salvage value → money received after selling a used product.

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Comparison of Alternatives:

1. Present worth method.
2. Future worth method.
3. Annual worth method.
4. Rate of return method.
5. Cost Benefit Analysis.

Present worth method:

In case of one project.

★ $NPW(i\%) = PW(B) - PW(C)$.

If $NPW > 0$, project will be selected.
If $NPW < 0$, project will be rejected.
If $NPW = 0$, project may or may not be selected.

★ In case of mutually exclusive project.

Methods:

1. Revenue Based method.
2. Cost Based method.

Revenue Based method.

It refers to that method where all types of benefit i.e profit, revenue, income or earning and salvage value will be assigned with +ve sign and all type of cost i.e payment or investment will be assigned with -ve sign.

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Cost Based Method.

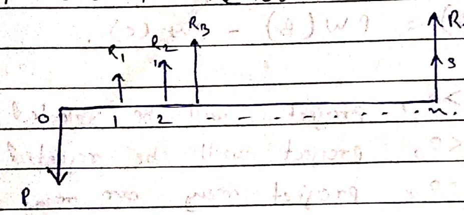
It refers to that method where all types of benefit will be assigned with -ve sign and cost will be assigned with -ve sign.

Comparison of Alternatives.

~~Present worth am method~~

(1) Revenue based method.

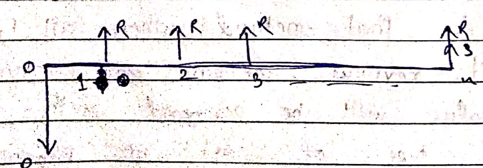
~~Present worth method~~. 1. Different series.



$$NPW(i\%) = -P + \overset{F}{R_1}\left[\frac{1}{(1+i)^1}\right] + R_2\left[\frac{1}{(1+i)^2}\right] + R_3\left[\frac{1}{(1+i)^3}\right]$$

$$+ \cdots + R_n\left[\frac{1}{(1+i)^n}\right] + S\left[\frac{1}{(1+i)^n}\right].$$

2. Equal Payment series.



$$NPW(i\%) = -P + \overset{A}{R}\left[\frac{(1+i)^n - 1}{i(1+i)^n}\right] + \overset{F}{S}\left[\frac{1}{(1+i)^n}\right].$$

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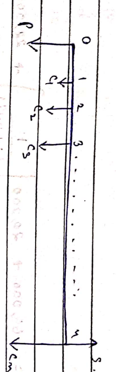
Cost Based Method:

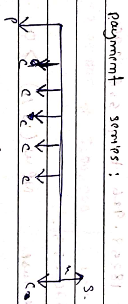
* Different series :



$$NPW\,(i\%) = P + C_1\left[\frac{1}{(1+i)^1}\right] + C_2\left[\frac{1}{(1+i)^2}\right] + \cdots$$

$$\cdots\ C_n\left[\frac{1}{(1+i)^n}\right] - S\left[\frac{1}{(1+i)^n}\right].$$

* Equal payment series :



$$NPW\,(i\%) = P + \overset{A}{C}\left[\frac{(1+i)^n - 1}{i(1+i)^n}\right] - \overset{R}{S}\left[\frac{1}{(1+i)^n}\right].$$

Q) From the following table find out project will be selected or rejected if i = 18 % compounded anually.

End of year	cash flows
0	− 65,000
1	20,000
2	22,000
3	30,000
4	36,000

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Solⁿ:

$$NPW\,(i\%) = -P + R_1\left[\frac{1}{(1+i)^1}\right] + R_2\left[\frac{1}{(1+i)^2}\right] + \cdots$$

so,

$$NPW\,(i\%) = -65{,}000 + 20{,}000\left[\frac{1}{(1+0.18)}\right] + 22{,}000\left[\frac{1}{(1+0.18)^2}\right]$$

$$+ 30{,}000\left[\frac{1}{(1+0.18)^3}\right] + 36{,}000\left[\frac{1}{(1+0.18)^4}\right]$$

$$\Rightarrow NPW\,(i\%) = -65000 + 16949.152 + 15800.057$$

$$+ 18258.926 + 18568.399.$$

$$\Rightarrow 4{,}576.53.$$

selected because $NPW\,(18\%) > 0$.

Q) From the following table find out the project is financially feasible or not on the basis of present worth method if i = 20% compounded anually.

End of year	cash flows.
0	−40,00,000
1	5,00,000
2	5,00,000
3	5,00,000
4	5,00,000
5	5,00,000
6.	"
	"

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7	"
8	"
9	"
10	"
11	"
12	"
13	"
14	"
15	"

Sol^n:

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

$$\Rightarrow -40,00,000 + 5,00,000\left[\frac{(1+0.2)^{15} - 1}{0.2\,(1+0.2)^{15}}\right]$$

$$\Rightarrow -166\,2263.679$$

It is not feasible because,

$$NPW(20\%) < 0.$$

Q) From the following table ~~wht~~ which ~~the~~ technology will be selected from Present worth Method if $i = 16\%$ compounded annually.

