17 marks (22+5)

Ch 4

① Payback period (PBP)
- Simple payback period (Time value consider गर्दैन)
- Discounted payback period (consider गर्छ + धेरैजसो meth

② Equivalent worth period
- Present worth (PW)
- Future worth (FW)
- Annual worth (AW)

③ Rate of Return method
- Internal rate of Return (IRR)
- External rate of Return (ERR)

④ Benefit cost ratio method
- Conventional method
- Modified method.

⑤ Minimal Attractive Rate of Return (MARR)

⑥ Payback ~~Perio~~ l

Payback period Method

The payback period is the length of time required to recover the cost of an investment.

Simple payback period.

The time period required to break even on an investment without considering time value of money.

$$\text{SPP}(\text{B}) = \frac{\text{Initial Investment}}{\text{Net cash inflow per period.}}$$

Discounted period Method.

The time period required to recover the Investment from discounting cash flow ie considering time value of money.

Ex 1

Determine the simple PBP and discounted PBP from the F.F. cashflow of the project if MARR is 20% per year

End of the year	Net c.F (RS) (Cash flow)
0	-25000
1	8000
2	8000
3	8000
4	8000
5	13000

Soln

SPBP

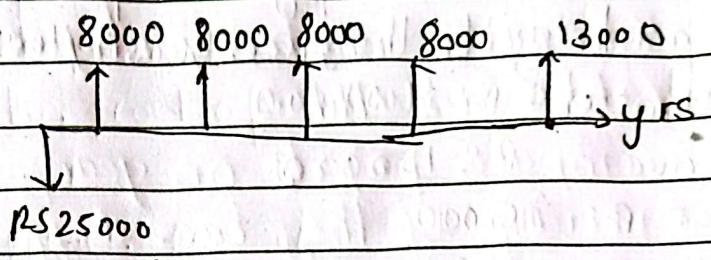
EOY	Net CF (RS)	Cumulative CF (RS)
0	-25000	-25000
1	8000	-17000
2	8000	-9000
3	8000	-1000
4	8000	+7000
5	13000	+20000

Now SPBP = $3 + \frac{1000}{8000}$

= 3.125 yrs

i.e < 5 years. accepted.

DPBP



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

Eqy 0 $P_1 = F_1(1+i)^{-N} = 8000(1+0.20)^{-1} = Rs\ 6667$

1 $P_2 = F_2(1+i)^{-N} = 8000(1+0.20)^{-2} = Rs\ 5556$

2 $P_3 = F_3(1+i)^{-N} = 8000(1+0.20)^{-3} = Rs\ 4630$

$P_4 = F_4(1+i)^{-N} = 8000(1+0.20)^{-4} = Rs\ 3858$

$P_5 = F_5(1+i)^{-N} = 13000(1+0.20)^{-5} = Rs\ 5224$

EOY	Net cash	Discounted payback	Cumulative cash (Rs)
0	-25000	6667 -25000	-25000
1	8000	5556 6667	-18333
2	8000	4630 5556	-12777
3	8000	3858 4630	-8147
4	8000	3858	-4289
5	13000	5224	+935

$DPBP = 4 + \frac{4289}{5224} = 4.82$ yrs < 5 yrs : accepted

But it is almost 5 yrs, may be rejected.

Pg 94

2015Fall, 2017Fall

Find simple and discounted payback period and justify investment with the given cashflow info.

Initial investment = Rs 4,00,000

Annual revenue = Rs 150000

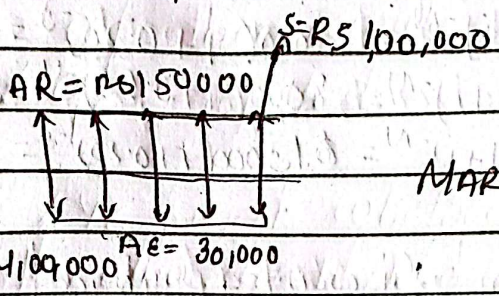
Annual cost = Rs 30,000

Annual life = 5 years

Annual MARR = 10%.

