$$

$$\Rightarrow i' = \frac{2.35 - 0.75}{1 + 0.75}$$

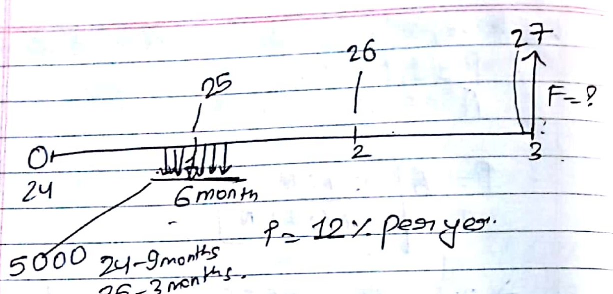
$$\therefore i' = 0.914 = 91.4\%$$

$$i = i' + i' \times f + f$$

$$\Rightarrow 0.02352 = i' + i' \times 0.0075 + 0.0075$$

$$\therefore i' = 0.0159 = \underline{\underline{1.59\%}}$$

Q)



$i = 12\%$ per year.

$\Rightarrow$ $i_{monthly} = (1+i)^{\frac{1}{N}} - 1$

$= (1+0.12)^{1/12} - 1$

$= 0.00948.$

$P_8 = A\left[\frac{(1+i_m)^N - 1}{i_m(1+i_m)^N}\right] \cancel{\times (1+i_m)^{-N} \times (1+i)^N}$

$= 5000\left[\frac{(1+0.00948)^7 - 1}{0.00948(1+0.00948)^7}\right]$

$= 33709.66931$

$P_0 = 33709.66931\,(1+i_m)^{-8}$

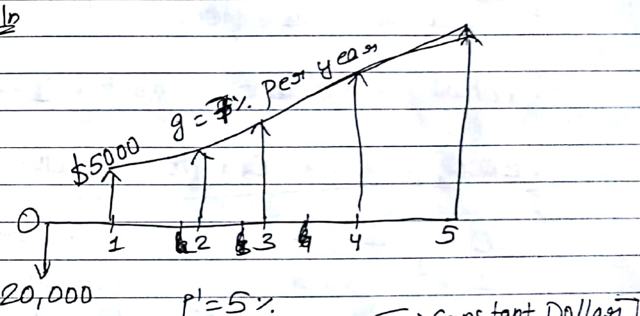
$= 31258.83152$

$\therefore F = 31258.83152\,(1+i)^3$

$= 43916.40765$

Q) A series of five constant dollar (or real dollar / constant cash flows) income (beginning with \$5000 at the end of 1st year) are increasing at the rate of 7% per year for 5 years. Inflation free interest rate is 5% and inflation is 8%. Is it feasible investment if Investment cost is \$20,000? (TU-2069)

$\Rightarrow$ soln



$i' = 5\%$

$f = 8\%$

→ Constant Dollar Analysis

→ Actual Dollar Analysis

$NPW = -20{,}000 + \frac{A_1}{i-g}\left[1 - \left(\frac{1+g}{1+i}\right)^N\right]$

$$= -20{,}000 + \frac{5000}{0.05-0.07}\left[1-\left(\frac{1+0.07}{1+0.05}\right)^5\right]$$

$= 4733.995 > 0$ feasible

Use i' = inflation free interest rate for constant cash flows.

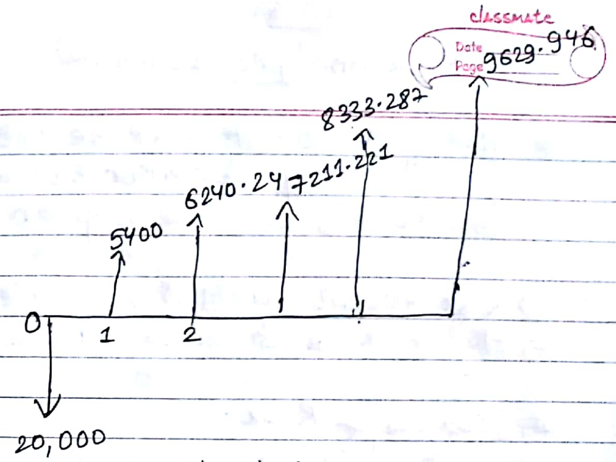
or in next method,

Actual cash flow Analysis:-

Convert all constant cashflows into actual cash flow.

Actual cash flow = Constant × $(1+f)^N$

EOY	Constant Cash flow	Actual Cash flow
0	$-20{,}000$	$-20{,}000(1+0.08)^0 = -20{,}000$
1	5000	$5000(1+0.08)^1 = 5400$
2	$5000(1+0.07)^1 = 5350$	$5350(1+0.08)^2 = 6240.24$
3	$5000(1+0.07)^2 = 5724.5$	$5724.5(1+0.08)^3 = 7211.221$
4	$5000(1+0.07)^3 = 6125.215$	$6125.215(1+0.08)^4 = 8333.287$
5	$5000(1+0.07)^4 = 6353.980$	$6353.980(1+0.08)^5 = 9629.946$



$i = i' + i' \times f + f$

$= 0.05 + 0.05 \times 0.08 + 0.08$

$= 0.134$

Use i for calculating Net PW

$$\text{Net PW} = -20{,}000 + 5400(1+0.134)^{-1} + 6240.24(1+0.134)^{-2} + 7211.221(1+0.134)^{-3} + 8333.287(1+0.134)^{-4} + 9629.946(1+0.134)^{-5}$$

$= 4733.992 > 0$ feasible.

Chp-6.

Risk Analysis (12 marks)

→ Risk is a condition where there is a possibility of deviation between desired and expected ~~output~~ outcome.

→ Risk means variability in projects NPW.
→ Higher Risk, Greater variability.

Sources of Risk:
→ Cash flow estimate-possible inaccuracy
→ study period -long-higher risk.
→ Nature of Business.
→ Inflation rate / interest rate.

Methods of Describing project Risk.