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Technology	initial outlay	Annual income	life in yrs.
1	10,00,000	5,00,000	15 yrs
2	18,00,000	7,00,000	15 yrs
3	16,00,000	6,00,000	15 yrs.

* revenue based method

Sol^n: Technology 1:

NPW (16%)

$$-10,00,000 + 5,00,000\left[\frac{(1+0.16)^{15} - 1}{0.16\,(1+0.16)^{15}}\right].$$

$$\Rightarrow 17,87,7282.081.$$

Technology 2:

NPW (16%).

$$= -18,00,000 + 7,00,000\left[\frac{(1+0.16)^{15} - 1}{0.16\,(1+0.16)^{15}}\right].$$

$$\Rightarrow 21,02,819.314$$

Technology 3:

NPW (16%)

$$= -16,00,000 + 6,00,000\left[\frac{(1+0.16)^{15} - 1}{0.16\,(1+0.16)^{15}}\right]$$

$$\Rightarrow 17,43,273.198.$$

So, Tech. 2 will be selected because it has greatest PW

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From the following table find which machine will be selected by Present worth method if i = 17% compounded anually.

Machine	Initial cost	Service life in yrs	Annual op^n & maintenance cost	salvage value.
A	6,00,000	20 yrs.	35,000	15,000.
B	7,00,000	20 yrs.	40,000	12,000

sol^n : machine A :

$$NPW(17\%) = 6,00,000 + 35,000\left[\frac{(1+0.17)^{20}-1}{0.17(1+0.17)^{20}}\right] - 15,000 \times \left[\frac{1}{(1+0.17)^{20}}\right].$$

$$\Rightarrow NPW(17\%) = 7,96,322.664$$

machine B :

$$NPW(17\%) = 7,00,000 + 40,000\left[\frac{(1+0.17)^{20}-1}{0.17(1+0.17)^{20}}\right] - 12,000 \times \left[\frac{1}{(1+0.17)^{20}}\right].$$

$$NPW(17\%) = 9,24,591.339$$

Machine A will be selected because cost on machine A is less.

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Future worth Method.

* In case of one project :

$$NFW(i\%) = FW(B) - FW(C).$$

If NFW > 0, project will be selected
If NFW < 0, project will be rejected
If NFW = 0, project may or may not be selected.

* In case of mutually exclusive projects :

☆ Revenue Based Method :

* Different series :

$$NFW(i\%) = -P(1+i)^n + R_1(1+i)^{n-1} + R_2(1+i)^{n-2} + \dots$$
$$\dots + R_n + S$$

* Equal payment series.

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

☆ Cost Based Method :

* Different series.

$$NFW(i\%) = P(1+i)^n + C_1(1+i)^{n-1} + C_2(1+i)^{n-2} + \dots$$
$$\dots + C_n - S.$$

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★ Equal payment series.

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

Q) From the following table find out which alternative will be selected on the basis of future worth method, if i = 13% compounded anually.

Particulars	Alternative A	Alternative B
initial cost.	4,00,000	6,00,000.
uniform annual benefit	64,000	96,000.
useful life (yrs)	15 yrs	15 yrs.

soln: Alternative A:

$$NFW(13\%) = -4,00,000(1+0.13)^{15} + 64,000\left[\frac{(1.13)^{15} - 1}{0.13}\right]$$

$\Rightarrow NFW(13\%) = 85009.573.$

Alternative B:

$$NFW(B\ 13\%) = -6,00,000(1.13)^{15} + 96,000\left[\frac{(1.13)^{15} - 1}{0.13}\right],$$

$\Rightarrow NFW(13\%) = 127514.36.$

Alternative B will be selected because NFW(13%) for B > A.
(annual benefit is more).

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Q) From the following table find out which machine will be selected on the basis of future worth method if i = 11% compounded anually

Particulars	machine 1	machine 2	machine 3
initial investment	80,00,000	70,00,000	90,00,000
life (yrs)	17 yrs	17 yrs	17 yrs
Annual op^n & maintainance cost	8,00,000	9,00,000	8,50,000.
salvage value	5,00,000	4,00,000	7,00,000.

soln: machine 1:

$$NFW(11\%) = 80,00,000(1.11)^{17} + 8,00,000\left[\frac{(1.11)^{17} - 1}{0.11}\right] - 5,00,000.$$

$= 8,22,61,415.91$

machine 2:

$$NFW(11\%) = 70,00,000(1.11)^{17} + 9,00,000\left[\frac{(1.11)^{17} - 1}{0.11}\right] - 4,00,000$$

$= 8,09,16,409.48.$

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Q) From the following table find out which machine will be selected on the basis of future worth method if $i = 11\%$ compounded annually.