Salvage value = Rs 1,00,000

Soln



SPBP

EOY	Net cash	Cumulative
0	-4,00,000	-400000
1	120,000	-280000
2	120000	-160000
3	120000	-40000
4	120000	+80000
5	220000	+300000

$SPBP = 3 + \frac{40000}{120000} = 3.33 \text{ yrs} < 5 \text{ yrs}$

accepted.

ii) Discounted payback period.

EOY	Net cash flow	Discounted payback	Commulative
0	-400000	-400000	-400000
1	120000	109091	-290909
2	120000	99174 ~~99173 55379~~	-191735
3	120000	90158	-101577
4	120000	81961	-19,616
5	220000	136603	1,16,987

Discounted payback period = $4 + \frac{19616}{136603}$

= 4.14 years

Project is feasible

Equivalent worth Method

Future worth - Compare which project gives more future wealth.

Annual worth: Compare projects on yearly earnings, especially if they have diff lifetimes.

Present worth: Decide if a project is worth starting.

Decision Rule

if PW(i%) > 0 ; accepted

if PW(i%) = 0, then remain ~~indifference~~ some

if PW(i%) < 0, rejected.

Evaluate the XYZ project whether it is feasible or not to invest, whose cash flow areas follows.

Initial investment = Rs 450000

Annual revenue = Rs 200000

Annual cash = Rs 50000

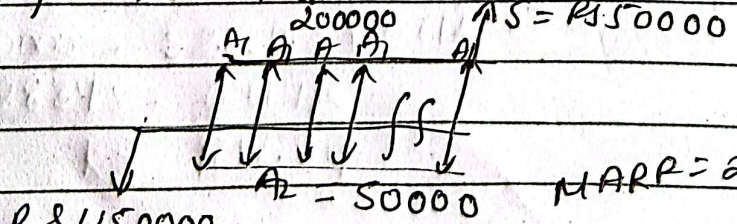
Salvage value = Rs 50000

Useful life = 8 yrs

MARR = 20%.

Use PW, FW, AW method.

By pw method



$A_1 = 200000$

$A_2 = 50000$

$A = 150000$

By PW

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

$= 150000(P/A, 20\%, 8) + 50000(P/A, 20\%, 8) - 450000$

$=$ Rs 1,37,210

i.e > 0 $\therefore$ accepted

By FW

$FW = A(P/A, i\%, N) + F - P(F/P, i\%, N)$

$= 150000(F/A, 20\%, 8) + 50000 - 450000(F/P, i\%, N)$

$=$ Rs 589955

i.e > 0 accepted

By AW method

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

$= 150000 + 50000(A/F, 20\%, 8) - 450000(A/P, 20\%, 8)$

$=$ Rs 35760

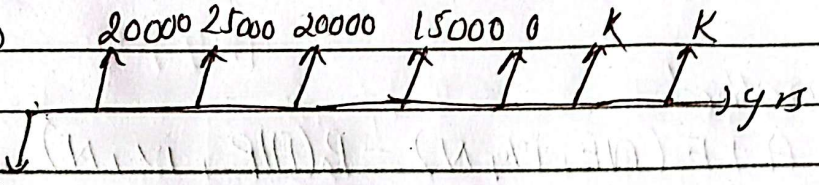
i.e > 0 accepted.

Ex 2

Find the value of k, from the FF: cash flow if MARR is 20%.

EOY	Net cash flow
0	-50000
1	20000
2	25000
3	20000
4	15000
5	0
6	k
7	k

CFD



Eq:

PW = 20000 (P/F, 20%, 1) + 25000 (P/F, 20%, 2) + 20000 (P/F, i%, 3) + 15000 (P/F, 20%, 4) + k (P/F, 20%, 6) + k (P/F, 20%, 7)

50000 = 20000 x 0.8333 + 25000 x 0.6944 + 20000 x 0.5787 + 15000 x 0.4823 + 0 + k x 0.3349 + k x 0.2791

50000 = 52834.5 + 0.61k

-2834.5 = 0.614k

K = 4616.44

Internal Rate of Return (IRR)

→ is the interest rate at which the PW of all cash flow become zero.

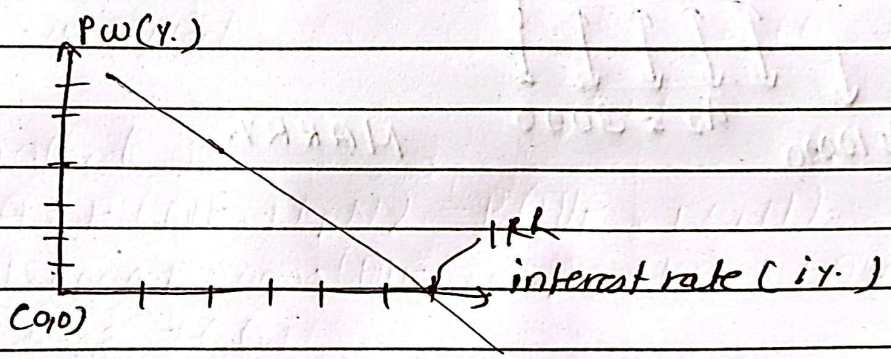
→ It is the break even rate of return for a project

cash inflow = cash outflow

→ The equivalent worth can be computed by different ways like PW, FW, AW formula.

→ The resultant interest ~~or~~ rate is called IRR.

→ This method is also called hit and trial method or assumption method.



Decision Rule

If IRR > MARR, then accepted

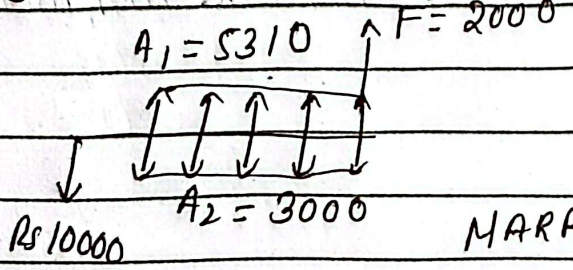
If IRR = MARR, then remaining indifferent

If IRR < MARR, then rejected.

Determine IRR of the FF: project whose cash flow a
as follow:

→ Inital investment = Rs 10,000
→ Project life = 5 yrs
→ Annual Revenue = Rs 5310
→ Annual expenses = Rs 3000
→ SV = Rs 2000
→ MARR = 8%

CFD



$A = 5310 - 3000 = 2310$

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

$= 2310(P/A, 8\%, 5) + 2000(P/F, 8\%, 5) - 10000$

Assume $i\% = 7\%$

$PW(i\%) = 2310 \times 4.1002 + 2000 \times 0.7130 - 10000$

$= 897.462$

Assume $i = 10\%$.

$PW(i\%) = -1.452$

formula for IRR

$$IRR(i\%) = \text{Interest of LR} + \frac{\text{PW of LR}}{\text{PW of LHR}} (HR - LR)$$

$$= 7\% + \frac{897.462}{897.462 + 1.452} (10 - 7)$$

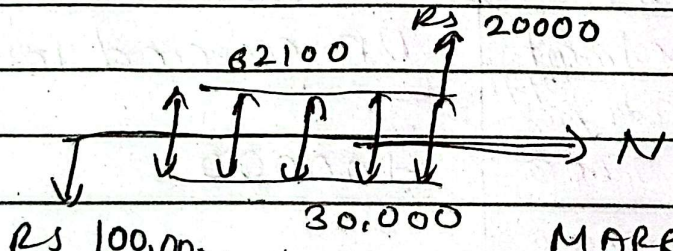
$$= 9.99\%$$

> MARR. accepted

Q2 2018 spring

An investment of Rs 100,000 can be make in a project that will produce uniform annual revenue of Rs 62100 for 5 years and then have a market salvage value of 20,000. Annual expenses will be Rs 30,000 each years. Company accepts project that earns 10% of more, evaluate IRR of this project & suggest whether the project is feasible or not? Also draw an investment balance diagram.

Soln



MARR = 10% per year

A = 32100

using PW formulation

$PW(i) = 32100(P/A, i\%, 5) + 20000(P/F, i\%, 5) - 100{,}000$

if $i = 10\%$

$PW = 34102.68$

if $i = 20\%$

$PW = 4036$

if $i = 22\%$

$PW = -686.86$

$IRR = 20 + \frac{4036}{4036 + 686.86}(22 - 20)$

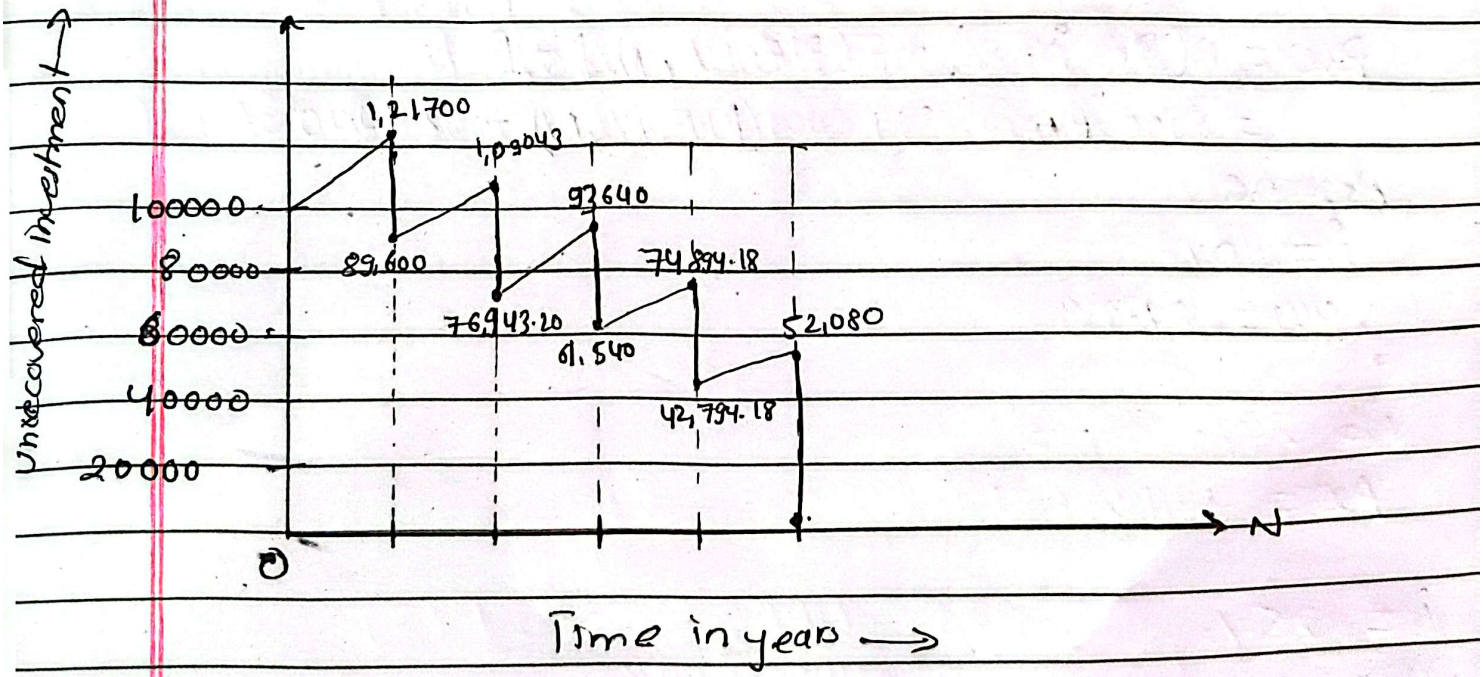
$= 21.70$

$> MARR$.

The project is feasible.

Unrecovered investment calculation

EOY	Cash	Unrecovered Investment		Unrecovered amount
		Beginning	End (21.7%)	(Cash + ~~investment~~ End)
0	100000	–	−100000	−100000
1	32100	−100000	−121700 (P×1.7+P)	−89600
2	32100	−89600	−109043	−76,943.2
3	32100	−76943.20	−93640	−61,540
4	32100	−61540	−74894.18	−42794.18
5	52100	−42794.18	−52,080	−80



Q.

Compute the IRR for the FF: project and also show unrecovered investment balance in the graphical and tabular form.

The cash flow are as follow

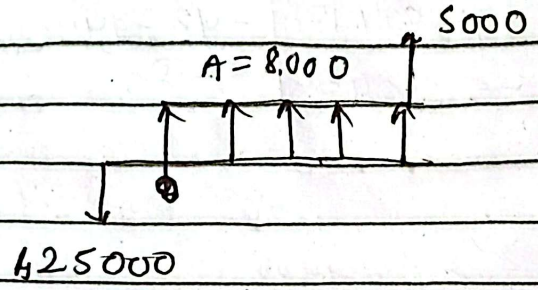
Initial Investment = Rs 25000

Net annual Revenue = Rs 8000

SV = 5000

useful life = 5 yrs

MARR = 20%



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

$$= 8000(P/A, i\%, 5) + 8000(P/F, i\%, N) - 25000$$

Assume

$i = 10\%$

$PW = 8430.9$

$i = 20\%$

$PW = 934.3$

$i = 25\%$

$PW = -1347.10$

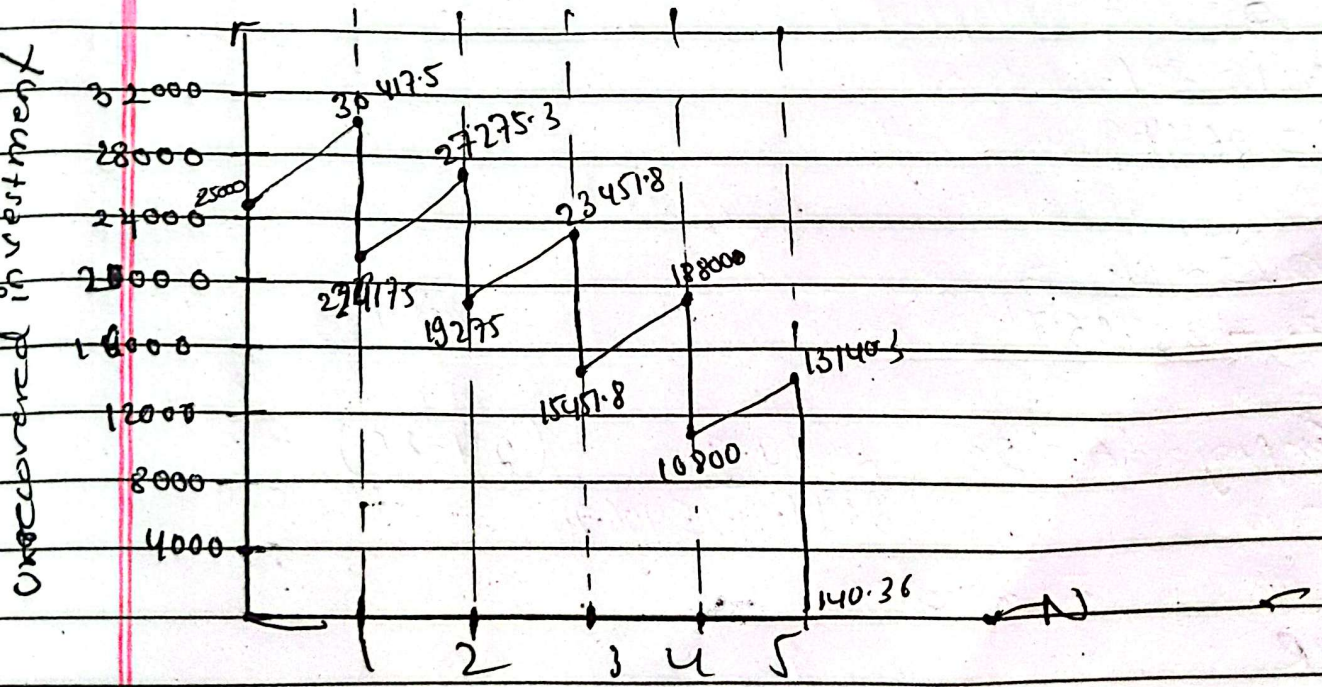
$$IRR = 20 + \frac{934.3}{934.3 + 1347.10}(25-20)$$

$$= 21.671.$$

> MARR accepted

Unrecovered Investment table.

cash	EOY	Unrecovered investment		Unrecovered amount
		Beginning	End at 21.67%	
25000	0	-	-25000	-25000
8000	1	-25000	-30417.5	-22417.5
8000	2	-22417.5	-27275.3	-19275
8000	3	-19275	-23451.8	-15451.8
8000	4	-15451.8	-18800	-10800
13000	5	-10800	-13140.3	-140.36



Q. 2020 Fall

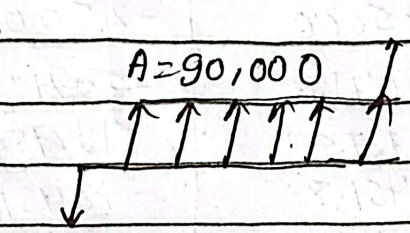
Select the best project by using IRR method when MARR is 8%.

	Project A	Project B
Initial Investment	3,00,000	5,00,000
Annual Revenue	90,000	175000
Life year	6	6
Salvage year	10,000	1,00,000

Soln

MARR = 8%.

for Project A



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

$= 90000(P/A, i\%, 6) + 10,000(P/F, i\%, 6) - 300000$

$= 0$

when i = 20%.

PW = 2644.9

when i = 24%.

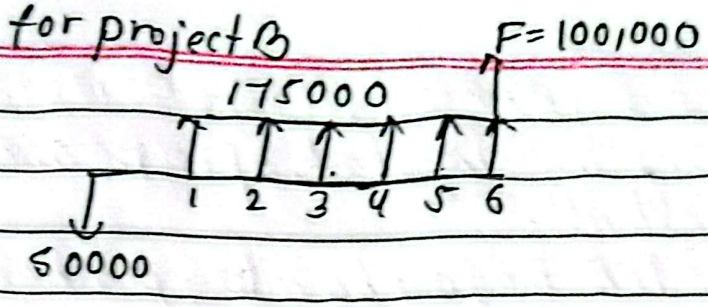
PW = −25406.71

IRR for project A $= 20 + \frac{2644.9}{2644.9 + 25406.71}(24-20)$

$= 20.38\%$.

> MARR.

for project B



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

$= 175000(P/A, i\%, 6) + 100000(P/F, i\%, 6) - 50000$

When $i = 28\%$

$PW = 5628.82$

when $i = 32\%$

$PW = -37602.78$

IRR for project B

$= 28 + \frac{5628.82}{5628.82 + 37602.78} \times (32 - 28)$

$= 28.52\%$

Here IRR of project B is greater than Project A and both IRR are greater than MARR. Hence Project B should be selected.

External Rate of Return (ERR)

⇒ ERR method eliminates the drawback of reinvestment assumption to some extent.

⇒ The reinvestment of IRR may not be always practical

Benefit cost Ratio Method (BIC R)

⇒ Special tool of benefit cost analysis

⇒ It revised to evaluate public sector project as well as big project of private sector.

⇒ It is defined as the ratio of the equivant worth of benefit to the equivalent worth of costs.

⇒ Also known as saving investment ratio

⇒ It is actually a ratio of discounted benefit to the discounted cost.

Has two types

1. Conventional method
2. Modified method

Conventional method.

By PW formula

$$\text{BIC ratio} = \frac{PW(B)_{\text{Benefit}}}{PW(I)_{\text{Investment}} - PW(S)_{\text{salvage}} + PW(O\&M)_{\text{operating \& maintenance}}}$$

By FW

$$\text{BIC ratio} = \frac{FW(B)}{FW(I) - FW(S) + FW(O\&M)}$$

B/C को case मा salvage दिको छैन भने
0 राख्ने
useful को year assume गर्न मिल्छ नदिएको

By AW

B/C ratio = $\dfrac{AW(B)}{AW(I) - AW(S) + AW(O\&M)}$

By modified method

By PW method

$BC(R) = \dfrac{PW(B) - PW(OSM)}{PW(I) - PW(S)}$

Decision Rules

if BC/R > 1.0 Accepted

if BC/R = 0 ; Remain indifferent

if BC/R < 1.0 ; Rejected.

Ex1

Find both types of B/C ratio by using PW, FW & AW,

Initial Investment = Rs 100000

Annual Investment = Rs 40000

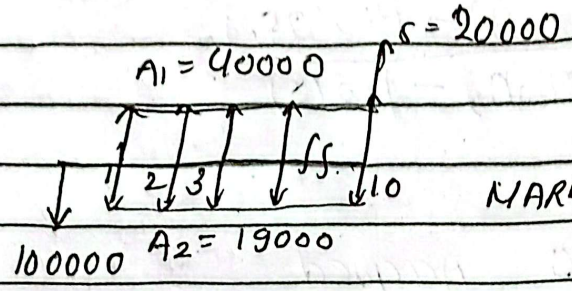
Annual Cost = Rs 19000

S.V = Rs 20,000

Useful life = 10 yrs

MARR = 10%

Soln



$A = A1 - A2 = 21000$

By conventional method.

$PW(B) = A_1(P/A, i\%, N)$

$= 40000(P/A, 10\%, 10)$

$= 245784$

$PW(I) = Rs\ 100000$

$PW(S) = F(P/F, i\%, N)$

$= 20000(P/F, 10\%, 10)$

$= Rs\ 7710$

$Pw(O\&M) = A_2(P/A, i\%, N)$

$= 19000(P/A, 10\%, 10)$

$= 1167740$

BIC ratio

$= \frac{100000 \quad 245784}{100000 - 7710 + 116747.40}$

$= 1.17$ i.e > 1 accepted.

By FW

$FW(B) = A_1(F/A, i\%, N)$

$= 637496$

$FW(I) = 100000(F/P, i\%, N)$

$= 259370$

$FW(S) = Rs\ 20000$

$FW(O\&M) = A_2(F/A, i\%, N)$

$= 3028160$

Conventional method

BIC ratio $= \frac{FW(B)}{FW(I) - FW(S) + FW(O\&M)}$

$= 1.17 > 1$ accepted

Modified method

$BCR = \frac{FW(B) - FW(O\&M)}{FW(I) - FW(S)}$

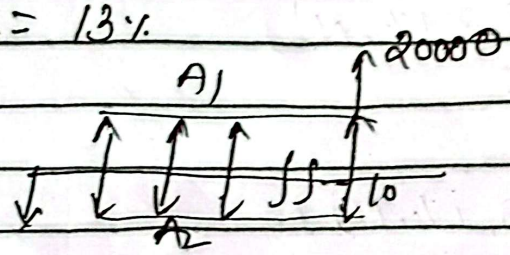
$= \frac{637496 - 3028160}{259370 - 20000}$

$= 1.39 > 1$ accepted

2023 Fall

Calculate both types of B/C ratio from the following information and also give your decision whether the project should be selected or not:

Initial Investment = 800000
Annual Revenue = 150000
Operating and maintenance = 25000
Life = 10 years
Salvage value = 20000
MARR = 13%



Sol^n

$AW(I) = P(A/P, i\%, N)$
$= 800000(A/P, 13\%, 10)$
$= 147440$

$AW(B) = 150000$
$AW(O\&M) = 25000$
$AW(S) = F(A/F, i\%, N)$
$= 20000(A/F, 13\%, 10)$
$= 1086$

By conventional method

$$= \frac{150000}{147440 - 1086 + 25000}$$
$$= 0.875 < 1$$

Modified B/C = $\frac{150000 - 25000}{147440 - 2086}$

= 0.8541 < 1

Since B/C ratio is both conventional & modified < 1 then reject the project.

Determine both type B/C ratio by FW

Initial Investment = 250000

Annual revenue = 50000 at end of year & increaded by 30000 each for 5 year

Annual O&M cost = 30,000

Salvage value = 50000

Useful life = 5

MARR = 15%

Soln

FW(B) FW(I) = 250000 (FIP, 15%, 5) = 502839

FW(S) = 50000

FW(B) = 50000 (FIA, 15%, 5) + 30000 (FIA, 15%, 5)

= 337120 + 348476

= 685595

Conventional ratio = 1.0475 > 1

Modified ratio = 1.0662 > 1

Find B/c ratio using Pw and Aw method

Initial Investment = Rs 600000

Annual benefit = Rs ~~30,000~~ 250000

Annual Cost = Rs 30000

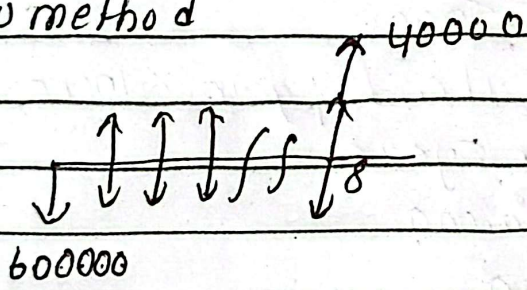
Salvage value = Rs 40,000

MARR = 10% per year

useful life = 8 years

Repair and maintenance cost at 5th year = Rs 5000

By Pw method



$Pw(B) = A_1(P/A, 10\%, 8)$

$= 1333725$

$Pw(I) = 600000 + 5000(P/F, 10\%, 5)$

$= 603104.5$

$Pw(S) = 40000(P/F, 10\%, 8)$

$= 18660$

$Pw(O\&M) = A_2(P/A, 10\%, 8)$

$= 160097$

B/C = 1.7971 accepted

Evaluate IRR of the following

Inibial Investment = 600000

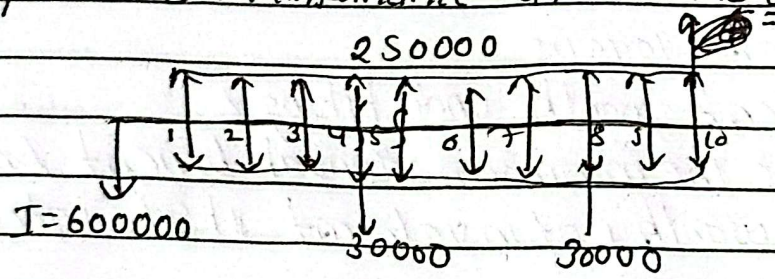
Annual revenue = 250000

Annual cost = 50000

Useful life = 10 years

MARR = 10% per year

Repair and maintainance at 4th and 8th = 30000



A = 250000 − 50000

= 20000

PW = A (P|A, i%, N) − 30000 (P|F, i%, N)

− 30000 (P|F, i%, N) − 600000

= 20000 (P|A, i%, 10) − 30000 (P|F, i%, 8)

− 30000 (P|F, i%, 4)

if i = 30%

PW (i%) = 4119

if i = 35

PW = −6875.1

$$IRR = 30 + \frac{4119}{4119 + 6875.1} (35 - 30)$$

= 30.283%

> MARR

A company is investing the purchase of new equipment Interest rate is 9% per year. The cash flow for the equipment is as follow

Initial Investment = 50,000

Annual income = 9000

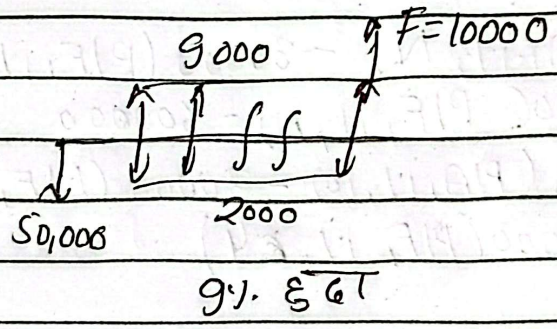
Annual O&M = 2000

Salvage value = 10,000

Useful year = 10 years

I) Is the investment worth undertaking?

II) What should be the minimum annual benefit for making it a worthy of investment at 9% rate of return.



$PW = 7000(P/A, 9\%, 10) + 10000(P/F, 9\%, 10) - 50,000$

$= -852.10$

since PW(9%) < 0, this is not worth investing.

If i = 10%

PW(10%) = -Rs 3132.80

If i = 8%

PW = 1602.7

$IRR = 8 + \frac{1602.7}{1602.7 + 3132.80}(10-8)$

$= 8.653\%$

IRR < MARR, Project is not feasible

ii) for minimum benefit annually (B)

$PW(9\%) = -50000 + B(P/A, 9\%, 10) + 10000(P/F, 9\%, 10)$

$0 = -50000 + B \times 6.4177 + 10,000 \times 0.4224$

$45776 = B \times 6.4177$

$B = Rs\ 7132.7735$