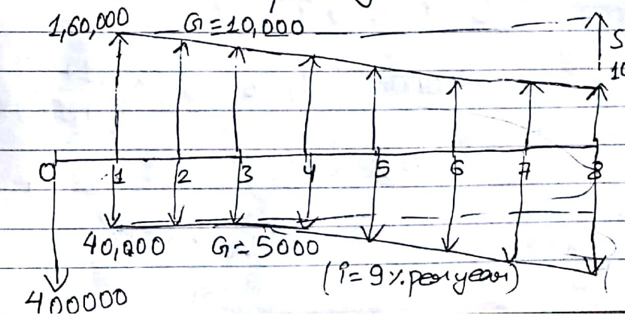
a) Sensitivity Analysis. (8)
b) Breakeven Analysis. (4)
c) Scenario Analysis. ↳

a) Sensitivity Analysis:
→ How much the NPW of the project will change in response to a given change in one input variable.
→ Sensitivity graph plot and Analysis.
↳

Q) Draw a Sensitivity chart using PW formulation of the following cash flow information. It is desired to evaluate the sensitivity over a range of ±30% changes on a) Initial Investment
b) Salvage Value c) Interest rate
d) Useful life

Initial Cost = Rs. 4,00,000
Annual Revenue = Rs. 1,60,000 for 1st year and then decreases by Rs. 10,000 there after.
Annual Expenses = Rs. 40,000 for 1st year and then increases by Rs. 5000 there-after.
Salvage Value = Rs. 1,00,000
Useful life (N) = 8 years
MARR (i) = 9% per year

=)



↳

Set the equation for Net present worth;

$$NPW(i\%) = -400000 + 1,60,000\,(P/A, i\%, N) - 10,000 \times (P/G, i\%, N) + 100000 \times (P/F, i\%, N) - 40,000 \times (P/A, i\%, N) - 5000 \times (P/G, i\%, N)$$

$$= -400000 + 1,60,000 \times \left(\frac{(1+i)^N - 1}{i(1+i)^N}\right) - 10,000 \times \left[\frac{(1+i)^N - 1 - Ni}{i^2(1+i)^N}\right] + 10000 \times (1+i)^{-N} - 40,000 \times \left(\frac{(1+i)^N - 1}{i(1+i)^N}\right) - 5000 \times \left(\frac{(1+i)^N - 1 - Ni}{i^2(1+i)^N}\right)$$

$$= -400000 + 1,20,000 \times \left(\frac{(1+i)^N - 1}{i(1+i)^N}\right) - 15000 \times \left(\frac{(1+i)^N - 1 - Ni}{i^2(1+i)^N}\right) + 100000 \times (1+i)^{-N}$$

$$NPW(9\%) = \Big\{-400000 + 120,000 \times \left(\frac{(1+0.09)^8 - 1}{0.09 \times (1+0.09)}\right) + 100000 \times (1+0.09)^{-8} - 15\,000 \times \left(\frac{(1+0.09)^8 - 1 - 8 \times 0.09}{0.09^2\,(1+0.09)^8}\right)\Big\}$$

$$= -400000 + 664178.29 + 50186.62 - 253314.8$$

$$= 61050.11$$

a) Variation in Initial Investment:

@ +30%	$NPW = -40,0000 \times (1.30) + \ldots$		$= -58949.89$
@ +20%		1.20	$= -18949.89$
@ +10%		1.10	$= 21050.11$
@ −10%		0.9	$= 101050.11$
@ −20%		0.8	$= 141050$
@ −30%		0.7	$= 181050$

b) Variation in Salvage value:

$NPW(9\%) = - - - + 100000 \times (1.30x) \times (1+0.09)^{-8}$

$=$

Salvage variation.

$= 76106.106$

$= 71087.49$

$= 66068.78$

$= 56031.45$

$= 51012.79$

$= 45994.12$

c) Variation in Interest rate:

$$NPW = -400000 + 120,000 \times \left[\frac{(1+0.09x)^8 - 1}{0.09x(1+0.09x)^8}\right]$$

$$+ 100000 \times (1+0.09x)^{-8} - 15000 \times \left[\frac{(1+0.09x)^8 - 1 - 8 \times 0.09x}{(0.09x)^2(1+0.09x)^8}\right]$$

Solve for.

$x = 1.30 \rightarrow NPW = 23297.619$

$= 1.20 \quad = 35269.00$

$= 1.10 \quad = 47839.00$

$= 0.90 \quad = 74944.00$

$= 0.80 \quad = 89569.03$

$= 0.70 \quad = 104975$

d) Variation in Useful life:

$$NPW = -400000 + 120,000 \times \left[\frac{(1+0.09)^{8x} - 1}{0.09(1+0.09)^{8x}}\right]$$

$$+ 100000 \times (1+0.09)^{8x} - 15000 \times \left(\frac{(1+0.09)^{8x} - 1 - 8x \times 0.09}{0.09^2(1+0.09)^{8x}}\right)$$

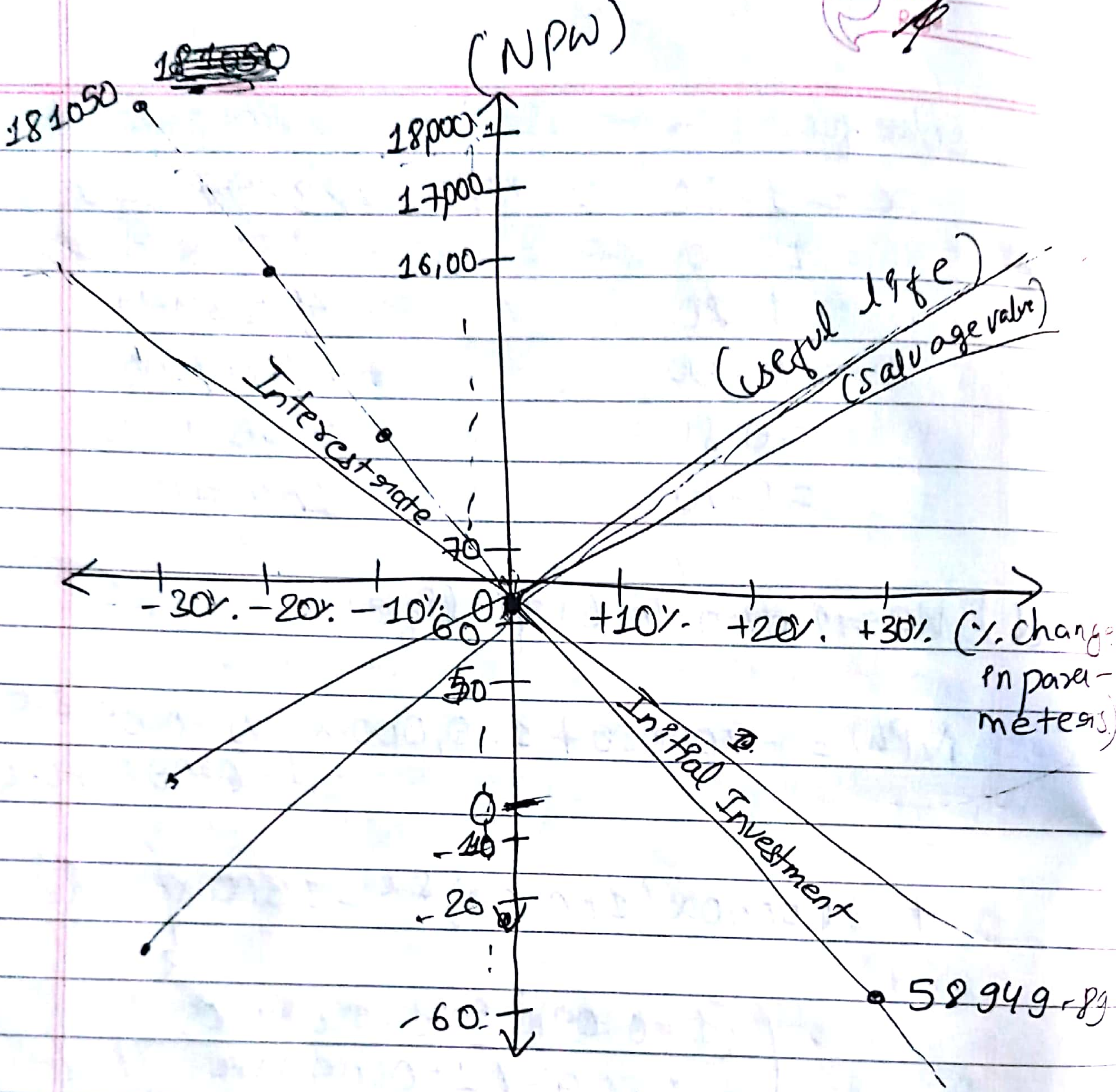


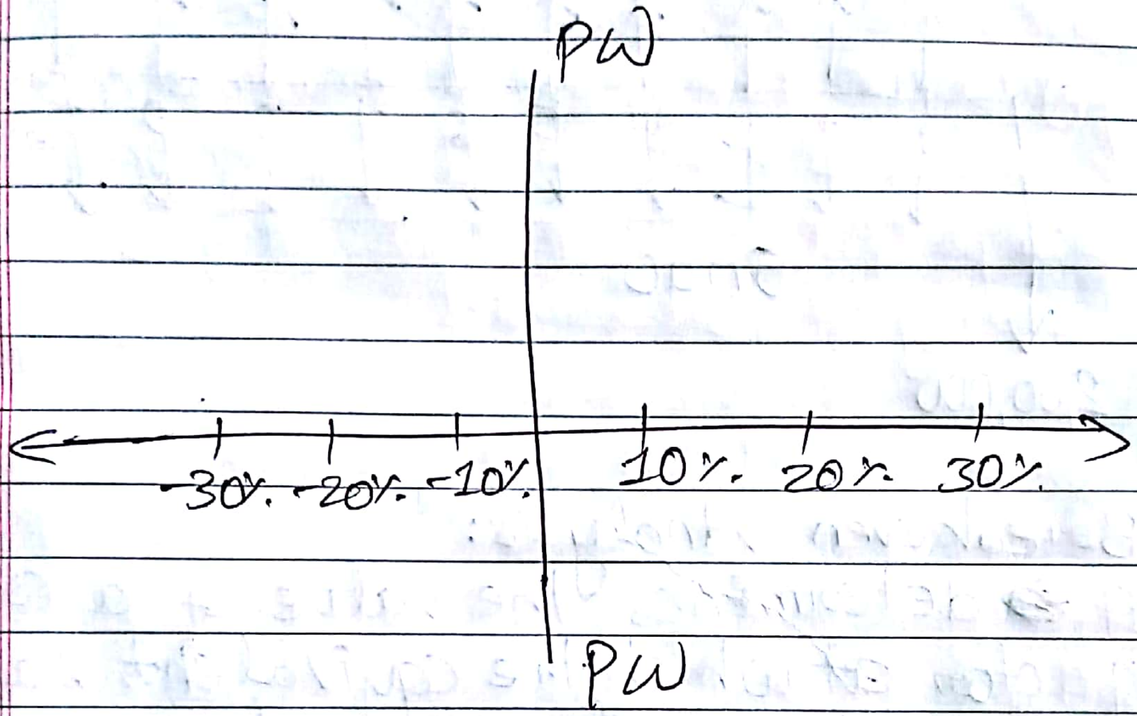
Fig: Sensitivity graph.

Interpretation and Decision:

The most sensitive parameter is Initial Investment and least sensitive is Salvage value (i.e. least slope).

6 : (Continued)

Sensitivity Analysis :



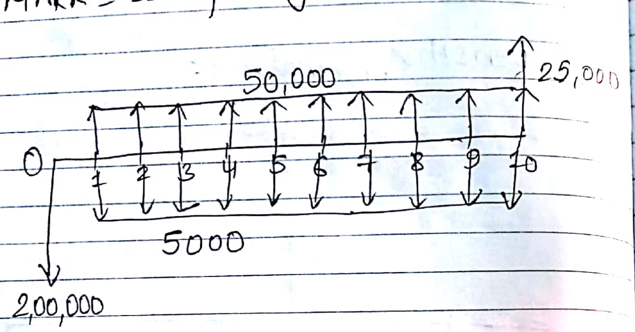
Q. Perform sensitivity analysis using IRR and BCR with an increment of 10% over a range of ± 30% in :

a) Initial investment
b) Net Annual Revenue
c) Salvage value
d) Useful life

Initial investment (I) = Rs. 2,00,000
Annual Revenues (R) = Rs. 50,000
Annual Expenses (E) = Rs. 5000
Salvage value (S) = Rs. 25,000
Useful life = 10 years

MARR = 12% per year

⇒



b) # Breakeven Analysis:

→ It determines the value of a critical factor at which the equivalent values of cash outflows equals the equivalent value of cash inflows.

→ For Single Project:

Total Cost = Fixed Cost + Variable Cost

$= C_F + V_c \times x$

where,

V_c = Variable cost/unit

x = Quantity of production/no. of units

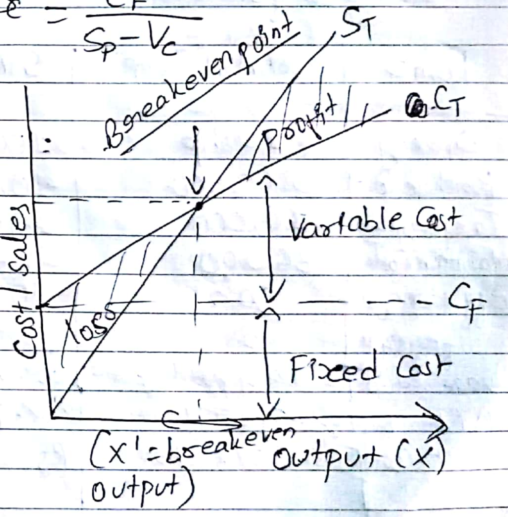
Total Sales Revenue $= S_p \times (x)$

where; S_p = Selling price per unit

At breakeven point, Total Sales = Total Cost

$\Rightarrow C_F + V_c \times x = S_p \times x$

$\Rightarrow x = \dfrac{C_F}{S_p - V_c}$



Breakeven Analysis for Comparing 2 alternatives:

Q. Calculate the breakeven hours of operation per year to become cost equal and recommend the economic pump if it is to be operated 5 hours daily at full load.

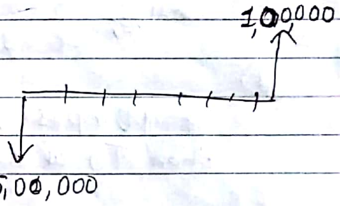
Pump	KHASA Pump	SARVO Pump
Capacity	100 hp	100 hp
Purchase Cost	5,00,000	10,000
Tax per year	10,000	15,000
Maintain Cost	36,500	29,200
efficiency	80%	90%
life year	5	5
Salvage value	20% of purchase cost	20% of purchase cost
MARR	20% per year	20% per year
electricity cost	Rs. 10/kwhr	Rs. 10/kwhr

soln

a) KHASA Pump:

Capital Recovery Cost (CR) =

$$500000 \times \left(\frac{i(1+i)^N}{(1+i)^N - 1}\right) - \frac{20}{100} \times 500000 \times \left(\frac{i}{(1+i)^N - 1}\right)$$



= Rs. 1,53,760.

Maintainance Cost/year = 36500,

Tax per year = 10,000

$$\text{Operating Cost} = \frac{100 \times 0.746 \times 10 \times x}{0.80}$$

$$= 932.50x$$

Total Annual Cost = 153760 + 36500 + 10,000 + 932.50x

= 200260 + 932.5x —(i)

[x = hours of operation]

Similarly,

Total cost for SARVO pump =

$351720 + 828.88x$ — (ii)

equating (i) and (ii),

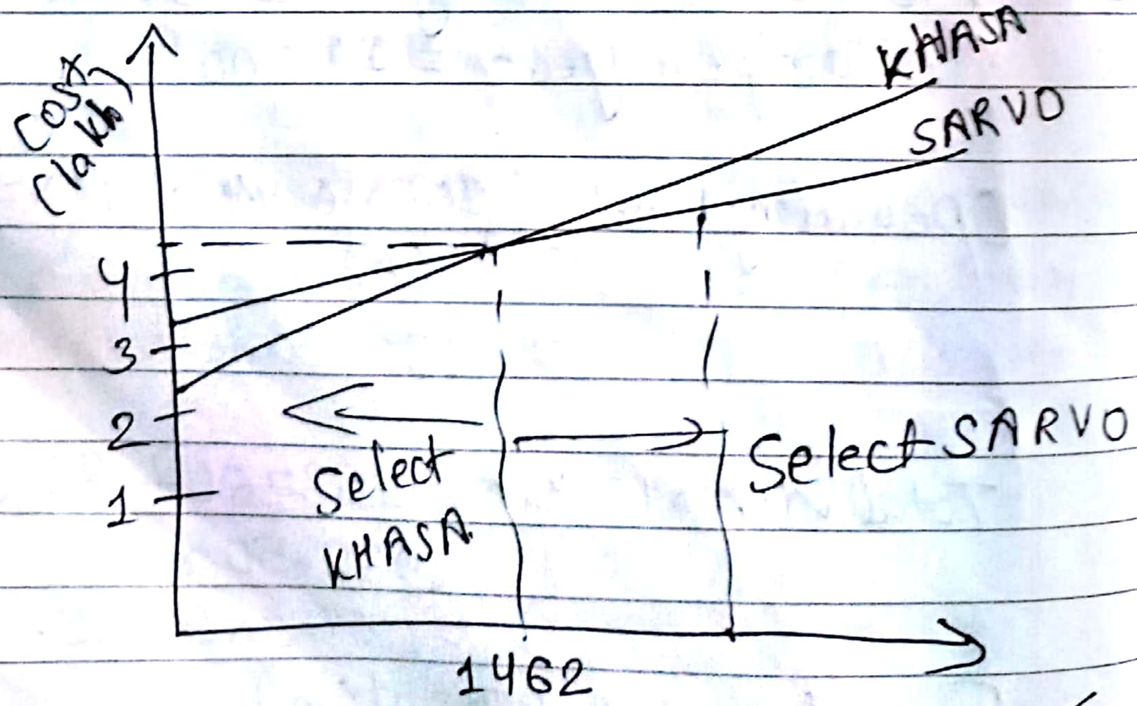
$2\cancel{0}0260 + 932.5x = 351720 + 828.88x$

Solve; $x = 1462$ hrs.

If pump is to be operated 5 hrs. daily, then Total hrs $= 5 \times 365$

$= 1825 > 1462$.

Select (SARVO Pump).



Chp-5.

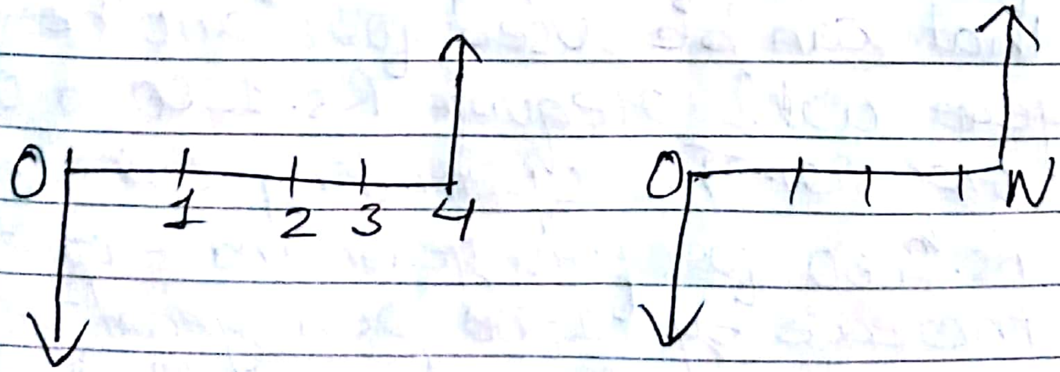
Replacement Analysis. (12 marks)

→ It is the choice between current using asset (called defender) and new alternatives (called Challenger).

→ Resons for replacement:

a) Physical impairment (wear and tear)
b) Insufficient output capacity.
c) Obsolescence (Insufficient quality) Technological Advancement.
d) Rental or lease possibilities than purchase.

→ Oppurtunity Cost:



Economic Service life:

→ The total annual equivalent cost (AEC) of an asset is the summation of the capital recovery cost and annual equivalent of operating cost of the asset.

→ The economic service life of an asset is defined as the period of useful life that minimizes the (AEC) of owning and operating the asset.

Replacement analysis under infinite planning horizon:

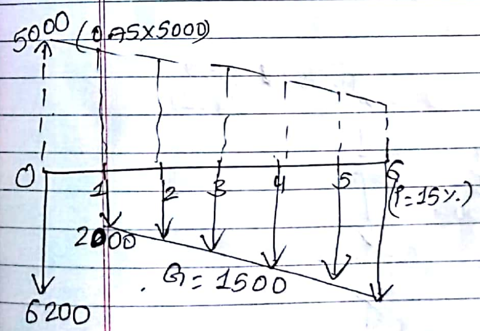
Q) An electric insulator company is considering replacing an old machine with a newer one. For it,

1) Defender: If repair the old machine that can be used for another 6 year will require Rs. 1200 to overhaul repair. The operating cost is estimated Rs. 2000 for first year and expected to increase by 1500 per year thereafter.

- However the company can sell it now for Rs. 5000 and future market values are expected to decline by 25% each year over the previous years value.

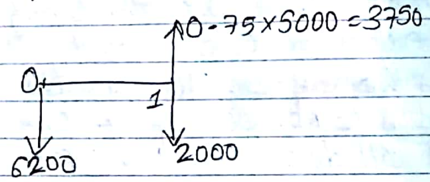
2) Challenger: The new machine cost is Rs. 10000 and will have operating cost of Rs. 2200 in the 1st year and expected to increase by 20% per year thereafter. The expected salvage value is Rs. 6000 after one year and will decline by 15% each year for 8 years. Find the economic service life for each option and determine when the defender should be replaced at $i = 15\%$.

⇒ Option 1:



For N=1;

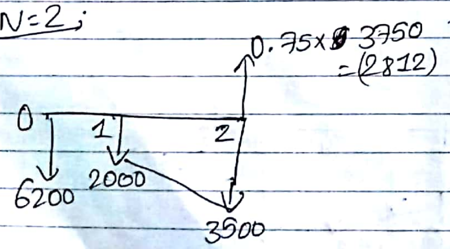
opportunity cost = 5000
repair cost = 1200



$(AEC)_1 = 6200 \times \left[\frac{i(1+i)^N}{(1+i)^N - 1}\right] + (2000-3750) \times \left[\frac{i}{(1+i)^N - 1}\right]$

=

For N=2;



$(AEC)_2 = 6200 \times \left[\frac{i(1+i)^N}{(1+i)^N - 1}\right] +$

$\left[2000 \times (1+i)^1 + 3500 - 2812\right] \times \frac{i}{(1+i)^N - 1}$

Similarly for 3, 4, 5 ...

or,

General eqn;

$AEC = 6200 \times \left[\frac{i(1+i)^N}{(1+i)^N - 1}\right] + 2000 + 1500 \times \left[\frac{1}{i} - \frac{N}{(1+i)^N - 1}\right] - 5000 \times (0.75)^N \times \left[\frac{i}{(1+i)^N - 1}\right]$

$= \frac{i}{(1+i)^N - 1}\left[6200 \times (1+i)^N - 5000 \times (0.75)^N\right]$

$+ 2000 + 1500 \times \left[\frac{1}{i} - \frac{N}{(1+i)^N - 1}\right]$

⇒ 1 = 5380
2 = 5203 → N = 2
3 = 5468
4 = 5845
5 = 6258
6 = 6682

option 2

General eqn;

$$(AEC)_N = 10{,}000 \times \left[\frac{i(1+i)^N}{(1+i)^N - 1}\right] + \frac{2200}{i-g} \times \left[1 - \left(\frac{1+g}{1+i}\right)^N\right] \times \left[\frac{i(1+i)^N}{(1+i)^N - 1}\right] - 6000 \times (0.85)^{(N-1)} \times \left[\frac{i}{(1+i)^N - 1}\right]$$

$\Rightarrow$ $N=1$ $= 7700$

$N=2$ $= 6184$

$N=3$ $= 5756$

$N=4$ $= 5625 \rightarrow N=4$

$N=5$ $= 5631$

$N=6$ $= 5721$

$N=7$ $= 5869$

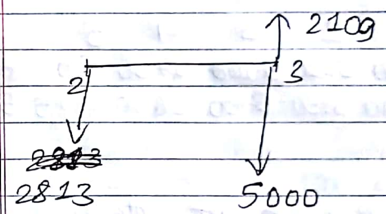
$N=8$ $= 6066$

When to replace:

$(AEC)_{Defender} = 5203 < (AEC)_{challenger}$.

So, defender should not be replaced now.

keep the defender for 2 years.



Opportunity cost

$$(AEC) = 2813 \times \left(\frac{i(1+i)^1}{(1+i)^1 - 1}\right) + (5000 - 2109) \times \frac{i}{(1+i)^N - 1}$$

$N=1$

$i=0.15$

$AEC = 6126 > (AEC)_{challenger}$.

Replacement Analysis under finite planning horizon:

Q) The Annual Equivalent Cost (AEC) of the defender and challenger are given in the table below. What is the best replacement strategy? Use $i = 12\%$. The planning horizon is 8 years.

EOY	1	2	3	4	5	6
$(AEC)_B$	5300	5250	5400	5750	6200	6550
$(AEC)_C$	7700	6150	5700	5600	5675	5800

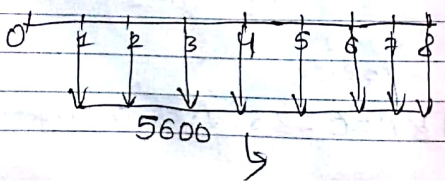
⇒ Soln

Various Replacement pattern as follows:

$J_0 \Rightarrow$ Defender

$J \Rightarrow$ Challenger.

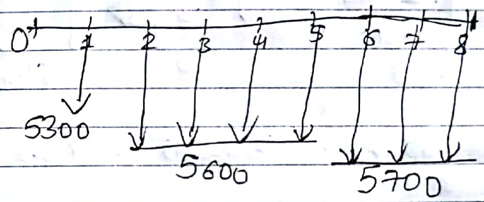
Option 1: $(J_0, 0)\ (J, 8) = (J_0, 0)(J,4)(J,4)$



$$PW(12\%) = 5600 \times \left[\frac{(1+i)^8 - 1}{i(1+i)^8}\right]$$

= Rs.

Option 2: $(J_0, 1)\ (J, 7) = (J_0, 1)\ (J, 4)(J, 3)$



Thus,

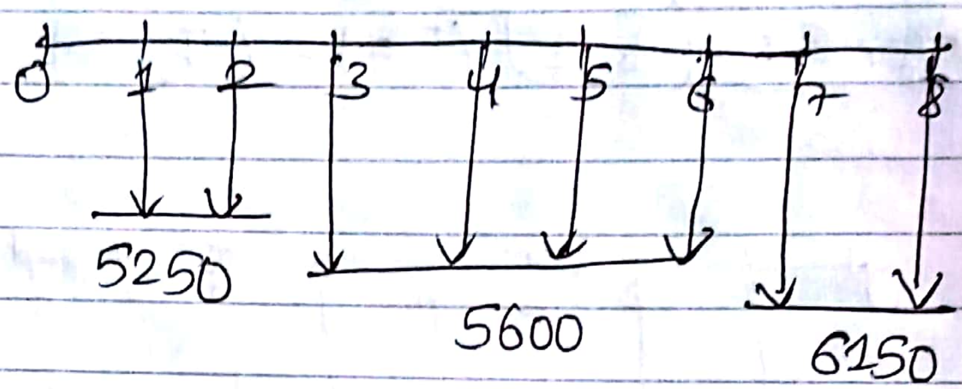
$$PW(12\%) = 5300 \times (1+0.12)^{-1} + 5600 \times \left[\frac{(1+0.12)^4 - 1}{0.12(1+0.12)^4}\right] \times (1+0.12)^{-1}$$

$$+ 5700 \times \left[\frac{(1+0.12)^3 - 1}{0.12(1+0.12)^3}\right] \times (1+i)^{-5}$$

= Rs.

Option 3:

$(J_0, 2)\ (J, 4)\ (J, 2)$



$$\cancel{PW(12\%) = 5250 \times (1+0.12)^{-2} + 5600 \times}$$

$$PW(12\%) =$$

Chp-7.

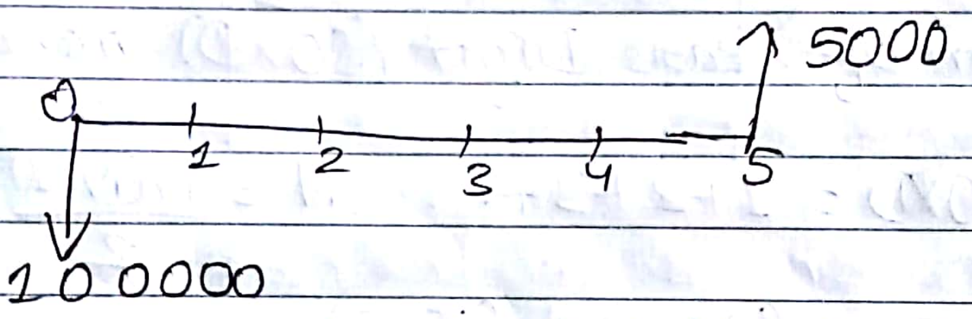
Depreciation and Corporate Income tax:

Depreciation:

* Causes:

Methods of Calculation of depreciation:

1a) Straight line method:



$$D_n = \left(\frac{I-S}{N}\right)$$

$$= \left(\frac{100000-5000}{5}\right)$$

$$= \frac{95000}{5}$$

$$= 19000$$

classmate
Date
Page

* Book Value Calculation:

Year	B_{n-1}	D_n	B_n
1	100000	19000	
2		19000	
3		19000	
4		19000	
5		19000	

2) Sum of Years Digit (SOYD) method:

$$SOYD = 1+2+3+\ldots N = \frac{N(N+1)}{2}$$

$$D_n = \frac{(N-n+1)(I-S)}{SOYD}$$

Q) Compute SOYD Depreciation:

$I = 15000$
$N = 5$ yrs
$S = 1000$

soln

$SOYD = 1+2+3+4+5 = 15$

classmate
Date
Page

n	D_n	B_n
1	$\left(\frac{5-1+1}{15}\right) \times (15000 - 1000) = 4666.67$	$15000 - 4666.67$
2	$4/15 \times$ " $= 3733.33$	
3	$3/15 \times$ " $= 2800$	
4	$2/15 \times$ " $= 1866.67$	
5	$1/15 \times$ " $= 933.33$	

3) Sinking fund method of depreciation:

Constant Amount of Sinking fund d =

$$(I-S) \times \frac{i}{(1+i)^N - 1}$$

Each year this gains interest as well.

Q) $I = 7000$
$S = 2000$
$N = 5$ yrs
$i = 10\%$

Find Sinking fund depreciation per year.

=> soln

Constant Amount Sinking fund ~~depreciation~~ depreciation $= (I-S) \times \frac{i}{(1+i)^N - 1}$

$$= (7000-2000) \times \frac{0.10}{(1+0.10)^5 - 1}$$

$= 819$

Now;

Year	Depreciation	Book Value
1	819	7000 − 819 = 6181
2	$819(1+i)^1 = 901$	6181 − 901 = 5280
3	$819(1+i)^2 = 991$	5280 − 991 = 4289
4	$819(1+i)^3 = 1090$	
5	$819(1+i)^4 = 1199$	

4b) Declining Balance Method:

Double Declining rate $= \frac{1}{N} \times 2 \times 100\%$

→ Here; fixed % of Initial amount is depreciated each year.

Q) $I = 10{,}000$
$N = 5$ yrs
$S = 778$

Now,
Double declining Rate $(\alpha) = \frac{1}{5} \times 2 \times 100$
$= 40\%$

Thus:

	B_{n-1}	D_n	B_n
1	10,000	40% of 10,000 = 4000	6000
2	6000	2400	3600
3	3600	1440	2160
4	2160	864	1296
5	1296	518	778

* Issues Regarding Salvage Value:

1) Final Book Value > S
2) Final Book Value < S

5) Modified Accelerated Cost Recovery System (MACRS) method of depreciation:

→ This scheme includes 8 categories of assets with lives of 3, 5, 7, 10, 15, 20, 27.50 and 39 years.

→ MACRS makes use of half year convention i.e. the assets are placed in service at mid-year and they have zero salvage value.

Q) A taxpayer wants to place in service of Rs. 10,000 asset that is assigned to the 5 year class. Compute the MACRS% and depreciation amount.

⇒ Soln

$N = 5$ years

$S = 0$

$I = 10,000$

Now;

Straight line rate $= \frac{1}{N} \times 100\% = \frac{1}{5} \times 100\%$

$= 20\%$

Double Declining rate $= \frac{1}{N} \times 2 \times 100$

$= 40\%$

MACRS % Calculation:

Year	MACRS% Calculation	Selected MACRS
1	$\frac{1}{2}$ year DB $= \frac{1}{2} \times \frac{1}{N} \times 2 \times 100\% = 20\%$ $\frac{1}{2}$ year SL $= \frac{1}{2} \times \frac{1}{N} \times 100\% = 10\%$	20% (Do not switch)
2	DB $= 0.40 \times (100-20)\% = 32\%$ $SL = \frac{1}{4.50} \times (100-20) = 17.78\%$	32% (Do not switch)
3	DB $= 0.40 \times (100-20-32) = 19.20\%$ $SL = \frac{1}{3.50} \times (100-20-32) = 13.7\%$	19.20% (Do not switch)
4	DB $= 0.40 \times (100-20-32-19.2) = 11.52\%$ $SL = \frac{1}{2.50} \times (100-20-32-19.2) = 11.52\%$	11.52% (Switch to SL)
5	DB $= 0.40 \times (100-82-72) = 6.912\%$ $SL = \frac{1}{1.50} \times (100-82-72) = 11.52\%$	11.52% (Switch to SL)
6	$\frac{1}{2}$ yr DB $= \frac{1}{2} \times 0.40 \times (100-94.24) = 1.152\%$ $\frac{1}{2}$ yr $SL = \frac{1}{2} \times \frac{1}{0.50} \times (100-94.24) = 5.76\%$	5.76%

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#) Introduction to Corporate Income tax:

After Tax Cash flow estimate:

R_k = Revenue
E_k = Expense
d_k = depreciation
t = tax rate.
T_k = tax amount

Taxable income $= R_k - E_k - d_k$
Tax amount $= t(R_k - E_k - d_k)$

Before tax Cash flow;
$BTCF_s = R_k - E_k$

After tax Cash flow;
$ATCF_s = (R_k - E_k) - \text{Tax Amount}$
$= R_k - E_k - t(R_k - E_k - d_k)$

Q) An asset has installed value of 45,000. It is classified as 5 year property. Determine approximate MACRS depreciation schedule. Over 6 years, it is estimated to generate revenue of Rs. 23,000 per year with annual operating cost 7,300. Required rate of return = 15%. Tax rate = 40%. Evaluate After tax Cash Flow.

=> Soln

$I = 45,000$
$R_k = 23,000$
$E_k = 7,300$
$d_k \Rightarrow$ MACRS
$t = 40\%$

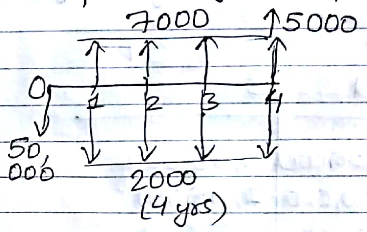
Year	$BTCF_s = (R_k - E_k)$ (A)	Depreciation (d_k) with MACRS (B)	Taxable income (A-B)	Tax Amount (C)	After Tax Cash flow (A-C)
1	$1/2 \times (23000 - 7300) = 7850$	20% of 45000 = 9000	7850-9000 = -1150	0	7850
2	23000-7300 = 15700	32% of 45000 = 14400	1300	40% of 1300 = 520	15180
3	23000-7300 = 15700	19.2% of 45000 = 8640	7060	2824	12876
4	15700	11.52% of 45000 = 5184	10516	4206.40	11493.60
5	15700	11.52% of 45000 = 5184	10516	4206.40	11493.60
6	$1/2 \times (23000 - 7300) = 7850$	5.76% of 45000 = 2592	5258	2103.20	5746.80

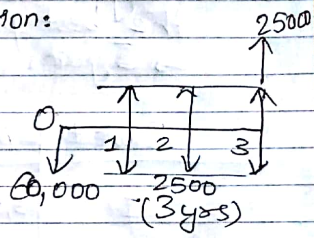
Chp-4.

Comparative Analysis of Alternatives.

a) When Useful life of 2 projects are different.

i) Repeatability Assumption:



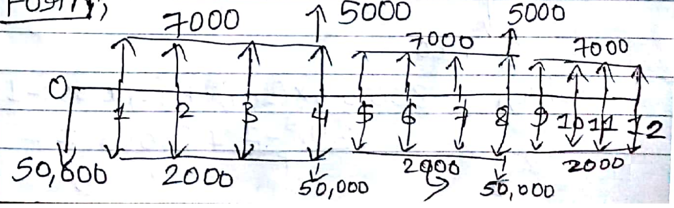


Useful life : A → 4 years
B → 3 years

$\boxed{\text{L.C.M of 4 and 3} = 12}$

Thus; Repeat the Cashflow upto 12 and then.
Adopt appropriate method of analysis.

For A;

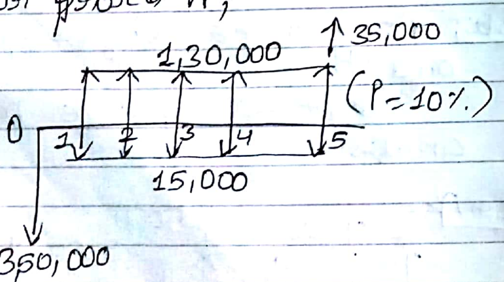


b) Co-terminal Assumption:

Q) Using Co-terminated assumption, Recommend the best project taking study period as 5 years.

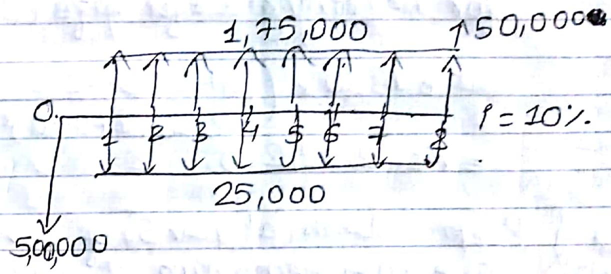
Project	A	B
I	3,50,000	5,00,000
Annual Revenue	1,30,000	1,75,000
Annual Cost	15,000	25,000
Salvage Value	35,000	50,000
Useful life	5 yrs	8 yrs.
i_p	10%	10%

For project A;



$$FW_A = -3{,}50{,}000 \times (1+i)^5 + (1{,}30{,}000 - 15{,}000) \times \frac{(1+i)^5 - 1}{i} + 35000 = - -$$

For Project B;



NOW;

Capital Recovery Cost of B;

$$= 500000 \times \left(\frac{i(1+i)^N}{(1+i)^N - 1}\right) - 50{,}000 \times \left(\frac{i}{(1+i)^N - 1}\right)$$

$$= 500000 \times \left(\frac{0.10 \times (1+0.10)^8}{(1+0.10)^8 - 1}\right) - 50{,}000 \times \left(\frac{0.10}{(1+0.10)^8 - 1}\right)$$

$$= Rs.\ 89350$$

Capital recovery cost depends on initial amount (I) and salvage value (S)

NOW;

Present Worth (at yr. 5) of this CR for remaining useful life (3 years)

$$= 89350 \times \left(\frac{(1+0.10)^3-1}{0.10\,(1+0.10)^3}\right)$$

$= Rs.\ 2,22,200$

Not done in damodar adhikari's note

Present Worth (at year 5) of market value for remaining 3 years;

$$PW_{(mv)} = 50,000 \times (1+i)^{-3}$$

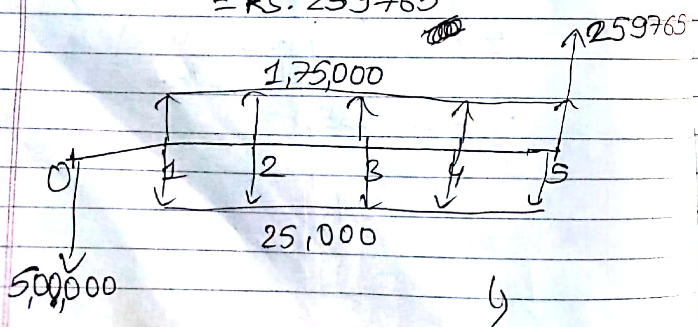
$$= 37565$$

Thus;

Imputed Market value at year 5

$= Rs.\ 2,22,200 + 37565$

$= Rs.\ 259765$



$(FW)_B =$

Project types:

a) Independent Projects:

-> One project is independent of other.

b) Dependent Projects:

-> Selection or rejection of one project is dependent on other.

i) Contingent projects -> Acceptance of one requires the acceptance of other.

ii) Mutually exclusive projects -> Acceptance of one excludes the acceptance of other.

Combination	A	B
1	0	0
2	0	1
3	1	0
4	1	1

Date
Page

eg: A is Congtingent on Acceptance of both B and C
C is Contingent on acceptance of B.

Combination	A	B	C
1	0	0	0
2	0	1	0
3	0	1	1
4	1	1	1