Particulars	machine 1	machine 2	machine 3
initial investment	80,00,000	70,00,000	90,00,000
life (yrs)	17 yrs	17 yrs	17 yrs
Annual op^n & maintenance cost	8,00,000	9,00,000	8,50,000.
salvage value	5,00,000	4,00,000	7,00,000.

sol^n: machine 1:

$$NFW(11\%) = 80,00,000\,(1.11)^{17} + 8,00,000\left[\frac{(1.11)^{17}-1}{0.11}\right] - 5,00,000.$$

$$= 8,2361,415.91$$

machine 2:

$$NFW(11\%) = 70,00,000\,(1.11)^{17} + 9,00,000\left[\frac{(1.11)^{17}-1}{0.11}\right] - 4,00,000$$

$$= 8,09,16,407.48.$$

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machine 3:

$$NFW(11\%) = 90,00,000\,(1.11)^{17} + 8,50,000\left[\frac{(1.11)^{17}-1}{0.11}\right] - 7,00,000$$

$$= 9,01,81,550.76.$$

~~Machine 3 with~~

Machine 2 will be selected because cost will be less.

Q) From the following table find out which alternative will be selected on the basis of future worth method if $i = 12\%$ compounded annually.

Particulars	Alternative 1	Alternative 2
First cost	15,00,000	20,00,000.
Annual property taxes	70,000	90,000
Annual income	5,00,000	7,00,000
life (yrs)	15 yrs	15 yrs.
net annual income	4,30,000	6,10,000.

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solⁿ:

$$NFW(12\%) = -15,00,000\,(1.12)^{15} + 4,30,000\left[\frac{(1.12)^{15}-1}{0.12}\right]$$

$$NFW(12\%) = 78,19,928.665$$

$$NFW(12\%) = -20,00,000\,(1.12)^{15} + 6,10,000\left[\frac{(1.12)^{15}-1}{0.12}\right]$$

$$NFW(12\%) = 1,17,93,94924.42$$

Alternative 2 will be selected.

Q) from the following table find out which machine will be selected on the basis of FWM, if $i = 16\%$ compounded anually.

Particulars	Machine A	Machine B
initial cost	5,00,000	7,00,000
life (yrs)	7 yrs	7 yrs.
salvage value	1,00,000	2,00,000.
Annual maintainance cost	30,000	0

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solⁿ: machine A:

$$NFW(16\%) = 5,00,000\,(1.16)^{7} + 30,000\left[\frac{(1.16)^{7}-1}{0.16}\right] - 1,00,000$$

$$\Rightarrow NFW(16\%) = 16,55,526.067.$$

machine B:

$$NFW(16\%) = 7,00,000\,(1.16)^{7} - 2,00,000.$$

$$\Rightarrow 17,78,353.814$$

Machine A will be selected.

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Annual Worth Method / Annual Equivalent Method

* In case of one project:

$$NAW(i\%) = AW(B) - AW(C).$$

If NAW > 0, project will be selected.
If NAW < 0, project will be rejected.
If NAW = 0, project ~~will be~~ may or may not be selected

* In case of mutually exclusive projects.

* ~~Different series.~~

* Equal payment series: (Revenue based method)

$$NAW(i\%) = -P\left[\frac{i(1+i)^n}{(1+i)^n-1}\right] + \overset{A}{R} + S\left[\frac{i}{(1+i)^n-1}\right].$$

* ~~B~~ Cost based method.

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

* Different series:

$$NAW(i\%) = NPW\left[\frac{i(1+i)^n}{(1+i)^n-1}\right]$$

same for both revenue and cost based method.

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Q) From the following table find out which technology will be selected on the basis of annual equivalent method if i = 18% compounded annually.

Particulars	Technology A	Technology B
Initial cost	5,00,000	3,00,000.
End of Year	cash inflows year end	Cash inflows year end.
1	10,000	~~15,000~~ 15,000
2	20,000	30,000
3	30,000.	0
4	45,000.	0.

Sol^n: Technology A:

$$NAW(i\%) = \left\{-5,00,000 + 10,000\left[\frac{1}{(1.18)^1}\right] + 20,000\left[\frac{1}{(1.18)^2}\right] + 30,000\left[\frac{1}{(1.18)^3}\right] + 45,000\left[\frac{1}{(1.18)^4}\right]\right\} \cdot \left[\frac{0.18(1.18)^4}{(1.18)^4-1}\right].$$

$$\Rightarrow -4,35,692.30 \times \left[\frac{0.18(1.18)^4}{(1.18)^4-1}\right]$$

$$\Rightarrow -1,61,963.676.$$

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Technology B :

$$NAW(18\%) = \left\{ -3,00,000 + 135000\left[\frac{1}{1.81^1}\right] + 30,000\left[\frac{1}{1.8^2}\right] \right\} \cdot \left[\frac{0.18 \times (1.18)^2}{(1.18)^2 - 1}\right]$$

$\Rightarrow -425,220.18$

∴ Technology A will be selected

∵ $NAW_A(18\%) > NAW_B(18\%)$

Q. From the following which machine will be selected on the basis of AEM, if i = 20% compounded anually.

Machine	Down Payment	Yearly equal installment	No. of installments
1	5,00,000	2,00,000	15
2	4,00,000	3,00,000	15
3	6,00,000	1,50,000	15

Machine 1 :

$$NAW(20\%) = 5,00,000\left[\frac{0.20(1.20)^{15}}{(1.20)^{15} - 1}\right] + 2,00,000$$

$\Rightarrow NAW(20\%) = 3,06,941.059$

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Machine 2 :

$$NAW(20\%) = 4,00,000\left[\frac{0.20(1.20)^{15}}{(1.20)^{15} - 1}\right] + 3,00,000.$$

$\Rightarrow NAW(20\%) = 3,85,552.847$

Machine 3 :

$$NAW(20\%) = 6,00,000\left[\frac{0.20(1.20)^{15}}{(1.20)^{15} - 1}\right] + 1,50,000.$$

$= NAW(20\%) = 2,78,329.271.$

machine 3 will be ~~not~~ selected, because cost is minm.

(Q) From the following table find out which alternative will be selected on the basis of AWM if i = 25% compounded anually. and life of both a the alternative is 5 yrs

Particulars	Alternative A	Alternative B
Investment	1,50,000	1,75,000.
Annual equal return	60,000	70,000.
Salvage value	15,000	35,000.

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Soln:

Alternative A:

$$NAW(25\%) = -1,50,000\left[\frac{(1.25)^5\,(0.25)}{(1.25)^5-1}\right] + 60,000$$

$$+ 15,000\left[\frac{0.25}{(1.25)^5-1}\right]$$

$$NAW(25\%) = 6050.69$$

Alternative B:

$$NAW(25\%) = -175000\left[\frac{(1.25)^5 \times (0.25)}{(1.25)^5-1}\right] + 70,000$$

$$+ 35,000\left[\frac{0.25}{(1.25)^5-1}\right]$$

$$NAW(25\%) = 9191.456$$

As return from alternative B is more so B will be selected.

(c) From the following table find out which machine will be selected on the basis of annual equivalent method if i = 22% compounded annually.

Particulars	Machine A	Machine B
Initial cost	3,00,000	6,00,000
Life in yrs	10 yrs	10 yrs
Salvage value	2,00,000	3,00,000
Annual maintenance	30,000	0

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Soln: Machine A:

$$NAW(22\%) = 3,00,000\left[\frac{(1.22)^{10}\cdot(0.22)}{(1.22)^{10}-1}\right] + 30,000$$

$$- 2,00,000\left[\frac{0.22}{(1.22)^{10}-1}\right]$$

$$\Rightarrow NAW_A(22\%) = 99,489.498$$

machine B:

$$NAW(22\%) = 6,00,000\left[\frac{(1.22)^{10}\cdot(0.22)}{(1.22)^{10}-1}\right] - $$

$$3,00,000\left[\frac{0.22}{(1.22)^{10}-1}\right]$$

$$\Rightarrow NAW_B(22\%) = 1,42,468.494$$

~~$NAW_A(22\%)$~~ ∴ machine A is selected because

$$NAW_A(22\%) < NAW_B(22\%)$$

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Rate of Return Method :

Types of Return.

① Minimum acceptable rate of return / Minimum attractive rate of return. (MARR).

② Net Present value (NPV)

③ Internal Rate of Return (IRR).

Minimum Acceptable Rate of Return

It refers to the lower limit of project acceptability beyond which if rate of return falls project will be rejected.

Net Present value : (NPV).

It refers to the addition of present values of all the future stream of benefits during the life span of a project.

Internal Rate of Return

It refers to the rate of return which equales the present value of benefit

If NPW $\neq$ 0.

IRR = (Interest rate of the last positive result) + (the difference between the two interest rate). { +ve value

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IRR = (Interest rate of the last +ve result) + (Difference b/w the two interest rate) × $\left[\frac{\text{+ve value} - \text{salvage value}}{\cancel{\text{+ve value} - (\text{-ve value})}}\right]$.

* Selection or rejection of the project:

If IRR > MARR, Project will be selected.

If IRR < MARR, Project will be rejected.

If IRR = MARR, project may or may not be selected

Q) From the following table find out the investor should go with the new bus or not on the basis of RRM. if MARR is 10%.

	cash flows
0	-1,00,000
1	30,000
2	30,000
3	30,000
4	30,000
5	30,000.

Sol:

$$NPW = -P + R\left[\frac{(1+i)^n - 1}{i(1+i)^n}\right] + 0.$$

$$\Rightarrow -100000 + 30,000\left[\frac{(1+0.1)^5 - 1}{0.1(1+0.1)^5}\right] = 13723.60.$$

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$$\Rightarrow NPW(12\%) = -1,00,000 + 30,000\left[\frac{(1+0.12)^5 - 1}{0.12(1+0.12)^5}\right]$$

$$\Rightarrow NPW(12\%) = 8143.286.$$

$$NPW(15\%) = 564.65.$$

$$NPW(17\%) = -1771.19.$$

$$\therefore IRR = 15\% + 2\% \times \left[\frac{564.65 - 0}{564.65 + 1771.19}\right].$$

$$\Rightarrow IRR = 15.48\%$$

The investors may go with the new business because IRR > MARR.

(?) A company is trying to diversify its buss. in a new product line. the life of the project is 10 yrs with no salvage value at the end of its life, the initial outlay of the project is 20,00,000 Rs annual cash inflow is 3,50,000. Rs. Find the rate of return for the new business.

Sol: Taking MARR as 10%.

$$NPW(10\%) = -P + R\left[\frac{(1+i)^n - 1}{i(1+i)^n}\right].$$

$$\Rightarrow -20,00,000 + 3,50,000\left[\frac{(1.1)^{10} - 1}{0.1(1.1)^{10}}\right]$$

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$$NPW(10\%) = 150598.487 \text{ Rs.}$$

$$NPW(11\%) = 61231.2039 \text{ Rs}$$

$$NPW(12\%) = -22421.94 \text{ Rs.}$$

$$\therefore IRR = 11\% + 1\% \times \left[\frac{61231.2039 - 0}{61231.203 + 22421.94}\right]$$

$$= 11.738\%$$

$$= 11.7\%$$

6) From the following table find out rate of return for all the alternatives and find out which alternative ~~which~~ will be selected on the basis of RRM if MARR is 12%.

Particulars.	Alternative A1	Alternative A2	Alternative A3
Investment	1,50,000	2,10,000	2,55,000
Annual net income	45,570	58,200	69,000
n (in yrs).	5 yrs	5 yrs	5 yrs

Sol: Alternative A1.

$$\Rightarrow NPW(12\%) = -1,50,000 + 45,570\left[\frac{(1+0.12)^5 - 1}{0.12 \times (1+0.12)^5}\right]$$

$$\Rightarrow NPW(12\%) = 14269.651.$$

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$IRR_{A_1} = 15.8\%$
$IRR_{A_2} = 12\%$
$IRR_{A_3} = 11\%$

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$NPW(13\%) = 10280.228$
$NPW(14\%) = 6445.0499$
$NPW(15\%) = 2757.707$
$NPW(16\%) = -790.438$

$$IRR = 15\% + 1\% \times \left[\frac{2757.707}{2757.707 + 790.438}\right]$$

$IRR = 15.77\%$

Alternative A2 :

$$NPW(12\%) = -2,10,000 + 58,260 \left[\frac{(1.12)^5 - 1}{0.12 \times (1.12)^5}\right].$$

$\Rightarrow 14.261\%$

$NPW(13\%) = -5086.106.$

$$IRR = 12\% + 1\% \times \left[\frac{14.261 + 0}{14.261 + 5086.106}\right]$$

$\Rightarrow 12\%.$

Alternative A3.

$$NPW(12\%) = -2,55,000 + 69,000 \left[\frac{(1.12)^5 - 1}{0.12 \times (1.12)^5}\right].$$

$\Rightarrow -6270.44.$

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$NPW(11\%) = 16.894.$

$$\therefore IRR = 11\% + 1\% \times \left[\frac{16.894}{16.894 + 6270.44}\right].$$

$\Rightarrow IRR = 11.00\%$

Alternative A2 will be selected because it has more rate of ~~IR~~ return i.e 15.77%.

~~Benefit~~ Cost ~~Analysis~~ :

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Benefit Cost Analysis:

★ Selection or rejection of the project:

Benefit cost ratio:

$\frac{B}{C} = \frac{\text{Present value of Benefit}}{\text{Present value of cost}} = \frac{PW(B)}{PW(C)}$.

If $\frac{B}{C} > 1$, project will be selected

If $\frac{B}{C} < 1$, project will be rejected

If $\frac{B}{C} = 1$ then project may or may not be selected.

Q) From the following table find out which project will be selected on the basis of B/C ratio.

Project.	Present worth of Benefit	Present worth of cost
1	60,00,000.	40,00,000
2	80,00,000	20,00,000
3	90,00,000	35,00,000

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Sol^n) $\left(\frac{B}{C}\right)_1 = \left[\frac{PW(B)}{PW(C)}\right] = 1.5$

$\left(\frac{B}{C}\right)_2 = \left[\frac{PW(B)}{PW(C)}\right] = 4.$

$\left(\frac{B}{C}\right)_3 = \left[\frac{PW(B)}{PW(C)}\right] = 2.57$

Project 2 will be selected ($\because$ B/C ratio is more)

Q) In a particular locality of a state, the vehicle users take around about root to reach certain places because of presence of a river, this results in excessive travel time and increased fuel cost. So the state government is planning to construct a bridge across the river. The estimated initial investment for constructing the bridge is 40,00,000. The estimated life of the bridge is 15 yrs. The annual maintenance and op^n cost is 1,50,000. The value of fuel savings due to the construction of the bridge is 6,00,000 Rs in first yr. and it increases by 50,000 Rs every year there after till the end of the life of the bridge. Check whether the project is justified based on BC ratio by assuming an interest rate of 12% compounded anually.

Ans: initial investment = 40,00,000

life = 15 yrs, R = 1,50,000.

Benefit = 6,00,000.

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sol^n:

★ $PW(C) = 40,00,000 + 1,50,000 \left[\frac{(1+0.12)^{15}-1}{0.12(1.12)^{15}}\right]$

Cost = ~~4150006.814~~ 5021629.673

★ $A_1 = 6,00,000.$

$G = 50,000.$

$A(B) = 6,00,000 + 50,000\left[\frac{1}{0.12} - \frac{15}{(1.12)^{15}-1}\right].$

$A(B) = 849015.169.$

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

$\Rightarrow 849015.169\left[\frac{(1+0.12)^{15}-1}{0.12\times(1+0.12)^{15}}\right].$

$\Rightarrow 5782527.266.$

$\frac{B}{C} = \frac{5782527.266}{5021629.673} = 1.15$

∴ Project justified because $B/C > 1$

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State government is planning a hydro electric project in addition of to the production of electric power, this project will provide flood control, irrigation and recreation benefits, the estimated benefits and cost are given as follows

Initial cost → 8 crore.

Annual power sales → 60,00,000. Rs.

Annual flood control savings → 30,00,000.

Annual irrigation benefits. → 50,00,000.

Annual recreation benefits → 20,00,000.

Annual operating & maintenance cost → 30,00,000

Life of project → 50 yrs.

$i = 15\%.$

Check whether the government should implement the project or not on the basis benefit cost analysis.

sol^n:

$PW(C) = 8,00,00,000 + (30,00,000 ~~30,00,000~~) \times \left[\frac{(1.15)^{50}-1}{0.15\,(1.15)^{50}}\right].$

$\Rightarrow PW(C) =$ ~~119963088~~ Rs. 99981543.98.

~~PW(B)~~ $PW(B) = A = 1,60,00,000.$

$PW(B) = 1,60,00,000\left[\frac{(1+0.15)^{50}-1}{0.15\,(1+0.15)^{50}}\right].$

$= 106568234.6.$

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$\Rightarrow \frac{PW(B)}{PW(C)} = \frac{10656 8234.6}{9998 1543.98}$

$\Rightarrow 1.06.$

$\therefore$ Project must be implemented.

$\because PW(B) / PW(C)$ is > 1.

(Q) Two mutually exclusive projects are being considered for investment, project A_1 requires an initial outlay of 30,00,000 with net receipts estimated as 9,00,000 Rs per year for the next 5 years. The initial outlay for the project A2 is 60,00,000 and net receipts have been estimated as 15,00,000 Rs per year for the next 7 yrs. Using B/C ratio. find out which project will be selected if i = 10% compounded anually.

Sol^n: Project A1:

$PW(C) = 30,00,000.$

$A = 9,00,000.$

$PW(B) = 9,00,000 \times \left[\frac{(1.1)^5 - 1}{(1.1)^5 \times 0.1}\right].$

$\Rightarrow PW(B) = 3411708.092$

$\therefore B/C = \frac{3411708.092}{30,00,000} = 1.137$

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Project A 2 :

$PW(C) = 60,00,000.$

$PW(B) = 15,00,000 \left[\frac{(1.1)^7 - 1}{(1.1)^7 \times 0.1}\right]$

$= 7302628.227$

$B/C = \frac{7302628.227}{60,00,000}$

$\Rightarrow 1.217.$

Project A_2 will be selected $(B/C)_{A1} < (B/C)_{A2}$.

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Pay-Back Period Method :

★ In case of equal return.

$P = \frac{I}{C}$ — I → Initial investment.

C → yearly equal cash inflows.

Pay back year.

Q) Suppose an investor has invested 50,00,000 on a project for which he is getting equal return of 2,00,000 at the end of every years. Find out how many yrs it will take to the investor to get back his money, which he has initially invested with the help of pay-back period method.

sol^n: $P = I/C$

$\Rightarrow P = \frac{50,\cancel{00},\cancel{000}}{2,\cancel{00},\cancel{000}} =$

$\Rightarrow$ 25 years.

★ In case of different amount of return.

$\frac{\text{Remaining amount}}{\text{Next cash inflow}} \times 12$.

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Q One investor has invested 10,00,000 Rs on a project, the investor wants to purchase a machine for which there are two machines are available in the market find out which machine with will be selected on the basis of pay back period method.

End of year	cash inflow from machine -1	cash inflow from machine -2
1	1,00,000	2,00,000
2	3,00,000	4,00,000
3	5,00,000	4,50,000
4	7,00,000	5,60,000
5	8,00,000	7,00,000.

★ For machine -1.

number of ~~years~~ month = $\frac{1,00,000}{7,00,000} \times 12 = 1.7$

$\Rightarrow$ 2 month

Total time = 3 years 2 month.

★ For machine -2

number of months = $\frac{4,00,000}{4,50,000} \times 12 = 10.66$.

$\Rightarrow$ 11 months.

Total time = 2 yrs 11 months

Machine 2 will be selected because it requires less time.

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A government is planning ... for which estimated benefits and costs are given as follows.

Particulars	Project A	Project B	Project C
Initial cost	15 crore	25 crore	40 crore.
Annual operating and maintaince cost	20,00,000	25,00,000	35,00,000
Annual power sales.	1,00,00,000 ~~1 crore~~ ~~1,20,00,000~~	1,20,00,000	1,80,00,000.
Flood control saving	25,00,000	35,00,000	50,00,000
irrigation benefits	35,00,000	45,00,000	60,00,000
recreation benefits	10,00,000	20,00,000	35,00,000

Find out which project will be selected on the basis of B/c ratio of i = 9% compounded annually.

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soln: Project A:

$$PW(C) = 15,00,00,000 + 20,00,000\left[\frac{(1.09)^{50}-1}{0.09(1.09)^{50}}\right]$$

$\Rightarrow 171923365.8$ Rs.

$$PW(B) = 1,70,00,000\left[\frac{(1.09)^{50}-1}{0.09(1.09)^{50}}\right]$$

$\Rightarrow PW(B) = 186348609.3.$

$$\therefore B/C = \frac{186348609.3}{171923365.8} = 1.08.$$

Project B:

$$PW(C) = 25,00,00,000 + 25,00,000\left[\frac{(1.09)^{50}-1}{0.09(1.09)^{50}}\right]$$

$\Rightarrow 277404207.3.$

$$PW(B) = 2,20,00,000.\left[\frac{(1.09)^{50}-1}{0.09(1.09)^{50}}\right]$$

$\Rightarrow 241157023.8.$

$$\Rightarrow B/C = \frac{241157023.8}{277404207.3} = 0.869.$$

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Project C:

$$PW(C) = 40,00,00,000 + 35,00,000 \left[\frac{(1.09)^{50} - 1}{0.09(1.09)^{50}} \right]$$

$\Rightarrow PW(C) = 438365890.2$

$$PW(B) = 3,25,00,000 \left[\frac{(1.09)^{50} - 1}{0.09(1.09)^{50}} \right]$$

$\Rightarrow PW(B) = 356254694.3$ $\quad \therefore B/C = 0.812$

So, Project A is selected.

Q) From the following table find out a company should select which alternative on the basis of rate of return method If MARR = 12%.

Alternative	Initial investment	Yearly Revenue
1	5,00,000	1,70,000 ~~8,00,000~~
2	8,00,000	2,70,000

n=5

Soln: Alternative 1:

$$NPW(12\%) = -5,00,000 + 170,000 \left[\frac{(1.12)^5 - 1}{0.12(1.12)^5} \right]$$

$\Rightarrow NPW(12\%) = 112811.95$

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$NPW(13\%) = 97929.314$

$NPW(14\%) = 83628.704$

$NPW(15\%) = 69866.36$

$NPW(18\%) = 31619.07$

$NPW(20\%) = 8404.063$

$NPW(21\%) = -2582.662$

$$IRR = 20\% + 1\% \times \left(\frac{8404.063}{8404.063 + 2582.662} \right)$$

$= 20.76\%$

Alternative 2:

$$NPW(12\%) = -8,00,000 + 2,70,000 \left[\frac{(1.12)^5 - 1}{0.12(1.12)^5} \right]$$

$NPW(12\%) = 173289.57$

$NPW(13\%) = 149652.44$

$NPW(20\%) = 7465.297$

$NPW(21\%) = -9984.229$

$$IRR = 20\% + \left(\frac{7465.297}{7465.297 + 9984.229} \right) = 20.4278\%$$

$\Rightarrow$ Alternative 1 will be selected because IRR

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(6) From the following table find out which route will be selected on the basis of annual worth method if i = 15% compounded annually.

Particulars	route around the lake.	route under the lake
length	15 km	5 km
First cost	1,50,000	7,50,000.
useful life	15 yrs	15 yrs.
maintainance cost	6,000 $km^{-1} yr^{-1}$	12,000 $km^{-1} yr^{-1}$
Salvage value	90,000 km^{-1}	1,50,000 km^{-1}
yearly power loss	15,000 km^{-1}	15,000 km^{-1}

Solⁿ: Route around the lake :

P = 1,50,000

C = 6,000 $km^{-1} yr^{-1}$

⇒ ∴ C_{Total} = 6000 × 15 = 90,000

S = 90,000 km^{-1}

S_{total} = 90,000 × 15 = 1350000.

Yearly power loss = 15,000 km^{-1}

= 15000 × 15 = 2,25,000

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$$\therefore NAW(15\%) = 1,50,000\left[\frac{0.15\times(1.15)^{15}}{(1.15)^{15}-1}\right] + (90,000 + 2,25,000)$$

$$- 13,50,000\left[\frac{0.15}{1.15^{15}-1}\right].$$

⇒ NAW (15%) = 312,279.536

★ Route under the lake.

P = 7,50,000

C_{total} = 12,000 × 5

= 60,000

S = 1,50,000 × 5.

⇒ 7,50,000

loss = 75,000

$$\therefore NAW(15\%) = 7,50,000\left[\frac{0.15 \times 1.15^{15}}{1.15^{15}-1}\right] + (60,000 + 75,000)$$

$$- 7,50,000\left[\frac{0.15}{1.15^{15}-1}\right]$$

NAW (15%) = 247,500

Route under the lake will be selected because the cost is less.

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Production

It refers to the process of physical transformation of inputs into output.

Production Function:

It refers to the functional relationship between inputs and output.

$$Q = f(N, L, K).$$

$$Q = f(x_1, x_2, x_3, \ldots\ldots, x_n).$$

If there are n number of inputs.

★ **Factors of Production:**

Fixed factor.
Variable factor.

Fixed factor:
It refers to those factors which can't be changed or remain fixed during the process of production.
Eg: Plant size, big machines and land.

Variable factor:
It refers to those factors which can be changed during the process of production.
Eg: Labour and raw materials.

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Production time period:

★ Short period of production. (Short run)
→ Long period of production (Long run).

Short period.
It refers to that period of production where fixed factor can't be change but variable factor can be changed.

Long period.
It refers to that period of production where nothing is called fixed, all the factors are variable factors.

★ **Three Concepts of Production:**
→ Total Product (TP)
→ Marginal Product (MP)
→ Average Product (AP).

Total Product:
It refers to the total amount of output produced with a fixed amount of variable factors.

Marginal Product:
It refers to the net addition to the total product by employing one more unit of input.

$$MP_n = TP_n - TP_{n-1}.$$

If Labour is input

$$MP_L = \frac{d(TP)}{dL} = \frac{dQ}{dL}$$

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- If capital (K) is input.

$$MP_K = \frac{d(TP)}{dK} = \frac{dQ}{dK}.$$

Average Product :

It refers to the total amount of output produced per unit of a variable factor.

★ If L is the input.

$$AP_L = \frac{TP}{L} = \frac{Q}{L}.$$

★ If K is the input.

$$AP_K = \frac{TP}{K} = \frac{Q}{K}.$$

★ Theories of Production Function:

① Law of variable Production (eg. of short run)

② Law of return to scale (eg: of long run).

Law of variable Prodn

It is a short run prodn function which discusses the relationship b/w output and one variable input.

It refers to the prodn function where as equal ~~implem~~ increments of one input

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are added, the inputs of other productive services being held constant, the resulting increment of product beyond a certain point will decrease i.e marginal product will diminish (given by G. Stigler).

Assumptions of the theory :

★ The state of technology remain constant.

★ There must be some inputs whose quantities can be kept as fixed.

Unit of Labour used	Total Product	Marginal Product	Average Product.
1	80	80.	80
2	170	90	85
3	270	100	90
4	368	98	92
5	430	62	86
6	503	73	83.83
7	503	0	71.85.
8	495	-8	61.9
9	480	-15	53.33
10	430	-50	43.

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Units of labour	TP	MP	AP	Stage of operation
	because TP increases at an increasing rate			
1	80	80	80	Stage I
2	170	90	85	increasing
3	270	100	90	return
4	368	98	92	stage II
T.P increases at a diminishing rate 5	430	62	86	
6	480	50	80	Diminishing
7	503	23	71.8.	return
8	503	0	62.8.	
9	490	-13	54.4.	stage III
10.	485.	-5	48.5.	negative return.

Producer will want to produce in stage II because total capacity is utilised.

Q) From the following table find out Marginal product and AP, also find stages of operation

Units of labour used (L)	TP	MP	AP	
1	30	30	30	stage I
2	80	50	40	
3	140	60	46.67	I.R
4	190	50	47.5	stage
5	190	0	38	II D.R
6	180	-10	30	stage III N.R

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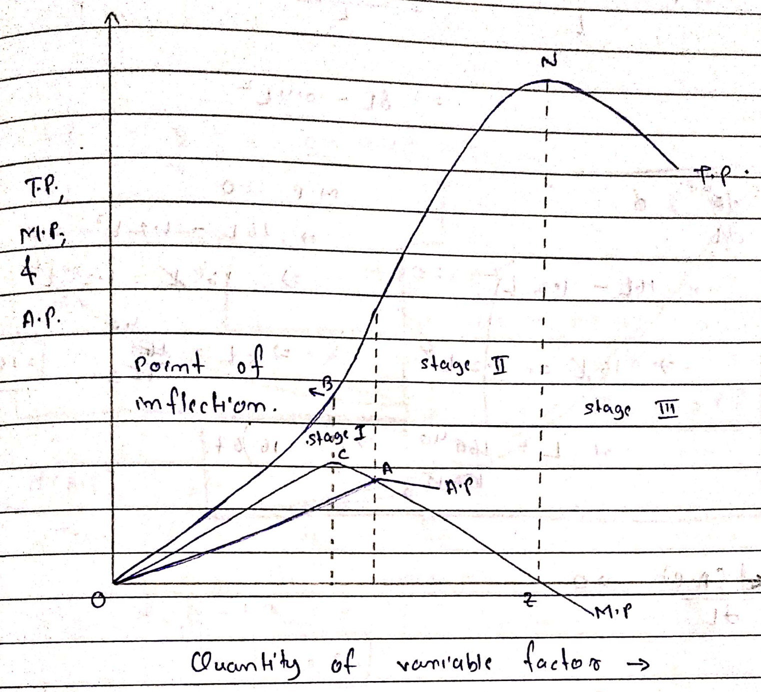
Diagrammatic Representation :



Q) From the following shortrun production function find out

1. Marginal product function.
2. Average Product function.
3. