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2023 - Spring

a) Why we need to study engineering economics? State and explain law of demand and supply.

→ Engineering Economics is the field of those activities which are concerned with the systematic evaluation of the cost and benefit of proposed technical and business projects.

· Engineering Economics helps engineers make sound financial decisions in projects. It combines technical knowledge with economic thinking.

Here are key reasons:

i) Better decision-making :- Helps in comparing different designs, machines, or projects based on cost & benefits.

ii) Cost control :- Helps in planning the budget & reducing unnecessary expenses.

iii) Project evaluation :- Helps to check if a project is profitable or worth investing in.

iv. Efficient use of resources:– Make sure money, time, & materials are used properly.

v. Bridge betn engineering and management:– Engineers can work better with finance and management teams.

So, engineering economics help in completing projects successfully, with minimum cost & maximum value.

Law of Demand:

→ The law of demand states "if the price of a product increases, the quantity demanded decreases, & if the price decreases, the quantity demanded increases; keeping other factors constant.

Ex:

if the price of cold drinks falls in summer, more people will buy them. If the price rises, fewer people will buy.

Law of supply:

→ The law of supply states that if the prices of a product increases, the quantity supplied also increases, & if the price decreases, the quantity supplied also decreases, assuming other conditions remain the same.

Example:
If the price of tomatoes increases, farmers will try to produce & sell more tomatoes to earn more profit.

1b] What do you mean by IRR? Evaluate IRR of the following project & decide whether the project acceptable or not? Where MARR 8% per year.

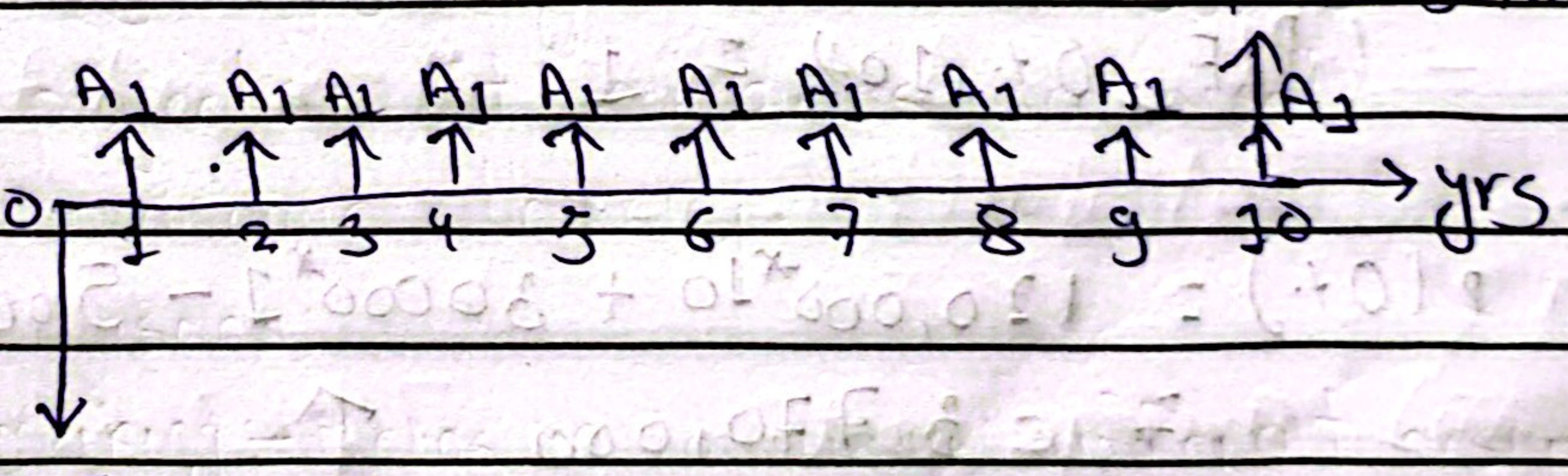
Initial investment = RS. 5,000,000
Expected life = 10 years
Salvage value = RS. 30,000
Annual revenue = RS. 120,000

→ It is that interest rate which equates the equivalent worth of an alternatives cash inflows to the equivalent worth of a project's cash out flows.
It is also called hit & trial method or assumption method.

Soln

F = RS. 30,000

CFD:



P_0 = RS. 5,000,000

MARR = 8%

A_1 = RS. 120,000

$PW(i) = A_1 (P/A, i\%, N) + F(P/F, i\%, N) - P_0$

$= 120{,}000 (P/A, i\%, 10) + 30{,}000 (P/F, i\%, 10) - 5{,}000{,}000$

Assume $i\% = 10\%$.

$P(10\%) = 120{,}000(P/A, 10\%, 10) + 30{,}000(P/F, 10\%, 10)$
$- 5{,}000{,}000$
$= 120{,}000 * 6.1446 + 30{,}000 * 0.3855$
$- 5{,}000{,}000$
$= -Rs. 4251083$ ↑

Assume $i\% = 5\%$.

$P(5\%) = A_1(P/A, 5\%, 10) + F(P/F, 5\%, 10) - P_0$

$= 120{,}000\left[\dfrac{1-(1.05)^{-10}}{0.05}\right] + 30{,}000\left[\dfrac{1}{(1.05)^{10}}\right]$
$- 5000000$
$= 926640 + 18417 - 5000000$
$= -Rs. 4054943$ ↑

At $i\% = 0$:

~~$P(0\%)$~~

$(P/A, 0\%, 10\%) = 10$

$(P/F, 0\%, 10) = 1$

$P(0\%) = 120{,}000 * 10 + 30000 * 1 - 5000000$
$= -3{,}770{,}000$ ↑

At $i\% = -20\%$.

$(1+i) = 0.8$, $(0.8)^{10} = 0.107$

$(P/A, -20\%, 10) = \dfrac{1 - 0.107}{-0.2} = -4.465$

$(P/F, -20\%, 10) = \frac{1}{(0.8)^{10}} = 9.345$

$P(20\%) = -5,000,000 + 120,000(-4.465) + 30,000 (9.345)$
$= -5,255,450$ ↑

At, $i\% = -19.43\%$

$P(-19.43\%) = -P + A \cdot \left[\frac{1 - (1+i)^{-n}}{i}\right] + S \cdot (1+i)^{-n}$

$= -5,000,000 + 120,000 \left[\frac{1-(1-0.1943)^{-10}}{-0.1943}\right] + 30,000(1-0.1943)^{-10}$

$= -5000,000 + (120000 * 8.36) + (30000 * 2.625)$
$= -Rs. 3918050$ ↑

Therefore, We used IRR = -19.43%, the NPV is still very negative. That means this project is generating a very poor return, & confirms the earlier finding.

IRR is negative (-19.43%) & MARR is positive (8%), so the project is not acceptable.

2b] How do you measure following cost concept in your engineering project; direct cost, indirect cost, average cost, variable cost, marginal cost, sunk cost, opportunity cost?

→

Cost concept in our engineering project is measured in following ways:

i) direct cost:

- It is those costs which can be reasonably measured and allocated with specific output or work activity.
- The labour & material costs directly associated with a product or service or a construction activity are direct costs.

ii) Indirect cost:

- It is the sum of indirect material cost, indirect cost & all other indirect expenses.
- It is used to mean all expenditures that are not direct costs.

iii) average cost:

- It is per unit cost of any output level.
- $AC = \frac{TC}{Q}$

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iv) Variable cost:

- Cost which are associated with variable factors of production & vary with change in level of output like labour, raw materials, fuel, etc.
- The difference betn fixed cost & variable cost may be found in only short-run production process.

v) Marginal cost:

- The change in total cost due to change in one unit of extra output.
- $MC = ~~TC_n - TC_{n-1}~~ \; TC_n - TC_{n-1}$
- $MC = \frac{\Delta TC}{\Delta Q}$

where, TC = Total cost,
Q = Output quantity & Δ = change

vi) Sunk cost:

- All the past costs which can't be recovered when a firm leaves from an industry.
- It have no relevance to decision making in future.

vii) Opportunity cost:

- The cost of best rejected opportunity to earn return.
- It is hidden or expected cost but important for decision making process.

2b)

Given:

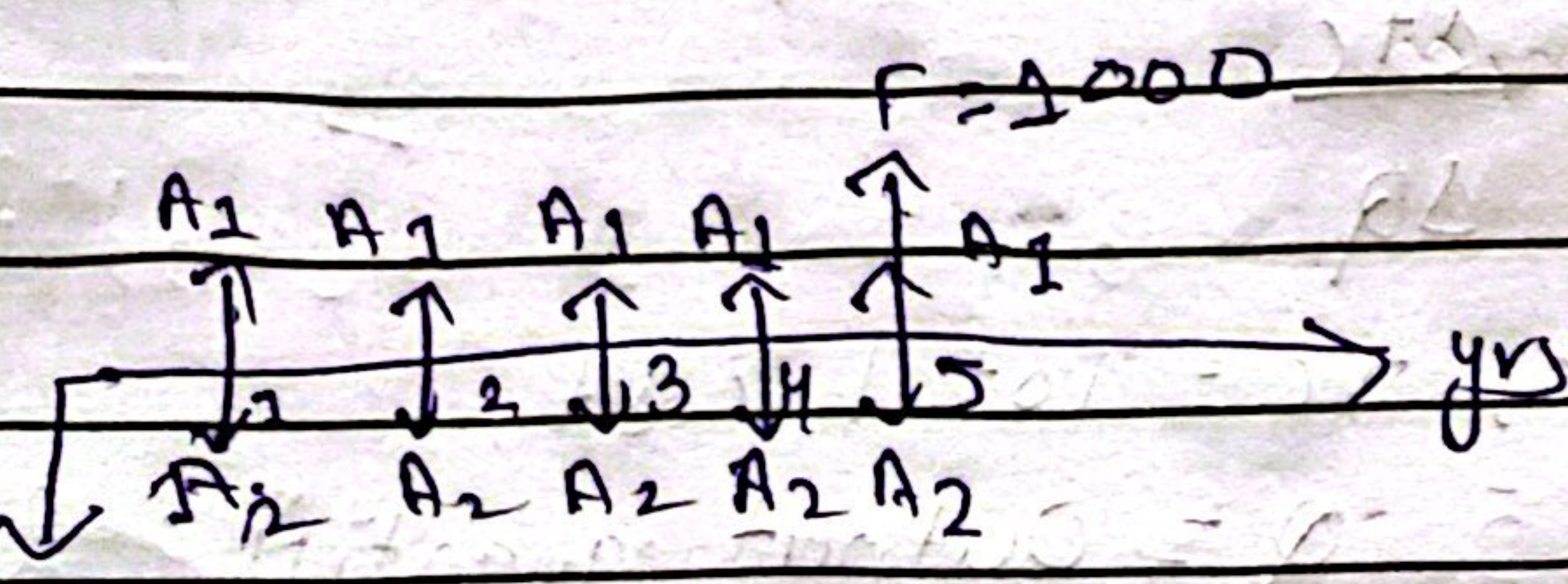
Items	X	Y	Z
initial investment	~~$~~50,000	40 000	30,000
Annual Revenue	20,000	15 000	14,000
Annual Expenses	15,000	10 000	8,000
Useful life year	5	7	9
Salvage Value	1000	500	0

MARR = 10%.

Soln

For X:

CFD



P_0 = Rs. 50,000

A_1 = ~~50~~ 20000

A_2 = 15000

$A = (A_1 - A_2)$ = Rs. 5000

MARR = 10%.

$AW(i\%) = -P.(A/P, 10\%, 5) + 1000(A/F, 10\%, 5) - \cancel{10}5000$

$= -50000(0.2638) + 1000(0.1638) + 5000$

$= -$Rs. 8353.8

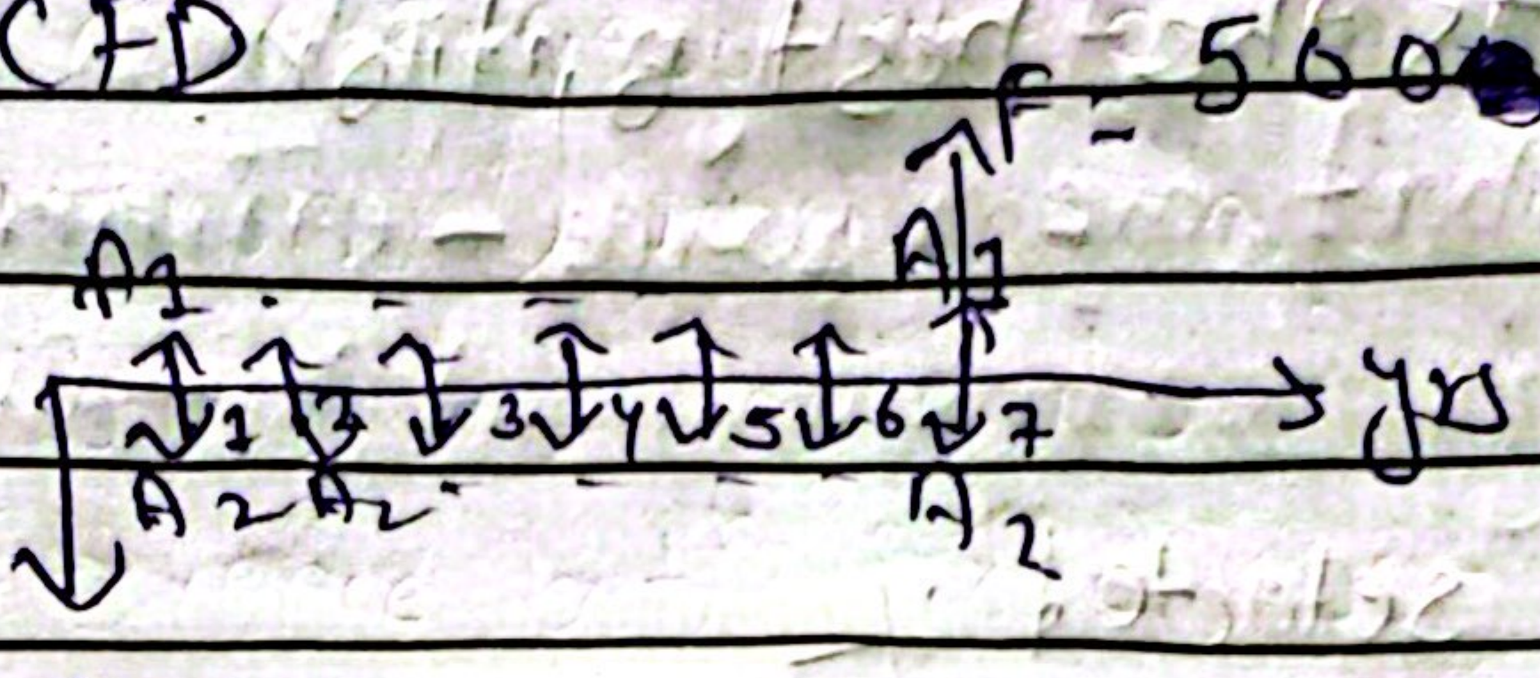
now,

Capitalized worth:

$CW(10\%) = \frac{AW \text{ of PA}}{i\%} = \frac{8353.8}{0.1} = -835$

for y:

~~AW(10%)~~ CFD



$P_0 = Rs. 40,000$

$A_1 = Rs. 15000$

$A_2 = Rs. 10,000$

$A = Rs. 5000$

$MARR = 10\%.$

$AW(10\%) = -P(A/P, 10\%, 7) + 500(A/F, 10\%, 7) + 5000$

$= -40000(0.2054) + 500(0.1054) + 5000$

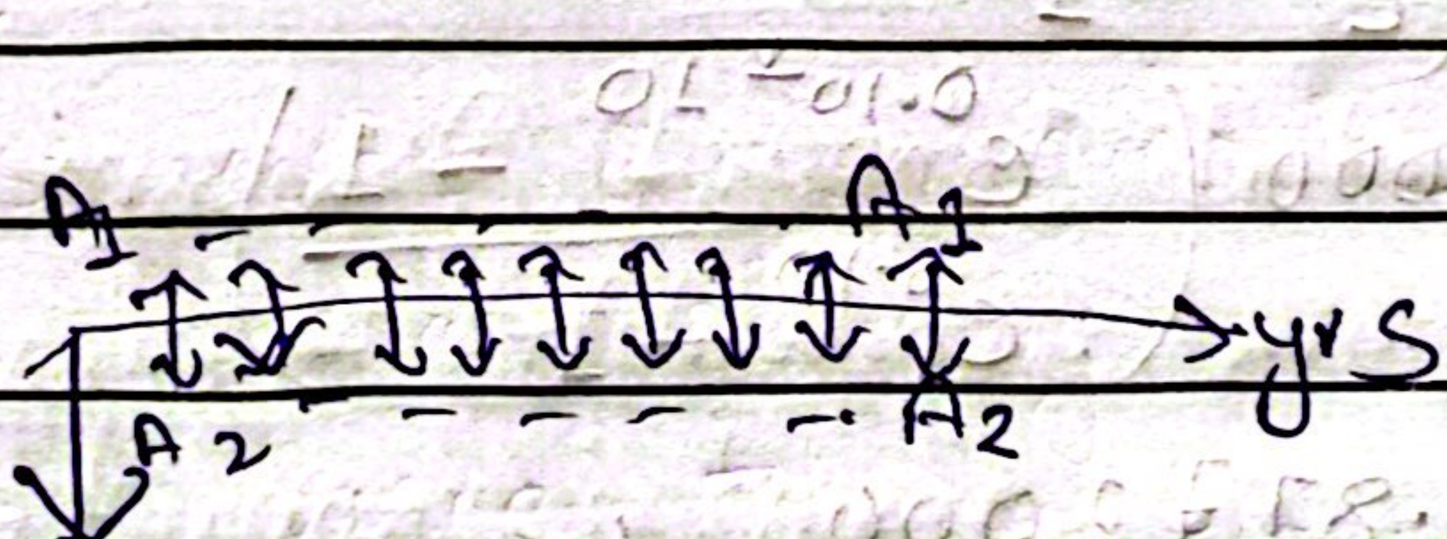
$= -Rs. 3163.3$

now:

$CW(10\%) = \frac{AW}{i\%} = \frac{-3163.3}{0.1} = -31633$

for z:

CFD



$P_0 = 30,000$ $A = (A_1 - A_2) = Rs. 6000$

$MARR = 10\%.$

$AW(i\%) = -30,000(0.1736) + 6000$

$= Rs. 792$

now,

$CW(10\%) = \frac{AW}{i\%} = \frac{792}{0.1} = +Rs. 7920$

since, Project 2 has the highest capitalized worth — Rs. 7,920, it is the best option.

Decision:

Project 2 is selected #

3a]

Soln

A = Rs. 500,000 (uniform annual cash flow)

i = 10% = 0.10 (Nominal interest rate & continuously compounded)

n = 10 yrs

e = ~~Euler's~~

compounded continuously vanyo vane: use this 'e' formula.

we know,

$$F = A\left(\frac{e^{i \cdot n} - 1}{e^{i} - 1}\right)$$

$$= 500,000\left(\frac{e^{0.10 * 10} - 1}{e^{0.10} - 1}\right)$$

$$= Rs. 81,72,000$$ #

3b]

→ Economic theory refers to the principles & modes that guide how resources are allocated in society to fulfill human wants & needs. It traditionally focuses on maximizing economic growth, efficiency, & profit. However, these theories often assume that natural resources are unlimited, which is unrealistic in today's environmentally challenged world.

Ecological footprint is a measure of the environmental impact of human activities. It calculates how much land, water, & natural resources are required to support a person, community, or nation. It highlights whether we are living within the Earth's ecological limits or overshooting them.

for eg: if a country has an ecological footprint of 2 Earths, It means that its consumption level is twice the Earth can regenerate sustainably.

Roles of Engineers in Achieving Global sustainable Goals:

→ In order to overcome ecological limits & promote environmentally responsible development, engineers have a vital role to play.

i. Sustainable Design & development:

- Engineers ~~must~~ must design systems, buildings, & technologies that are resource-efficient, energy-saving, & environmentally friendly.

ii. Promoting Green Technologies:

- Engineers can promote the use of renewable energy (like solar & wind), green transportation (like electric vehicles), & sustainable construction materials to reduce pollution & carbon emissions.

iii. Reducing Waste & Pollution:

- By applying life-cycle thinking & circular economy principles, engineers can minimize waste generation & design for recycling, reuse, & sustainability.

iv. Environmental Impact Assessment:

- Engineers are responsible for assessing the long-term environmental impact of projects & ensuring they comply with environmental regulations.

v. Ethical & Responsible Innovations:

- Engineers must work ethically & consider not just technical feasibility but also environmental & social responsibility in their decisions.

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vi) Policy Support & Public Awareness:

- Engineers should support environmental policies & help educate industries & communities about sustainable practices.

4a)

Given:

initial investment = Rs. 2,50,000

Annual benefits = Rs. 75,000

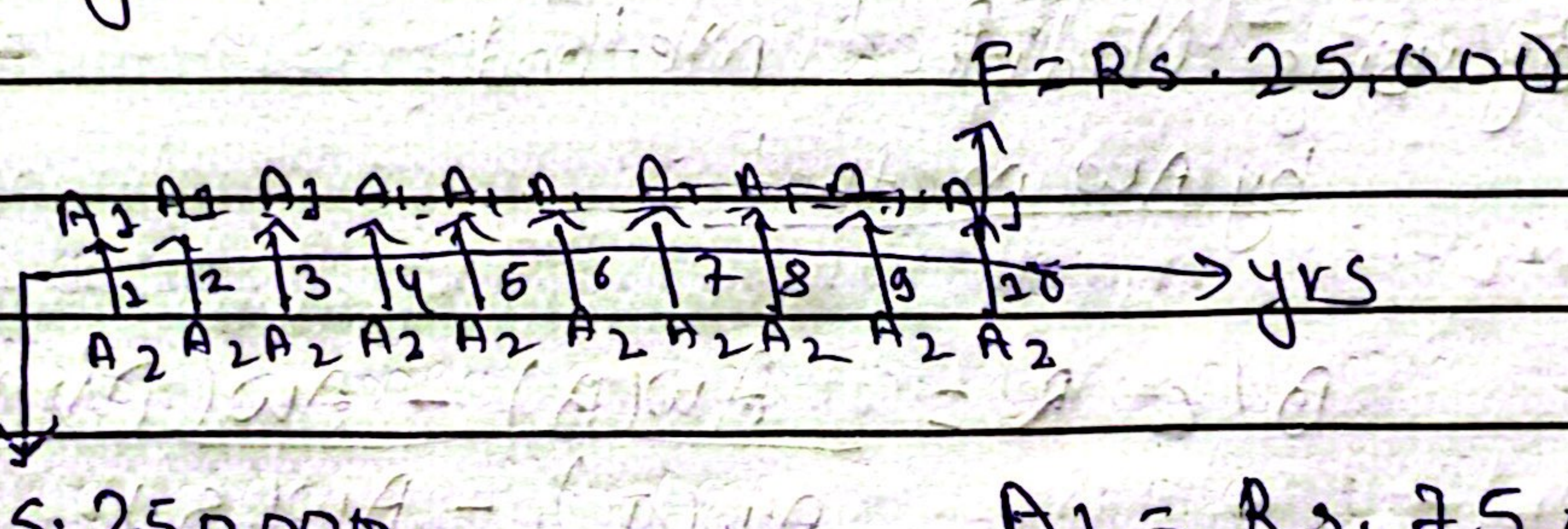
Annual cost = Rs. 15,000

salvage value = Rs. 25,000

MARR = 12%

No. of years = 10

Sol^n



A_1 = Rs. 75000

A_2 = Rs. 15,000

MARR = 12%

i) ~~By~~ for conventional method:

By AW method:

$AW(B) = Rs.\ 75,000$

$AW(I) = P(A/I; 12\%, 10)$

$= 250{,}000 * 0.1770$

$= Rs. 44250$

$AW(S) = F(A/F, 12\%, 10)$

$= 25000 * 0.0570$

$= Rs. 1425$

$AW(O\&M) = Rs. 1{,}50{,}000$

now,

$$B/C \; R = \frac{AW(B)}{AW(I) - AW(S) + AW(O\&M)}$$

$$= \frac{75000}{44250 - 1425 + 150000}$$

$= \cancel{0.389}\ 1.29$

i.e. $\cancel{< 1.0}$ & > 1.0

∴ ~~rejected~~ accepted #

ii) By using Modified method:

by AW method:

$$B/C \; R = \frac{AW(B) - AW(O\&M)}{AW(I) - AW(S)}$$

$$= \frac{75000 - 150000}{44250 - 1425}$$

$= \cancel{1.75}\ 1.40$

i.e. & > 1.0

∴ accepted ~~rejected~~ #

4b]

→ Project financing refers to a method of raising long-term capital for infrastructure or industrial projects where the project itself is treated as a separate entity, and the repayment of the loan depends on the cash flow generated by the project, not on the assets or credit of the project sponsors

Example:

Suppose a private company wants to build a hydropower plant. Instead of using its own money or borrowing based on its own balance sheet, it creates a special purpose vehicle (SPV) for the project. Banks provide loans to the SPV, and the loan is repaid from the revenue generated by selling electricity - not from the parent company's income.

→ Project funding refers to the overall provision of money (or capital) required to carry out a project. It can come from various sources, such as:

- Equity (owner's capital)
- Grants
- loans
- public contributions
- Government support

Project funding includes both debt & Equity, & is not limited to just loans or structured finance.

Example:

To build a public school, a government may provide 60% of the cost as a grant, a doctor agency may provide 30% as a soft loan, & the remaining 10% may come from Community contributions. All these combined form the funding for the project.

~~key~~

Key differences:

	Basics	Project financing	Project funding
1)	Source	Mostly bank loans or private investors.	Multiple sources: equity, loan, grants, etc.
2)	Risk	Lenders depend on projects cash flow	Risk is spread across all contributors.
3)	Ownership	Special purpose vehicle (SPV) created	No need for seperate entity.
4)	Example	Hydropower project loan repaid by electricity sale	funding a school using grants + community funds.

5 a)

$\Rightarrow$

Project	A	B
Initial investment	4,00,000	6,00,000
Annual Revenue	30,000	35,000
Annual O&M	3,000	4,000
Useful life in year	6	8
Salvage value	4,000	7,000
MARR	12%	12%

Soln

By Repeatability Assumption:

Step 1:

Take LCM of both project's useful life,

$$LCM = \begin{array}{r|l} 2 & 6, 8 \\ \hline 2 & 3, 4 \\ \hline & 3, 2 \end{array}$$

$$= 2 * 2 * 3 * 2 = 24 \text{ yrs}$$

step 2:

- Determine the repetation no. of the project

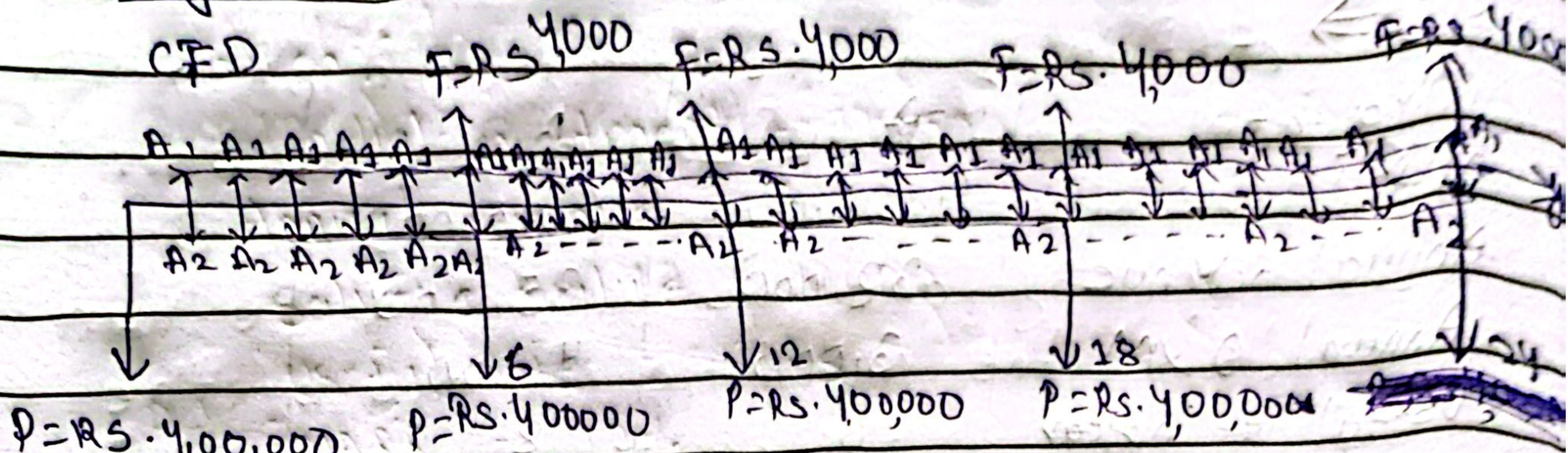
$$\text{Repetation} = \frac{LCM}{\text{Project life.}}$$

Repetation of Project A = 4 times

" " " B = 3 times

Project A:

CFD



$A_1 = 30,000$

$A_2 = 3,000$

MARR = 12%

$A = A_1 - A_2 = Rs. 27000$

By PW method,

$PW(12\%) = -P + F(P/F, i\%, 24) - (400000 - 4000)(P/F, 12\%, 6) - (400000 - 4000)(P/F, 12\%, 12) - (400000 - 4000)(P/F, 12\%, 18) + A(P/A, 12\%, 24)$

$= -4,00,000 + 4000(P/F, 12\%, 24) - 396000(P/F, 12\%, 6) - 396000(P/F, 12\%, 12) - 396000(P/F, 12\%, 18) + 27000(P/A, 12\%, 24)$

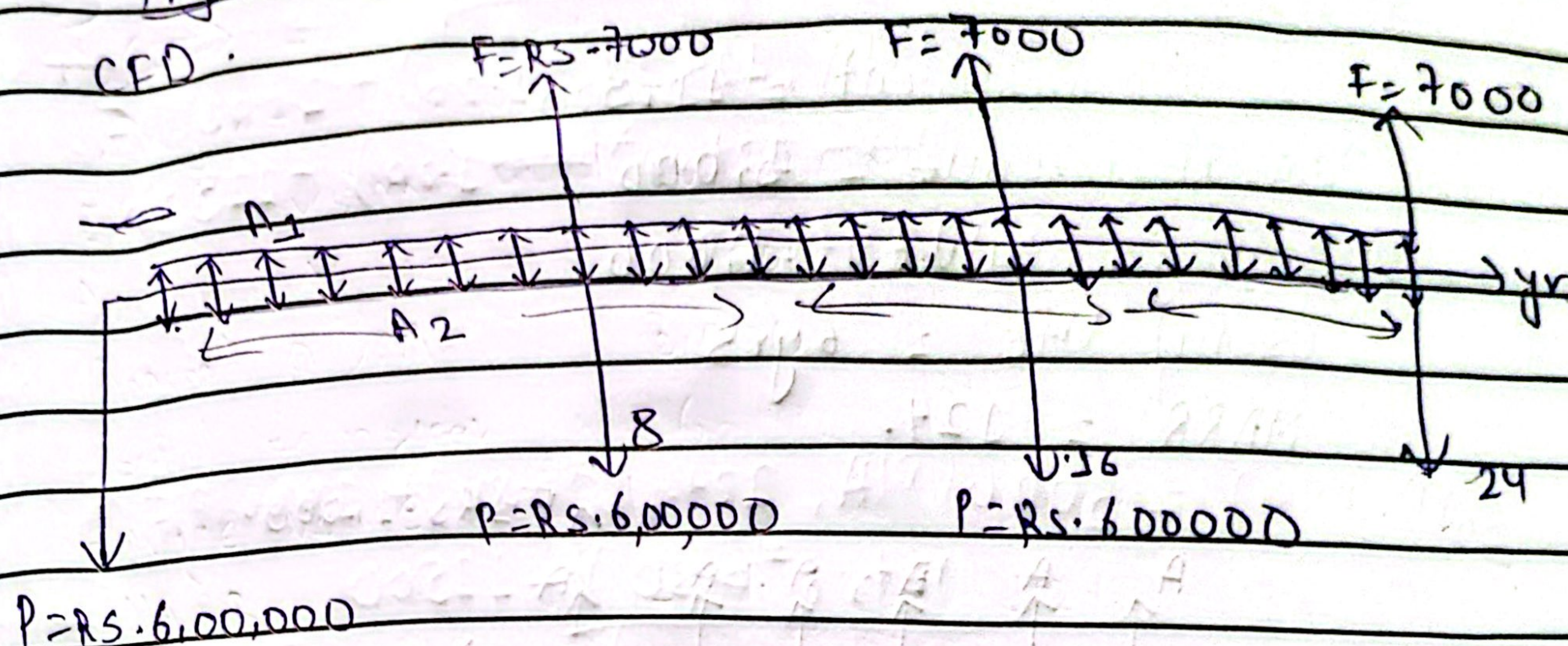
$= -4,00,000 + (4000 * 0.0659) - (396000 * 0.5066) - (396000 * 0.2567) - (396000 * 0.1300) + (27000 * 7.7843)$

$= -543307.1$

i.e. < 0, $\therefore$ rejected #

Project-B

CFD:



$A = A_1 - A_2$

$= Rs.\ 31000$

MARR = ~~Rs~~ 12%

By PW method:

$PW(12\%) = -P + F(P|F, 12\%, 24) + A(P|F, 12\%, 24) - (600000 - 7000)(P|F, 12\%, 8) - (600000-7000)(P|F, 12\%, 16)$

~~(600000-7000)(P|F, 12%,~~

$= -600000 + 7000 * 0.0659 + 31000 * 7.7843 - 593000 * 0.4039 - 593000 * 0.1631$

$= Rs. -694456.4$

Decision:

Both projects have negative value i.e. both are not preferable but if decision is to be made we should go for lesser negative value i.e. Project A is best. #

6a)

Given:

initial investment = 11,500

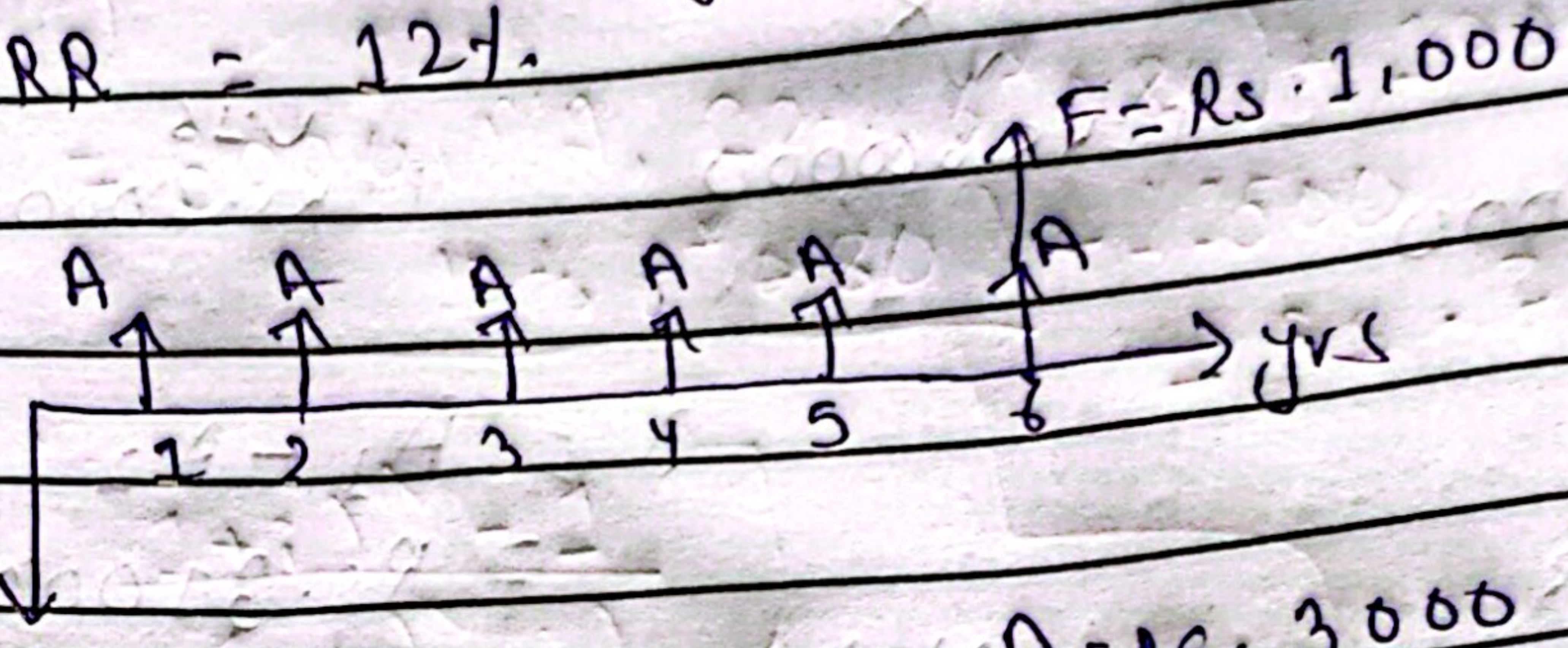
Annual revenue = 3,000

Salvage value = 1,000

Useful life = 6 yrs

MARR = 12%

Soln



A = Rs. 3000

MARR = 12%

Base eqn, over a range of (0%),

$PW(i\%) = A(P|A, i\%, N) + F(P|F, i\%, N) - P_0$

$PW(10\%) = 3000(P|A, 12\%, 6) + 1000(P|F, 12\%, 6) - 11500$

$PW(10\%) = 3000 * 4.1114 + 1000 * 0.5066 - 11500$

$= Rs.\ 327.6$

over a range of (±) 20%

a) initial investment:

At (+40%)

$PW(12\%) = 3000(P|A, 12\%, 6) + 1000(P|F, 12\%, 6)$

~~= Rs. 11827.6~~ $- 11500 \times 1.2$

$= Rs. 959.2$

At (-40%),

$PW = 3000(P/A, 12\%, 6) + 1000(P/F, 12\%, 6) - (11500 * 0.80)$

$= Rs. 3640.8$

b) Net amount revenue:

At (40%),

$PW(12\%) = (3000 * 1.20)(P/A, 12\%, 6) + 1000(P/F, 12\%, 6)$

$- 11500$

$= Rs. 3807.64$

At (-40%)

$PW(12\%) = (3000 * 0.80)(P/A, 12\%, 6) + 1000(P/F, 12\%, 6)$

$- 11500$

$= \cancel{Rs\ 3807.64}\ - Rs. 1126.04$

c) Salvage value:

At (40%)

$PW(12\%) = 3000(P/A, 12\%, 6) + (1000 * 1.20)(P/F, 12\%, 6)$

$- 11500$

$= Rs. 1442.12$

~~PW~~ At (-40%)

$PW(12\%) = 3000(P/A, 12\%, 6) + (1000 * 0.8)(P/F, 12\%, 6)$

$- 11500$

$= Rs. 1239.48$

d) Useful life

At (40%) $\rightarrow 13944.70$ $\rightarrow 2261.36$

$PW(12\%) = 3000(P/A, 12\%, 6*1.20) + 1000(P/F, \cancel{10\%}\ 12\%, 6*\cancel{0.80}\ 1.20) - 11500$

$= Rs.\ 4706.06$

At (-40%)

$PW(12\%) = 3000(P/A, 12\%, 6*0.80) + 1000(P/F, 12\%, 6*0.80) - 11500$

$= Rs.\ 711.96$

we know,

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

$$= 3000\left[\frac{(1+0.12)^{4.8} - 1}{(1+0.12)^{4.8}(0.12)}\right]$$

$= Rs.\ 10489.12$

$$P = F(1+i)^{-N}$$

$$= 1000(1+0.12)^{4\times 0.8}$$

$= 1722.84$

Summary,

Details	-40%	0%	+40%
I.I	3640.8	317.6	-959.2
Net A.R	-1126.04	317.6	3807.64
S.V	1239.48	317.6	1442.12
life	711.96	317.6	4706.06

6b]

Soln

Using Double Declining Balance method,

Given,

Initial cost (P) = Rs. 5,000

Life = 8yrs

Salvage value = Rs. 0

~~Depreciation Method~~.

DDB Rate = $\frac{2}{N} = \frac{2}{8} = 25\% = 0.25$

i) cumulative depreciation charge up to the 7th year;

year	Beginning Book value	Depreciation (25%)	Ending Book value
1	5,000	5000 × 0.25 = 1250	3750
2	3,750	3750 × 0.25 = 937.50	2812.50
3	2812.50	2812.50 × 0.25 = 703.13	2109.38
4	2109.38	2109.38 × 0.25 = 527.34	1582.03
5	1582.03	1582.03 × 0.25 = 395.51	1186.52
6	1,186.52	1186.52 × 0.25 = 296.63	889.89
7	889.89	889.89 × 0.25 = 222.47	667.42
8			

ii) book value at the end of 6th year = Rs. 889.89

i) Cumulative Depreciation up to yr 7 =

Rs. (1250 + 937.50 + 703.13 + 527.34 + 395.51, 296.63 + 222.47)

= Rs. 4332.58.

#