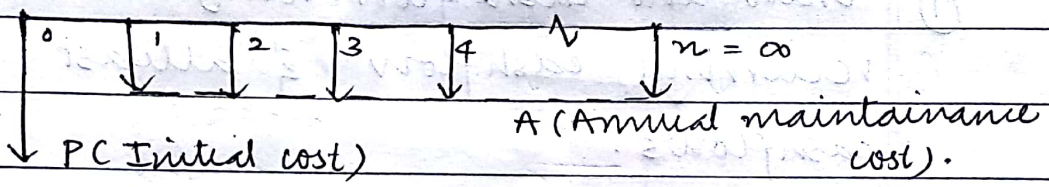
Particulars	Cottage 1	Cottage 2
First cost	₹4500	₹10,000.
Estimated life	3yrs	4yrs.
Annual maintance cost	₹1,000	₹720.

Additional data: Market value at the end of 2nd yr for cottage 1 is ₹3000 & market value at the end of 1st yr for cottage 2 is ₹8500. Solve using LCM & study period method (5yrs)

→ Cottage 1:

III CAPITALISED COST METHOD

* It is used for comparing assets for with infinite life.
* Evaluatn of projects such as dams, railway line, are done using capitalized cost method.
* Capitalized cost is present worth of an alternative that will last forever.



$$PW = P + A(P/A, i, n \to \infty)$$

$$= P + A\left[\frac{(1+i)^n - 1}{i(i+1)^n}\right]$$ (Divide & multiply by $(1+i)^n$.)

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

$$PW = P + A\left[\frac{1}{i}\right] \quad \left[\lim_{n \to \infty}\right]$$

$$\boxed{PW = P + \frac{A}{i}}$$

capitalized cost

$$\boxed{CC = P + \frac{A}{i}}$$

Cash flows in a project with infinite life can be of two types:

(1) Recurring cost (2) Non-recurring cost.

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(*) Annual operating cost of $50,000 & rework cost $40,000 every 12 years are examples of recurring cashflows.

(*) Examples for non-recurring cash flows are initial investment & one time cashflow estimate in future.

Procedure to solve capitalized cost problem:

(1) Draw the cash flow diagram showing all non recurring cashflow & atleast 2 cycles of recurring cashflows.

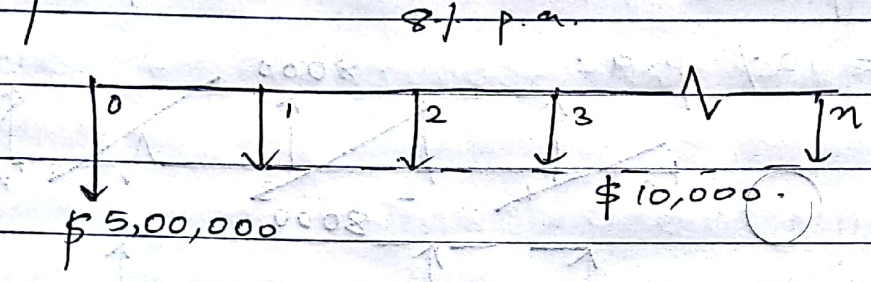
(2) Find the present worth of all non-recurring cashflow using single payment present worth relat^nship.

(3) Find equivalent uniform annual amount for one cycle of all recurring cashflows & divide the amount by interest rate to get capitalized cost of all recurring cashflows.

(4) Divide all the uniform cashflows occuring from year 1 to infinity by the interest rate to get capitalized cost of those uniform cash flows.

(5) Add the values obtained in ~~ob~~ above steps to get total capitalized cost of given investment.

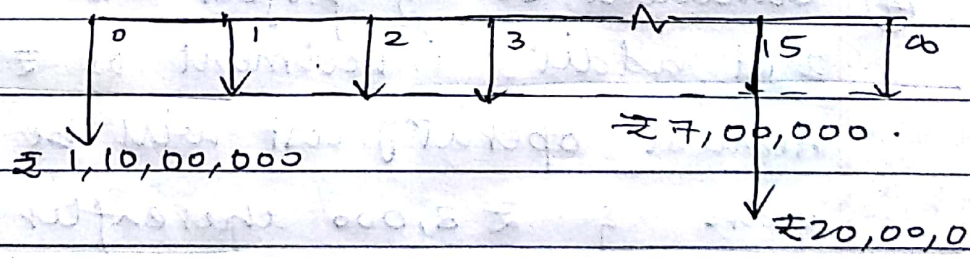
(1) Calculate CC of project having initial cost $5,00,000 & annual maintainance cost $10,000 at 8% p.a.



$$CC = PW = P + A/_i = 5,00,000 + \frac{10000}{0.08}$$

$$CC = \$6,25,000$$

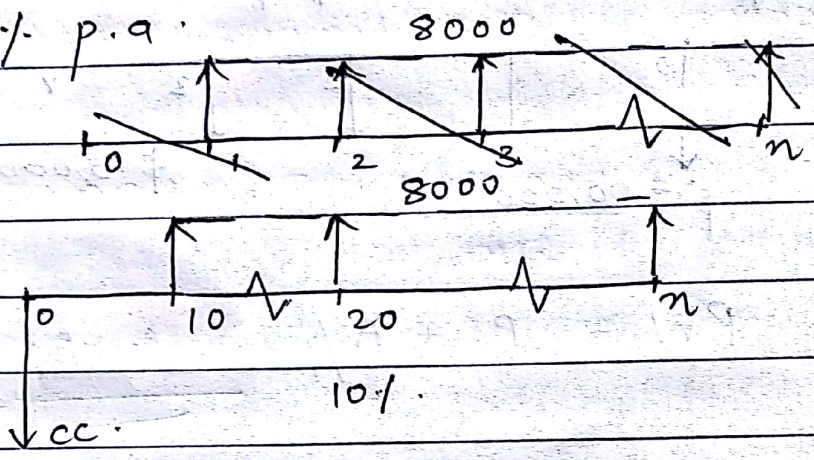
(2) A public project has an initial cost of ₹1,10,00,000 & annual operating cost ₹7,00,000. Further the project will have one time major repair work of ₹20,00,000 in the 15th yr, Find CC if i = 12%.



$$CC = 1,10,00,000 + \frac{20,00,000}{(1+0.12)^{15}} + \frac{7,00,000}{0.12}$$

$$= ₹1,71,98,725.86$$

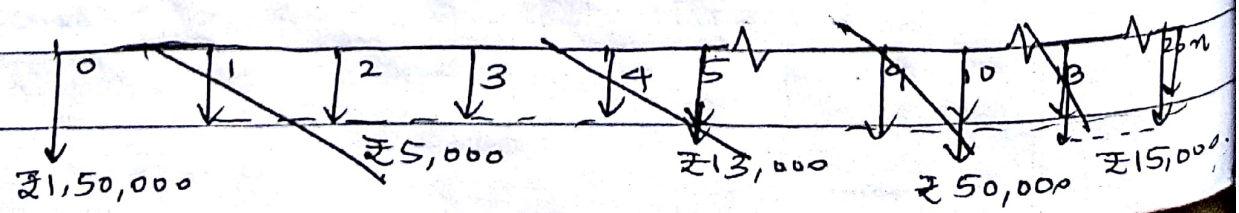
(3) ₹ 8,000 is to be withdrawn from a savings account at the end of every 10 year. Calculate lumpsome amount to be deposited now if i = 10% p.a.

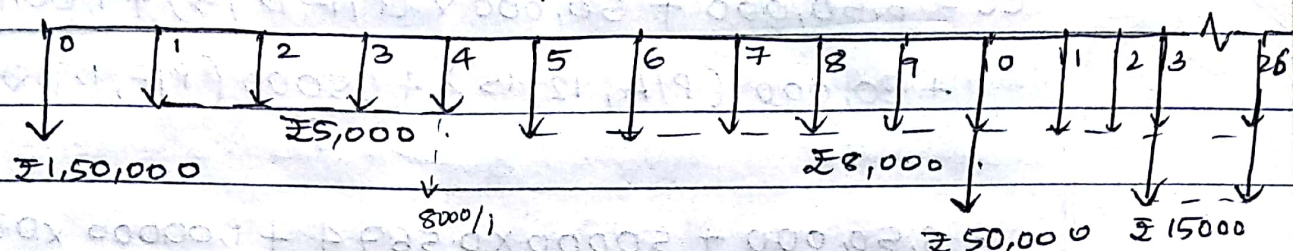


Finding equivalent uniform amount for one cycle of recurring amount,

$$CC = 8000 \times (A/F, 10, 10) / 0.1$$
$$= 8000 \times 0.0627 / 0.1$$
$$CC = 5016$$

(4) Calculate CC of project that initial cost ₹1,50,000 and additnal investment of ₹50,000 after 10yrs. Annual operating cost will be ₹5,000 for 1st 4 years & ₹8,000 thereafter. In addit^{n} there is expected to be a recurring major rework costing ₹15,000 every 13 years. Assume i = 15%.



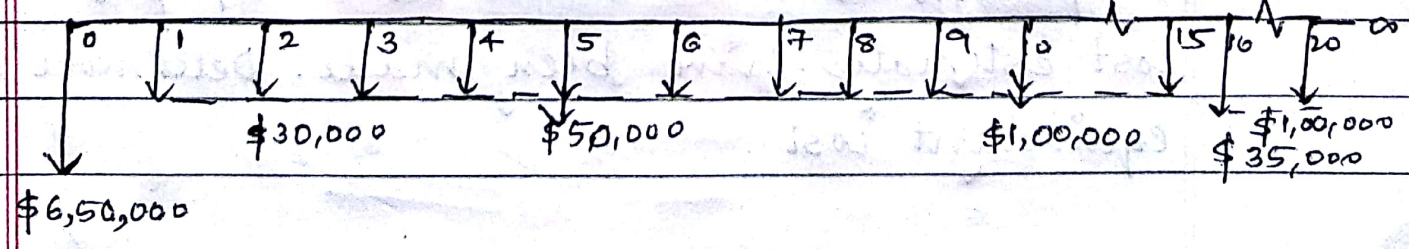


$$CC = 1,50,000 + 50000(P/F, 15, 10) + 5000 \times (P/A, 15, 4) + \frac{8000}{i} \times (P/F, 15, 4) + 13000 (P/A, A/F, 15, 13)/i$$

$$= 1,50,000 + 50,000 \times 0.2472 + 5000 \times 2.855 + \frac{8000}{0.15} \times 0.5718 + \frac{13000}{0.15} \times 0.0291$$

$$= ₹\ 2,10,041$$

(5) The expenditures involved in building & maintaining a bridge are shown. Calculate capitalized cost if i = 15%. Cost of design & building bridge is $6,50,000. It is estimated that bridge will have to be renovated every 10 yrs at a cost of $1,00,000. In addition $50,000 has to spent in 5th yr to relay the road on the bridge. Annual operating cost are expected to be $30,000 for 1st 15 years & $35,000 thereafter.



$$CC = 6,50,000 + 50,000 \times (P/F, 12, 5) + \frac{1,00,000}{i}(A/F, 12, 10) + 30,000\,(P/A, 12, 15) + \frac{35000}{0.12}(P/F, 12, 15)$$

$$= 6,50,000 + 50000 \times 0.5674 + \frac{1,09000}{0.12} \times 0.0570 + 30,000 \times 6.8111 + \frac{35000}{0.12}(0.1827)$$

$$CC = \$\,983487.5$$

IV ANNUAL WORTH METHOD (Gives working capital reqd every yr)

(1) In an annual worth method, all the receipts & payment occuring over a period of time are converted to an equivalent uniform yearly amount.

(2) Annual worth method is widely used to because of the inclinatn to view a year's gains & losses as a yardstick of progress.

(3) Major tools used in annual worth calculatn are capital recovery factor & sinking fund factor.

(1) Two types of power converters α & β are under considerath for a particular applicath. An economic comparison is to be made at $i = 10\%$ p.a Following cost estimates have been made. Determine annual equivalent cost.

EUAC / EUAW

Equivalent uniform annual cost – Cost dominant – classmate

" " " worth – Revenue

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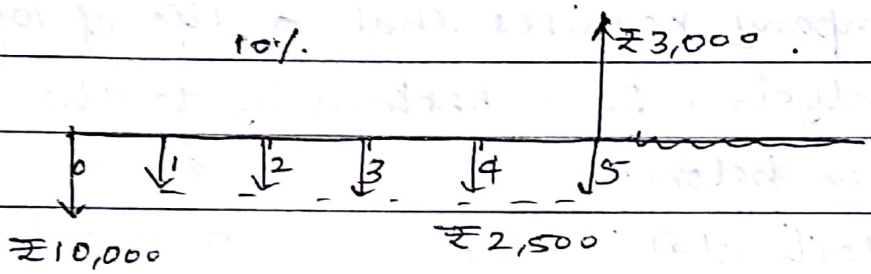
Particulars	α	β
Purchase price	₹10,000	₹25,000.
Annual operating cost	₹2,500	₹1,200.
Salvage value	₹3,000	₹5000.
Life	5yrs	9 years.

α

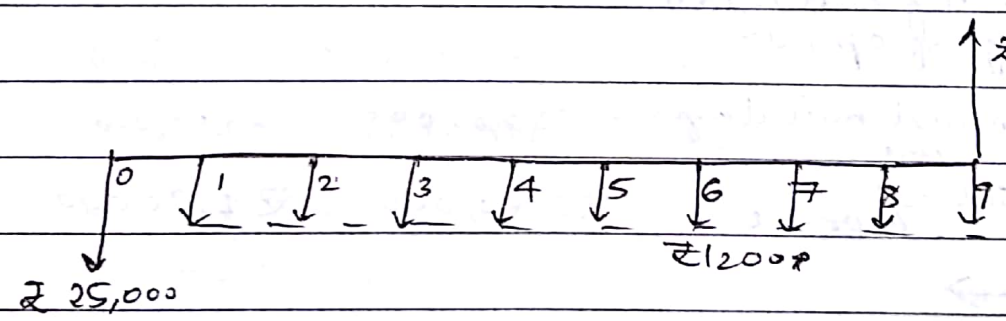


$EUAC_\alpha = 10000\,(A/P, 10, 5) + 2500 - 3000\,(A/F, 10, 5)$

$= 10000 \times 0.2638 + 2500 - 3000\,(0.1638)$

$= ₹\ 4646.6$

β ;



$EUAC_\beta = 25000 \times (A/P, 10, 9) + 1200 - 5000\,(A/F, 10, 9$

$= 25000 \times 0.1736 + 1200 - 5000 \times 0.0736$

$= ₹5172.$

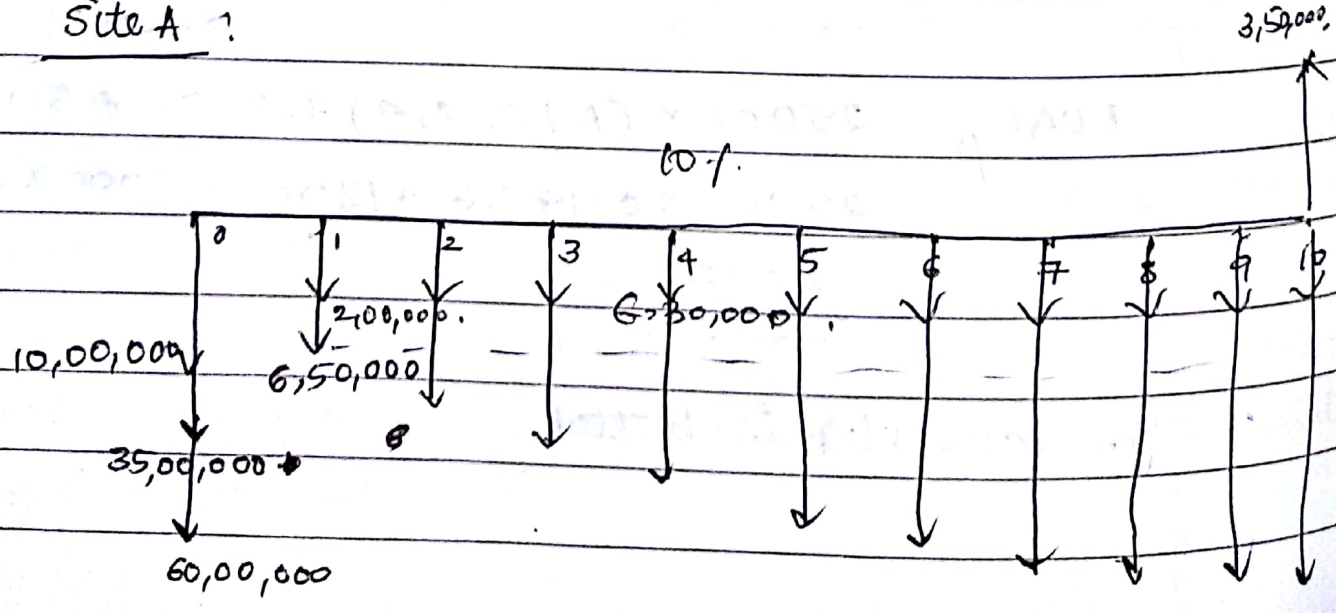
∴ α converter is better.

(2) A beverage company is planning expansn of its cold storage. 3 alternative sites are being considered that uses a MARR of 10%. Sites A & B require an expenditure of ₹35,00,00 on land whereas site C requires ₹45,00,000. Estimated income ↑ due to new sites available is annualized at ₹24,80,00 Company requires that a life of 10yrs be used for analysis. Data pertaining to the project are as given below:

Particular	A	B	C
Building & machinery	₹60,00,000	₹70,00,000	₹80,00,000
Cost of compressors.	₹10,00,000	₹13,50,000	₹8,50,000
Energy cost during 1st yr of operatn	₹6,50,000	₹4,80,000	₹6,50,000.
↑ in energy cost during each additional yr of operatn	₹30,000	₹20,000	₹35,000.
Annual maintainance cost	₹2,00,000	₹1,50,000	₹5,00,000.
Salvage value	₹3,50,000	₹4,30,000	₹1,80,000.

→

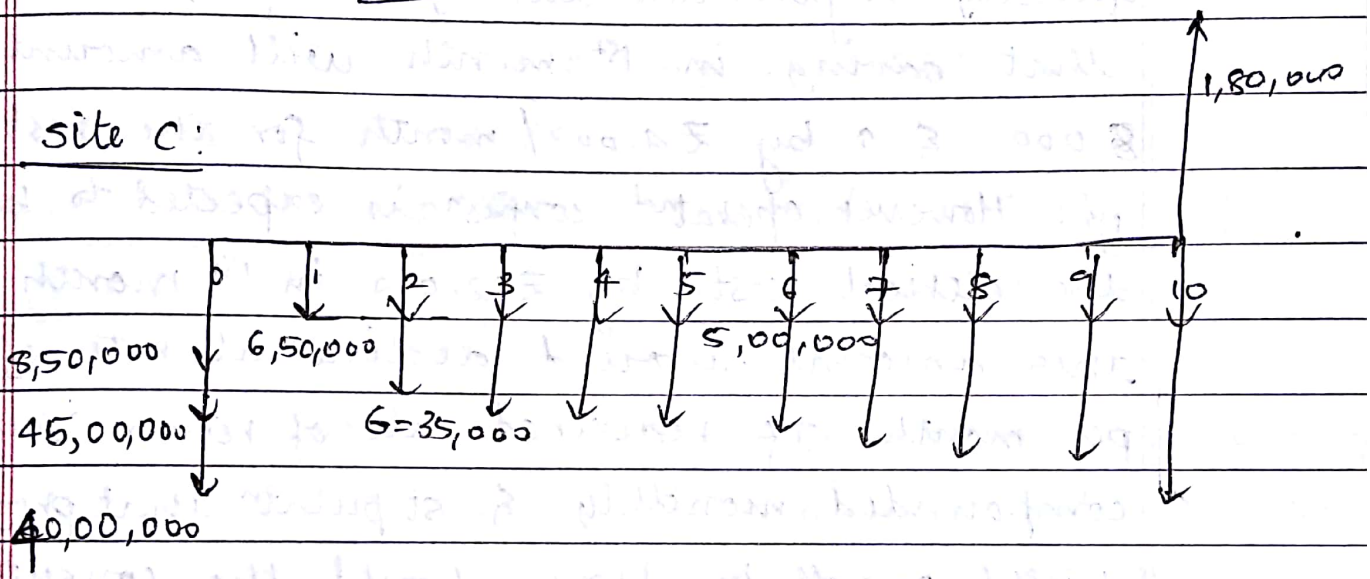
Site A :



$EUAC_A = 10,50,000(A/P,10,10) + 35,00,000(A/P,10,10) + 2,00,000 + 6,50,000(A/G,10,10) + 30,000 - 3,50,000 \times (A/F,10,10)$

$= 2648629.57$

site C:

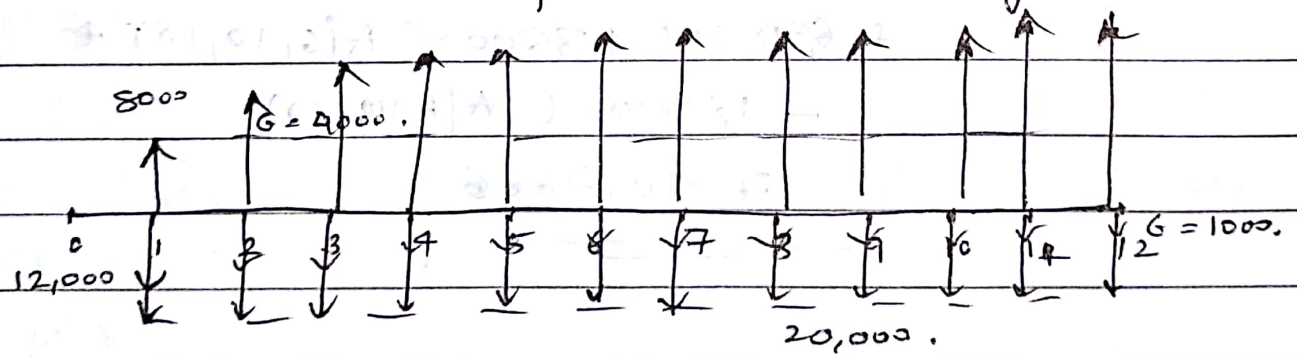


$EUAC_A = 93,50,000 \times (A/P,10,10) + 5,00,000 + 6,50,000 + 35000(A/G,10,10) - 180,000(A/F,10,10)$

$= 27,90,7666.$

(3) A consulting firm proposes to provide a self inspectn training for clerks who work with insurance claim. The program last for 1yr & cost 20,000 / month. & professor to improve service quality. A potential user of the program estimates that saving in 1st month will amount to ₹8,000 & ↑ by ₹4,000/ month for the rest of yr. However operatnl confusn is expected to boost the clerical cost by ₹12,000 in 1st month but this amount would decline at rate of ₹1,000 per month. If required rate of return is 12% compounded monthly & stipulatn that program should pay off in 1yr, should the consultant be hired?

i = 12% p.a compounded monthly



PP – monthly
CP – monthly

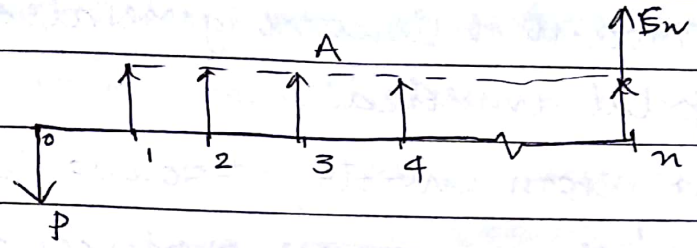
$$i = \left(\frac{r}{n}\right) = \frac{0.12}{12} = 0.01 \text{ or } 1\%$$

$$EAVC_A = 8000 + 4000\,(A/G, 1\%, 12) - \left[12000 - 1000\,(A/G, 1, 12)\right] - 20,000.$$

$$= -1691 - 16195 + 2905$$

∴ should be hired.

V CAPITAL RECOVERY WITH RETURN



$P = C_0$

S_n = salvage

A - annuity.

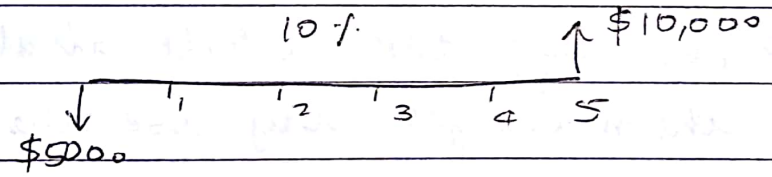
$$CR(i) = P(A/P, i, n) - S_n(A/F, i, n)$$

$$(A/F, i, n) = (A/P, i, n) - i.$$

$$CR(i) = P(A/P, i, n) - S_n[(A/P, i, n) - i]$$

$$\boxed{CR(i) = (P - S_n)(A/P, i, n) + S_n i.}$$

(1) An asset with a 1st cost of \$5,000 has an estimated service life of 5 yrs & estimated salvage value of \$1000. For an $i = 10\%$, what is capital recovery with return?



$$CR(i) = (5000 - 1000)(A/P, 10, 5) + 1000 \times 0.1$$

$$= +4000 \times 0.2638 + 1000 \times 0.1$$

$$CR(i) = \$1155.2$$

(ROR)

VI RATE OF RETURN METHOD / RETURN ON INVESTMENT (ROI)

It is amount of income generated in an year in the capital invested.

For ex, is a person invests ₹50,000 to start a company & after one yr the company produces a profit of 2500 then ROR is 2500/50,000 = 5%.

Types of ROR:

① MARR (Minimum Acceptable/Attractive Rate of Return)

Lowest level of return at which the investment is acceptable & is set by the top management.

Ex: Suppose that a manager knows that investg in an alternative such as bond/FD yields a known ROR (6% say) then while analyzing a new project, the manager may use the return of investg in bond as MARR (6%). The manager will only implement the project if its anticipated ~~result~~ return is atleast equal or more than return from investg in bond.

② IRR (Internal Rate of Return)

The IRR for a project is defined as the ROR at which the present value of cash inflow and cash outflows are equal or the rate at which the

investment breaks even.

IRR allows manager to rank project easily. The project with highest IRR is preferred.

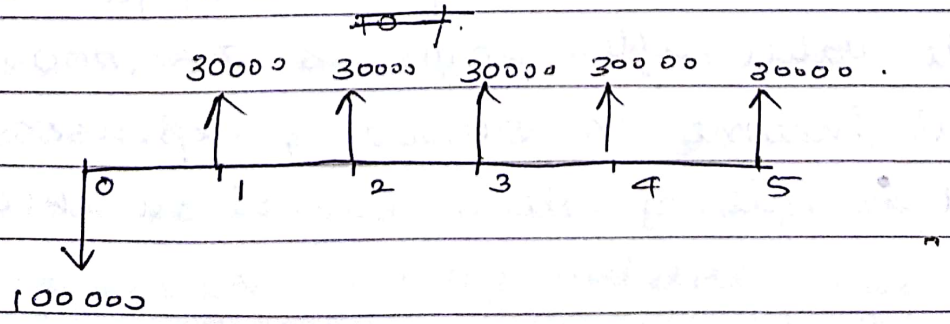
Easy of comparison makes IRR attractive.

③ ERR (External Rate of Return)

It is the possible ROR for an investment under the given economic condition.

① A person is planning a new business. The initial outlay & cashflow pattern for new business are as listed below. The expected life of business is 5yr. Calculate IRR.

Period	Cashflow.
0	− 100000
1	30000
2	30000
3	30000
4	30000
5	30000.



$$-100000 + 30000 \times (P/A, i, 5) = 0$$

$$3.33 = (P/A, i, 5)$$

$$i = 15\%$$

$$\frac{+100000}{30,000} = \frac{(i+1)^5 - 1}{i(i+1)^5}$$

$$3.33 = \frac{(i+1)^5 - 1}{i(i+1)^5}$$

$i = 10\%$

$3.33 \neq 3.79$

$i = 15\%$

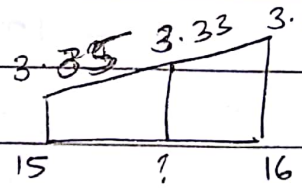
~~$3.33 = 3.35$~~

$i = 16\%$

~~$i = 16\%$~~

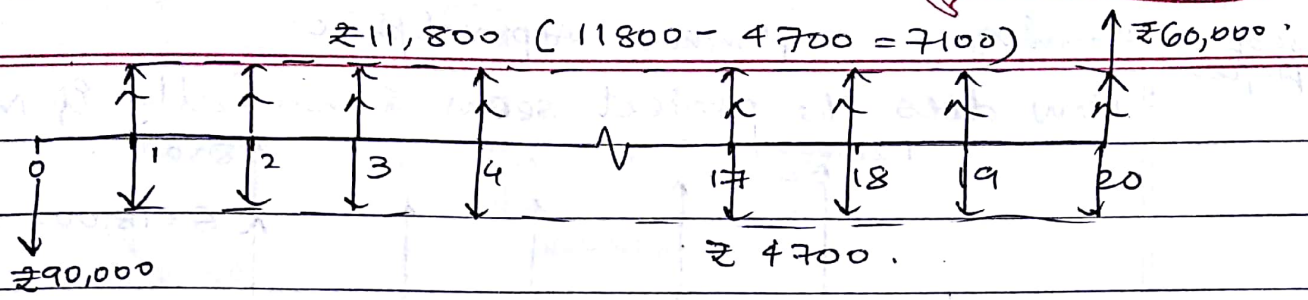
~~$3.43 \neq 3.27$~~

16	—	3.27
?	—	3.33
15	—	3.35



$i = 15.5\%$

(2) A farm house can be purchased for ₹90,000 & resale value after 20 yrs is ₹60,000. If annual rental income is ₹11,800 & expenses ₹4,700. What is rate of return earned on this farmhouse.



$(P/F, i, 20)$

$-90,000 + 7100(P/A, i, 20) + 60000 = 0$

~~$7100 (P/A, i, 20) = 4.22$~~

~~$\frac{(1+i)^5 - 1}{i(1+i)^5} = 4.22$~~

~~At 10%. $i = 3.79$~~ ~~RHS = 3.79~~

~~At 8%~~ ~~RHS = 3.99~~

~~At 6%~~ ~~RHS = 4.21~~

~~At 5%~~ ~~RHS = 4.32~~

~~RHS = 4.22~~

~~$i = 5\%$~~ ~~4.32~~

? ~~4.22~~

~~$i = 10\%$~~ ~~4.21~~

$i = 7.5\%$

$i = 5\%$ 21095

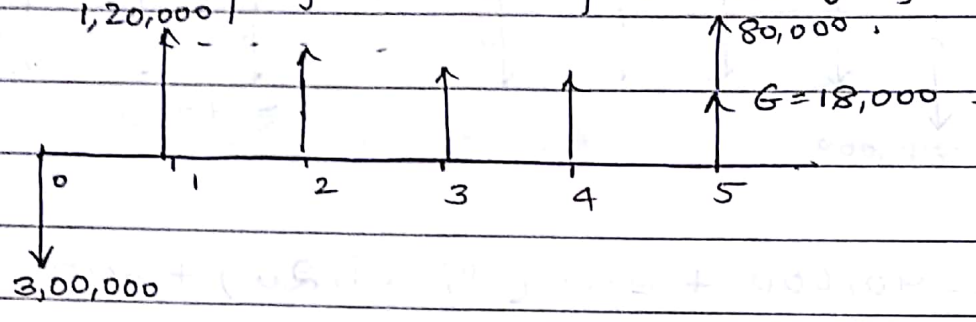
$i = ?$

$i = 10$ -20635.

(3) A oil company has purchased an oil well by paying 3,00,000. Field engineers estimates that net receipt will be $1,20,000 during 1st yr with reduct^n of $18,000 in following yrs. It plans to sell the well after 5 yrs for $80,000.

	PW/FW/CC	AW	IRR
Interpretation	Expenditure	Working capital	—
Level of management	Lower level/ML	LL/ML	Top management
Phase of project	Planning	Implementation	Approval phase.

How does the project seem financially if MARR = 20%?



$$-3,00,000 + [120,000 (A/G, i, 5)](P/A, i, 5) + 80,000 \times (P/F, i, 5) = 0$$

~~18000~~

$i = 10\%$

~~2638346.04~~ 81081.22

(MARR) $i = 20\%$

2723

$i = 30\%$ 0

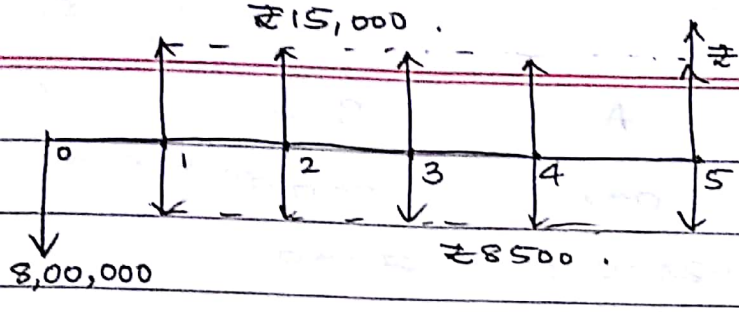
-51469

IRR = 20.5%

IRR > MARR.

∴ Project is feasible.

④ A patch of land is likely ↑ in value. Cost of land now is ₹8,00,000 & expected to be ₹15,00,000 within 5 yrs. During this period, it can be rented for small scale industry at ₹15,000/yr. Annual taxes are ₹8,500 & are likely remain constant. What ROR will be earned on the investment if estimates are accurate?



$$-8,00,000 - 8500\,(P/A, i, 5) + 15000\,(P/A, i, 5) + 15,00,000\,(P/F, i, 5) = 0.$$

$i = 10\%$ 220438.5 155991.5

$i = 15\%$ − 32412

IRR = 14.1%.

Limitations of IRR method:

Case I: ₹ 90,000 MARR = 16%,

Project	A	B
Investment	-₹50000	-₹85,000.
IRR	35%	29%

Overall ROR $= \frac{50000 \times 0.35 + 85000 \times 0.29}{90000}$ (A) $= 26.56\%$

Overall ROR = 28.3% (B)

By inspection project A seems better because of higher IRR but overall ROR (B) is greater. ∴ IRR can't be used. (It is due to different investment on 2 projects).

Case 2: ₹ 5000 MARR = 10%.

Project	A	B
0	-1000	-5000
1	2000	7000
PW	₹818	₹1364.

$PW(A) = -5000 + 2000/(0.1)^1$

$= -5000 + [2000 + 4400] (P/F, 10, 1)$

$= -1000 + 2000/1.1 = 818//$

$PW(B) = -5000 + \left[\frac{7000}{1.1}\right] = ₹364$

$IRR_{(A)} = 100\%.$

$IRR_{(B)} = 40\%.$

Even though IRR of A of is better than B. But decisn should be taken on present worth ∴ Proj is preferred.

Since IRR method is doesnot give proper results for above 2 cases. Incremental analysis is implemented.

Incremental analysis

A project C with investment ₹4000 & return 5000.

C

-4000

+5000

IRR = 25%.

↑ 5000 (5000-1000)

4000

$-4000 + \frac{5000}{(1+i)^1} = 0$

$i = 25\%.$

$\Delta_{IRR} = 25\%$.

Instead of the investing amount at MARR = 10%, it is invested at 25%, Making project B feasible.

* If $\Delta_{IRR} > MARR$, Project B. (project with higher initial investment)

Decision rules:

(1) If $\Delta_{IRR} > MARR$, select a project with ↑ initial project.

(2) If $\Delta_{IRR} < MARR$, select a project with lower initial project.

(3) If $\Delta_{IRR} = MARR$, select any project.

(1) A college student wants to start a small scale painting business during his ofs school hours. To economise his startup, he purchases used painting items. He has 2 opt^ns

option 1: Do most of the painting by himself by limiting his business to residential jobs.

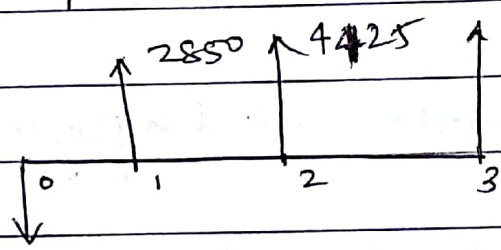
opt^n 2: Purchase some painting equipment & hire some helpers to do some residential & commercial jobs. In either case, he expects to fold up business in 3yrs.

Cashflows are given below. MARR = 10%.

n	B_1	B_2
0	-3000	-12000
1	1350	4200
2	1800	6225
3	1500	6330
IRR	25%	17.43%

* Unequal initial investment & IRR, use incremental analysis.

* If project IRR is more than MARR, adopt incremental analysis.



PW eqn.

$$-9000 + 2850 \times (P/F, i, 1) + 4425 (P/F, i, 2) + 4830 (P/F, i, 3) = 0.$$

$i = 15\%$

ΔIRR > MARR, Select project with higher investment B_2.

(2) Consider the following 3 sets of mutually exclusive alternative. Which project would you select based on ROR on incremental investment (MARR = 15%)

n	D_1	D_2	D_3
0	-2000	-1000	-3000
1	1500	800	1500
2	1000	500	2000
3	800	500	1000

* Investg extra in next highest alternative is feasible is checked.

IRR	34.47%	40.76%	24.81%

∴ Compare D_1 & D_2 (2nd & 3rd highest investment)

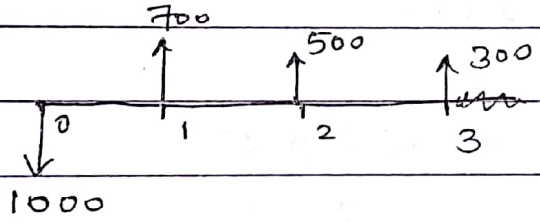
$D_1 - P_2$

-1000

700

500

300



$$-1000 + \frac{700}{(i+1)^1} + \frac{500}{(1+i)^2} + \frac{300}{(1+i)^3} = 0.$$

i = 10%	274.98
i = 20%	
i = 25%	33.6
i = 27%	7.
i = 28%	-4.89.

i = 27	7	$\frac{27-28}{28-x} = \frac{7+4.89}{-4.89-0}$
i = ?	0	
i = 28	-4.89	$28-x = \frac{1 \times (+4.89)}{7+4.89}$

$28 - x = +0.411$

$\Delta IRR\ D_1 - P_2\ x = 27.6 // > 15\%.$

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↑ investment.

Compare (1) & (3)

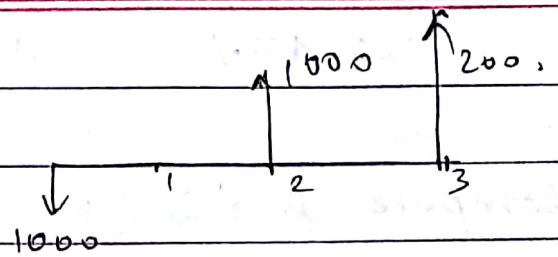
$D_3 - D_1$

1000

0

1000

200



$$-1000 + \frac{1000}{(i+1)^2} + \frac{200}{(1+i)^3} = 0$$

10 % = − 23.

8 % = 16.105.

8	—	16.105
x	—	?
10	—	− 23.

$$\frac{10-8}{x-8} = \frac{16.105 + 23}{0 - 16.105}$$

$$\frac{2}{x-8} = \frac{39.105}{16.105}$$

$$x - 8 = +0.82$$

$$x = 8.82$$

$\Delta IRR_{D_1 - D_3} = 8.82 < 15\%$

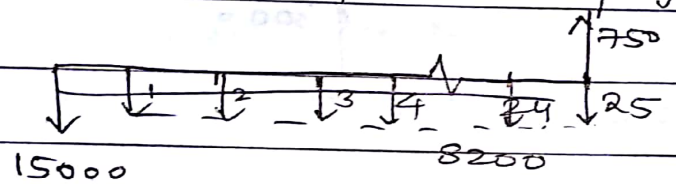
∴ D_1 is selected.

③ Select the best alternative using incremental ROR

MARR = 10%.

Year	Alt A	Alt B
0	−15000	−21000
1−25	−8200	−7000
25	+750	+1050

~~Calculate IRR for each project~~,



~~−15000 − 8200 (P/A, i, 25) + 750 (P/F, i, 25) = 0.~~

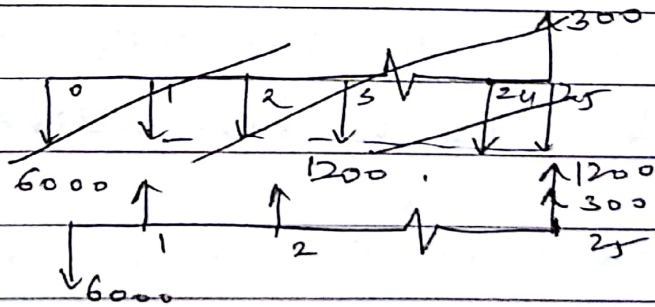
~~i = 15%.~~ ~~− 67982~~

~~i = 10%.~~

IRR cannot be calculated because no return.

A − B.

−6000
+1200
300



$-6000 + 1200\,(P/A, i, 25) + 300\,(P/F, i, 25) = 0.$

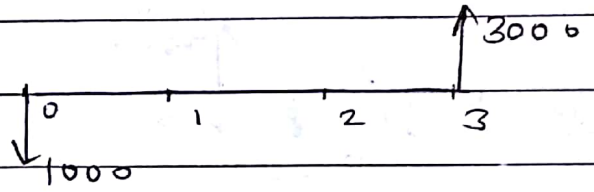
i = 10%	~~+6864.77~~	4920.09.
i = 15%	1765.92	
x: i = 20%	−59.25	$15 + \frac{(x-15)\times(1765.92)}{(59.25+1765.92)}$

$x = 19.82\% > 10\%.$

∴ Alt B.

④ Select best alternative. if MARR = 10 %.

n	E_1	E_2	E_2 (LCM ~~action~~ method)	$E_2 - E_1$.
0	-2000	-3000	-3000	~~-1000~~ -1000
1	1000	4000	4000 -3000	0
2	1000		4000 -3000	0
3	1000.		4000.	3 000



$$-1000 + \frac{3000}{(i+1)^3} = 0.$$

~~i = 10 %~~.

$$3 = (1+i)^3$$

$$(i+1) = \sqrt[3]{3}$$

$$i = 44.22\ \%.$$

E_2 is best alternative.

Replacement analysis

Replace an existing equipment

To determine when asset (in service) should be replaced by a more economical alternative

1) Loss
2) Quality degrades
3) Production may come to a halt
4) Maintainance cost ↑s (annuity)

* Application of annual worth method.

Reasons for replacement

* More efficiency * New technology * ↓ in quality * ↑ maintainance * Outdated technology

① Deterioration (wear & tear, high manufacturing cost, ↑ maintainance, higher rejection rates, degrading quality).

② Obsolescence (new development, order asset moves ways accompanying objectives, less appealing)

③ Inadequacy (when current operatⁿ conditions change, an order asset occasionally lacks capacity to meet new requirements)

Basic Terminologies

① Physical life of an asset: Time period upto which

we are prepared to keep the obsolete asset in service (may not be efficient working life) of vintage case.

② Economic life of an asset.

Time period spent to use machine in less time after which we save money by replacing the asset

③ Sunk cost

Cost incurred by past actions & not relevant to decisions because they cannot be changed.

₹35000 + ₹5000 to keep car working → ₹32,000.

Sunk cost : inforce cost, but doesnt affect decisions

Sunk cost = Present book value − Present Market value
(actual value)

= 35000 − 32000 = ₹3000

General Nature

1. Defender : Existing Ad asset to be replaced.
2. Challenger : Asset proposed to be replaced.

Methods

1. Outsider's point of view (the defender is sold for market value)
2. Cash flow approach (the dd cost of defender is only considered ~~on roof~~ no initial cost considered)
3. Economic life. * here the defender is sold & used for challenger)

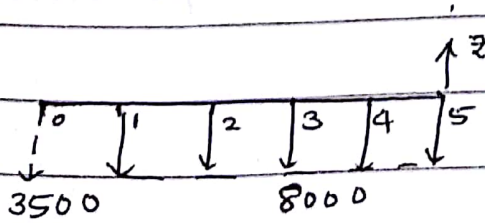
Outsider's Point of view

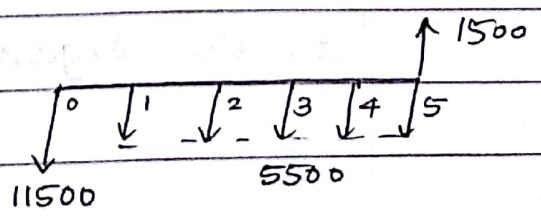
① A company purchased machine x a year ago for ₹ 8500 with following:
Estimated life = 6 yrs.
Salvage value = ₹ 1000
Operating expenses = ₹ 8000 / year
At end of 1st year, a salesman offers machine Y for ₹ 11500 which has:
Estimated life = 5 yrs
Salvage value = ₹ 1500.
Operating cost = ₹ 5500 / year due to improvement.
Salesman offers ₹3500 for machine X if machine Y is purchased.
This appears ~~less~~ low to the company but best offer received now here is only ₹ 3000.
Assume i = 8%, Determine best course of action by taking outsider's point of view.

→* Outsider's pov can be used when remaining life of defender is equal / unequal to the life of the challenger.

Analyzing for 5 years

Defender MKX 8% Challenger MKY





Management chooses we cant go with X (no additional investment) ∴ Outsider's Point of view is reqd.

X → no initial cost ∵ 1 year ago it was bought

So ~~use~~ we take market value, ₹8500 isnot applicable

↳ ₹3500 / ₹3000 (to maximize gain)

From 3rd person point of view, evaluat^{n} of alternatives

① EUAC = 8000 + 3500 (A/P, 8, 5) − 1000 (A/F, 8, 5)

= ₹8706.25

② EUAC = 5500 + 11500 (A/P, 8, 5) − 1500 (A/F, 8, 5)

= ₹8125 (least).

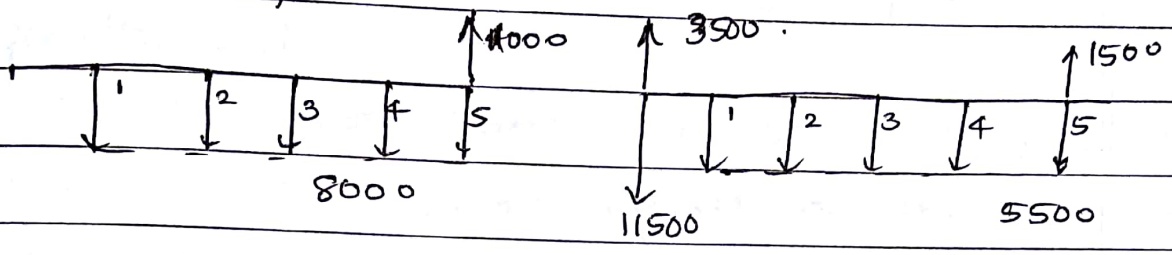
Saving = ₹581.25

Same decision we be conveyed

Cash Flow Approach / Insider's Point of view

This method is applicable only when the remaining life of defender = life of the challenger. It is based on the fact that if challenger is selected, the defender's market value is a cash inflow for the challenger and if defender is selected there is no actual expenditure of cash to the organisation.

Here, the defender's first cost is taken as zero & the market value of defender is subtracted from challenger's first cost



(1) EAUC = 8000 − 1000 (A/F, 8, 5) = ₹7829.5

(2) EAUC = 5500 + 11500 (A/P, 8, 5) − 3500 (A/P, 8, 5) − 1500 (A/P, 8, 5)

= ₹7248.25 → least.

saving = ₹581.25

Decision doesn't change w.r.t method.

Economic life of an asset :

The cost of owning & operating an assest can be divided into 2 categories: (1) Capital cost (2) operatng cost.

Capital cost have 2 components : Initial investment & salvage value at the time of investment. The annual equivalent of capital cost called capital recovery with return over a period of n yrs can be calculated,

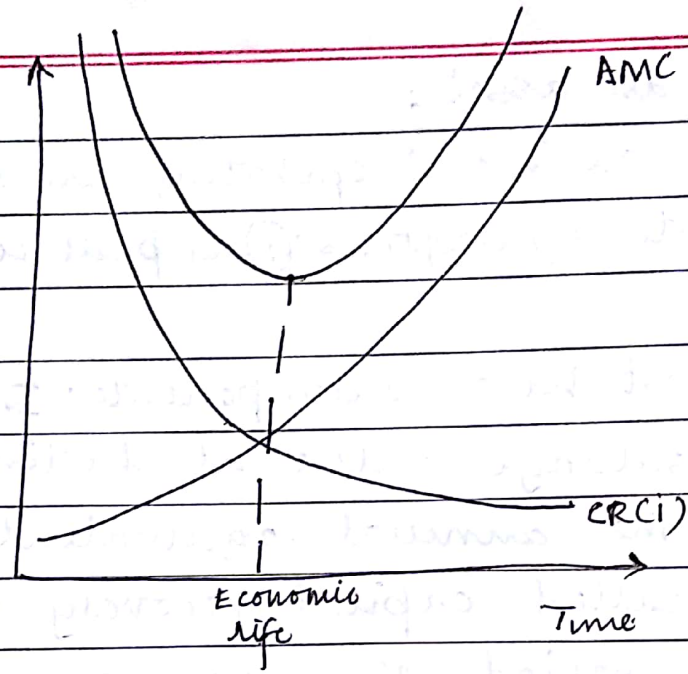
$$CR(i) = (P - S_n)(A/P, i, n) + S_n i \quad \text{---(1)}$$

The operatng cost of an asset include the maintainance cost, labour cost, material cost etc For the same equipment, the labour & material cost are constant for a given level of product^n. However the maintainance cost tend to ↑ as the asset ages. Because of the ↑ing trend of maintainance cost, the total operatg cost of the asset ↑s, as it ages. The operatg cost can be expressed as,

$$OC(i) = \sum_{n=1}^{N} OC_n (P/F, i, n)(A/P, i, n) \quad \text{---(2)}$$

The total annual cost of ownning & operatg the asset is the summat^n of capital recovery cost & the operatg expenses.

Cost ↓s over many yrs' ∴ More opportunities to repay the debt.



The economic life of an asset is the period of useful life that minimizes the total annual equivalent cost of owning & operating the asset.

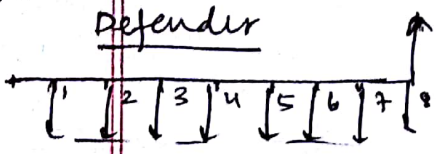
(1) A machine has a 1st cost of ₹1,30,000. The anticipated salvage value & annual operating cost for next 5 yrs are as given. Determine economic life if i=10%.

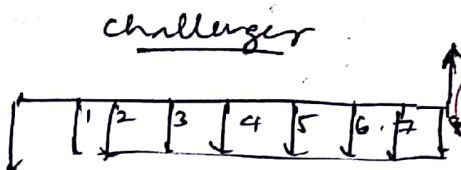
n	Salvage value	AOC
1	90000	25000
2	80000	27000
3	60000	30000
4	20000	35000
5	0	45000

n	$CR(Ci) = (P-S_n)(A/P,i,n)+Si$	$OC(Ci) = \sum_{n=1}^{N} (OG_n(P/F,i,n))(A/P,i,n)$	$TC(Ci) = CR(Ci) + OC(Ci)$
1	$(130000-90000)\times(A/P,10,1)$ $+90000\times0.1$ $=53000$	25000	78000
2	$(130000-80000)(A/P,10,2)$ $+80000\times0.1$ $=36810$	$\left(25000\times(P/F,i,n)+27000\times(P/F,i,2)\right)$ $\times 0.5762 \hookrightarrow (A/P,i,2)$ $=25952.22$	62762
3	34147	27173.63	61320 ✓
4	36705	28863	65567
5	34294	~~26153~~ 31504	65798

Economic life = 3 yrs

FWh



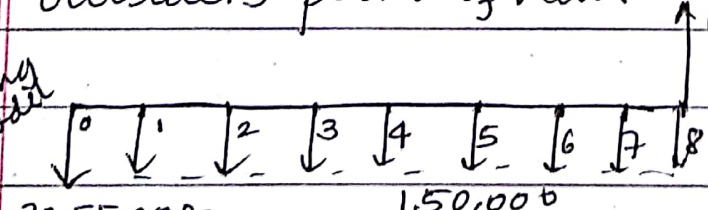


When outsider pov, it is evaluatn of alternatives, so the market value of ₹29,50,000 is considered.

② A construct^n company had purchased a piece of construct^n equipment 3 yrs ago at a cost of ₹ 40,00,000. Estimated life & salvage value at the time of purchase were 12 yrs & 8,50,000. Operat^g & maintainance cost was ₹1,50,000. The construct^n company is now considering replacing of exist^g model by new model. Due to depreciat^n, the present book value of exist^g equipment is ₹30,55,000. Current market value of existing equipment is ₹29,50,000 Revised estimate of salvage value & remaining life are ₹6,50,000 & 8 yrs. Annual operat^g & maintainance cost are same.

Initial cost of new model = ₹35,00,000, estimated life & salvage value, annual operat^g cost are 8yrs, ₹9,00,000, ₹1,25,000. If i=10 % p.a, should the company retain old equipment or buy new model. Use Outsiders pov & cash flow method.

→ Outsider's point of view:



Market value is considered in outsider's pov (Outsider's is buying for market value)

$EAC = 30,55,000\,(A/P,10,8) + 1,50,000 - 6,50,000\,(A/F,10,8)$

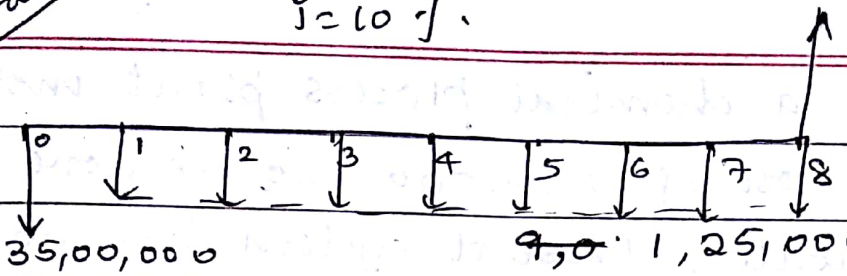
$= 29,50,000 \times 0.1874 + 1,50,000 - 6,50,000 \times 0.0874$

$= 646020$

$= ₹\ 6656\,97$ //

New model

$i = 10\%$



EAUC = 35,00,000 (A/P, 10, 8) + 125,000 − 9,00,000 (A/F, 10, 8)

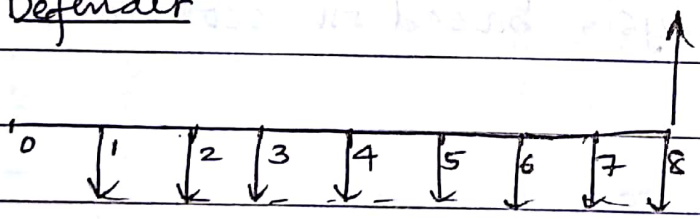
= 35,00,000 × 0.1874 + 125000 − 9,00000 × 0.0874

= 792,240

∴ Existing

Cash flow approach

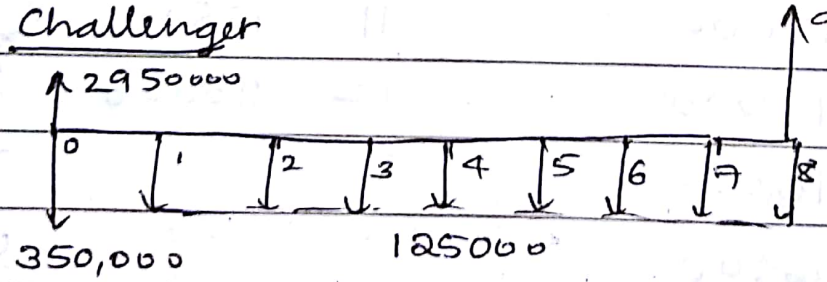
Defender



EAUC = 150,000 − 650000 (A/F, 10, 8)

= 93140

Challenger



EAUC = 550000 (A/P, 10, 8) + 1250000 − 900,00 · (A/F, 10, 8)

= 56 220

(3) 3 yrs ago a chemical process plant installed a system at cost of $ 20,000 to remove pollutants from waste water. Present system has no present salvage value & will cost $ 14,500 to operate in the next yr with operating cost expected to ↑ @ rate of $500/yr thereafter.

The new system designed to replace existing system at a cost of $10,000. New system is expected to have 1st yr operating cost of $9,000 with these cost ↑s @ rate of $1000/yr. The new system is estimated to work for 12 yrs before break down. Salvage value of the system at any future time is zero. If i = 12% p.a, conduct replacement analysis based on economic life of the asset.

→ Defender:

n	AOC	n	
1	14500	10	19000
2	15000	11	19500
3	15500	12	20000
4	16000		
5	16500		
6	17000		
7	17500		
8	18000		
9	18500		

(Sunk cost)

Defender

n	CR(i) = (P − Sn)(A/P, i, n) + Sn i	OC(i) = $\sum_1^n$ OC(P/F, i, n)(A/P, i, n)	TC
1	—	= 14500 ~~× (P/F, 12, 1)(A/P, 12,~~	14500 ✓
2	—	= 14500 (P/F, 12, 1) + 15000 (P/F, 12, 2) (A/P, 12, 2)	
		= [14500 × 0.8929 + 15000 × 0.7972] × 0.5917 =	14736

Challenger

1	10000 × 1.1200 × 0.5917 = ~~0.5917~~ 11200	9000	~~9000~~ ~~14917~~ 20200
2	= ~~0.5917~~ 10000 × 0.5917 = ~~0.5917~~	[9000 × 0.8929 + 10000 × 0.7972] × 0.5917 = 9417.99	15 336.99
3	10000 × 0.4163 = 4163	[9000 × 0.8929 + 10000 × 0.7972 + 11000 × 0.7118] × 0.4163	
5	1000 × 0.2774 = 2774	10774.24	13548.24

Economic life of defender = 1 yrs. Cost @ 1 yr = 14500

" " " challenger = 5 yr Cost @ 5 yr = 13548.24 ✓

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DEPRECIATION

Reduction in value of an asset over a period of time.

Types of depreciation: "physical impairment"

(1) Physical depreciatn: ↓ in cost due to wear & tear.

(2) Functnal " : ↓ in cost due to better technology (obsolescence)

* Depreciatn is ~~accessed~~ used for tax. reduce tax.
received as part of business expenses - that

Depreciatn is taken in account when tax amount is determine (Revenue - (cost + depreciatn)
= Net profit → determines tax to be paid]

* Salvage value is calculated from book value (minor value) after deducting depreciatn.

Book value for current yr, $B_1 = B_{t-1} - D_t$ → Depreciatn. cost for current yr.
↳ book value for previous yr.

If $B_{t-1} = ₹3,00,000$.

D_t = 10 % of ₹3,00,000.

B_t = 300000 − 30000 = ₹2,70,000

Three methods to determine depreciatn:

(1) Straight line method (3) Double declining balance method.

(2) Declining balance method

Straight line method:

Depreciatn amount is constant.

Straight line depreciation assumes that value of an asset decreases by constant amount as the asset ages. Annual depreciation is given by

$$\frac{\text{Purchase price} - \text{Salvage value}}{\text{Years of useful life}} = \text{Annual depreciatn } (D_t)$$

① A person started a small business by purchasing a machine. First cost $25000. Useful life is 5yrs. Salvage value is $5000. Make a straight line depreciatn schedule for D_t every yr.

$$D_1 = \frac{25000 - 5000}{1} = \$20000.$$

$$D_2 = \frac{25000 - 5000}{2}$$

$$D_3 = \frac{25000 - 5000}{3} = D_t = \frac{25000 - 5000}{5} = 4000$$

$$D_4 = \frac{25000 - 5000}{4} =$$

$$D_5 = \frac{25000 - 5000}{5} =$$

n	Value before Depreciatn	Depreciatn amount	Value of after depreciatn
1	25000	4000	21000.
2	21000	4000	17000
3	17000	4000	13000
4	13000	4000	9000
5	9000	4000	5000 [Salvage value]

(2) A person started a small business. He bought some machinery worth $25,000 for the new business. Useful life of this asset is 7yrs & salvage value is $4000. Make a straight line depreciatn schedule showing book value & depreciatn value every yr.

$D_t = 3000$

Value before depreciatn	D_t	After depreciatn
25000	3000	22000
22000	3000	
19000		
16000		
13000		
10000		
7000		4000.
~~4000~~		

DECLINING BALANCE METHOD

1) Method assumes that an asset ↓s in value at a faster rate in early portn of the service life than in the later portn of its life.

End of yr	Depreciatn charge during yeart	Book value at end of yr, t
0	—	$P = B_0$
1	$R \times B_0 = R \times P$	$B_0 - R \times B_0 = (1-R)B_0$ $= (1-R)P = B_1$
2	$R \times B_1 = R(1-R)P$	$(1-R)B_1 = (1-R)^2 P = B_2$
3	$R \times B_2 = R(1-R)^2 P$	$(1-R)B_2 = (1-R)^3 P = B_3$
:		
t	$R \times B_{t-1} = R(1-R)^{t-1} P$	$(1-R)B_{t-1} = (1-R)^t P = B_t$
:		
n	$R \times B_{n-1} = R(1-R)^{n-1} P$	$(1-R)B_{n-1} = (1-R)^n P = B_n$

$$B_n = (1-R)^n P$$

$$\frac{B_n}{P} = (1-R)^n$$

$$\left(\frac{B_n}{P}\right)^{1/n} = 1-R$$

$$\boxed{R = 1 - \left(\frac{B_n}{P}\right)^{1/n}}$$

① An asset costs ₹ 5000 now & salvage value is 1000 at end of its service life & R = 30% per yr. Determine depreciatn charges for 3 yrs & its book value at end of each year.

P = 5000 S_n = 1000 R = 30%.

Year	Depreciation charge during t	Book value at end of yr $B_0 = (1-R)^n P$
0	—	5000 (B_0)
1	~~5000~~ 1500 ($B_0 \times R$)	~~3500~~ B_1 = 3500 ($1-R \times B_0$)
2	~~3500~~ 1050 ($B_1 \times R$)	2450 (B_2) ($(1-R) B_1$)
3	735 (0.3×2450)	$(1-0.3) \times 2450 = 1715$ (~~B3~~)

(2) An asset purchased for ₹2,50,000. It has an expected life of 10 yrs & S_n = 50000 at end of 10th yr. What will undepreciated amount of capital remaining in asset at end of 6th yrs. If asset is depreciated according to declining balance method. Also calculated the depreciation charge for 6th yr.

$$R = 1 - \left(\frac{B_n}{P}\right)^{1/n}$$

$$= 1 - \left(\frac{50000}{250000}\right)^{1/10} = 14.86\%.$$

B_t (for 6 yrs)

DOUBLE DECLINING BALANCE DEPRECIATN.

Annual rate of decrease = 2/years of useful life.

(1) An asset was purchased 10 yrs ago for ₹500,000. It is depreciated according to DDB for estimated life of 20 yrs. Salvage value is 50,000. Calculate current book value.

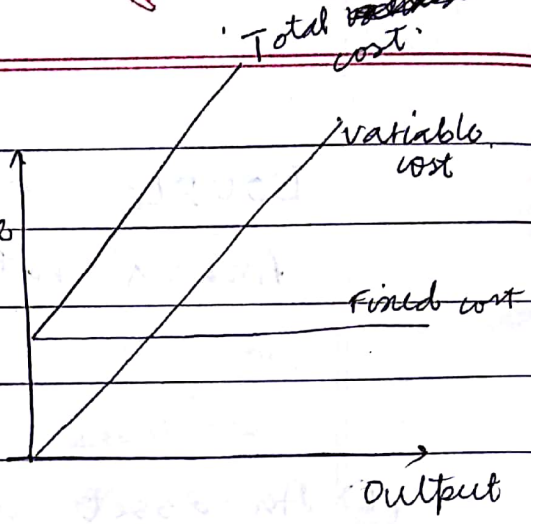
$$R = 2/20 = 10\%.$$

$$B = (1-R)^{10} P = ₹17433.92$$

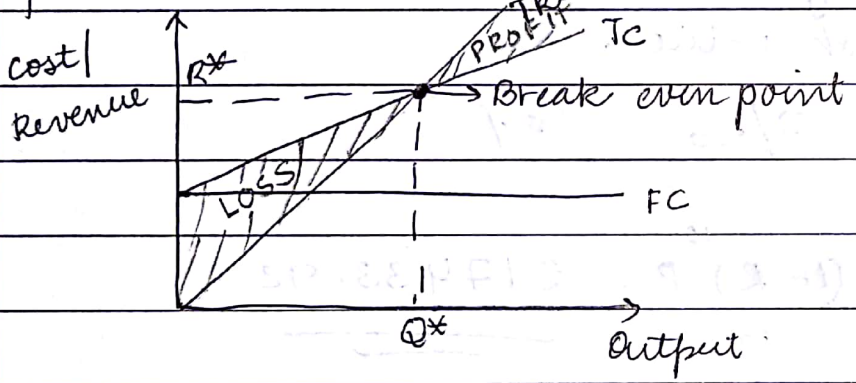
Break-even analysis

Cost → ① Fixed cost (FC)
② Variable cost (VC)

Total cost TC = FC + Q * VC.



* The variable cost line is not shown in the graph for break even analysis.



TR → Total Revenue

Break even point : Total cost = Total revenue.

Value of x-intercept of break even pt → Q^*.

Q^* → For this output, no revenue.

Output > Q^*, profit.

Output < Q^*, loss.

Value of y-intercept → R^*.

R^* – total cost generated to generate break-even.

Break even point is that point of activity where total sales revenue & total expenses are equal. It is the point of zero profit. It is a pt where losses cease to occur while profits have not yet begun.

In case the firm produces & sells less than the break even pt, it would incur losses, while if it produces & sells more than level of break even point it makes profit.

It reveals the relatnship b/w the volume & cost of productn on one hand and revenue & profit obtaind from the sales on the other hand. It captures the relatnship b/w FC, VC & TR.

Terminology

Let Q be the units of output or actual output.

Q_B → break even quantity.

P → selling price or price per unit.

TR → Total Revenue. $TR = P \times Q$.

TFC → Total fixed Cost,

TC → Total cost. $TC = FC + Q \times VC$.

According to Maritz, Curry & Frank, break even pt is the level of activity where total cost = total revenue.

$$TR = TC$$

$$P \times Q = FC + Q \times VC$$

$$(P - VC)\,Q = FC$$

Break even quantity, $\boxed{Q^* = \dfrac{FC}{(P - VC)}}$

(1) A ship ~~company~~ can carry a max of 1,00,000 passengers / month at a fee ₹850. Variable cost / passenger is ₹100 while fixed cost are ₹75,00,000 / month. Calculate (1) Break even quantity. (2) Break even sales value.

$$Q^* = \frac{FC}{(P - VC)} = \frac{75,00,000}{(850 - 100)} = 10,000$$

Break even sales value $R^* = 10,000 \times 850$

$= ₹85,00,000$

(2) A manufacturer sells his product at ₹5 each. The variable cost are ₹2 / unit & fixed cost amount to ₹60,000. (1) Calculate break even point (2) What would be the profit if firm sells 30,000 units (3) what would be break even pt if firm spends ₹3,000 on advertising

$$Q^* = \frac{FC}{(P - VC)} = \frac{60,000}{(5 - 2)} = 20000$$

$10000 \times (5 - 2)$ ₹30000

Profit = ~~10,000 × 5 - 50,000~~

$30,000 = 60000$

$(P - 3)$

$20 P = 3$

$P = 5$

$$Q^* = \frac{60000 + 30000}{(5-2)} = 21000$$

Contribution

To determine health of firm.

Diff/ b/w SP & VC.

Break even analysis from Engineering Economics Perspective

Often, we have a choice b/w 2 alternatives where one of them may seem economical under one set of conditns & other under another set. By altering the values of some variables & holding others constant, it is often possible to find value for variable which makes 2 alternatives equally economical. This values may be described as break even pt.

Mathematically,

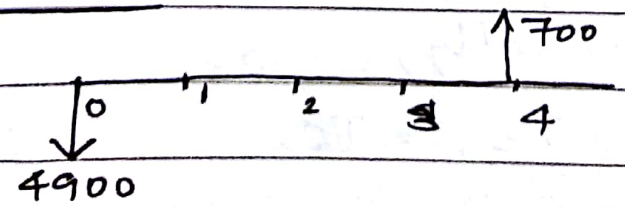
$$TC_1 = TC_2.$$

① A 50 HP motor is reqd to drive a pump to remove water from a tunnel. The unit will be needed for a period of 3yrs. 2 alternatives are under considerdtn. A calls for constructn of power line & purchase of electric motor at TC of $4,900. Salvage value of this equipment after 4 yrs is estimated to be $700. Cost of power for per hour operation is estimated to be $2.9 & maintainance is estimated as $420/yr. Alternative B calls for purchase of a diesel pump set at a cost of $1925 & it will have no salvage at the end of 4yr. Cost of diesel per hour of Operatn is estimated as $1.47 maintainance is estimated at $0.53/hr of operatn. Cost of wages chargable when the engine runs is $2.8/hr.

① How many hours per year the 2 machines have to run so that the 2 alternative incur equal cost? ② If no/ of hours of operatn is estimated at 100/yr, which alternative is economical. Consider rate of interest 10%.

→

Alternative A



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0.3155

$AW_1 = (4900 - 700)(A/P, 10, 4) + 700 \times 0.1$
$+ 2.94x - 420$

$AW_1 = 1815.1 + 2.94x$.

$AW_2 = 1925 \times (A/P, 10, 4) + 1.47x \times x$
$+ 0.53 \times x$
$+ 2.8x$

$= 607.3375 + 4.8x$.

$AW_1 = AW_2$.

$1815.1 - 607.3375 = -2.94x + 4.8x$

$x = 635.66$ hrs.

(2)

$AW_1 = 1815.1 + 2.94x$ → 100

$= \$2109.1$

$AW_2 = 607.335 + 4.8x$ → 100

$= \$1087.335$ ✓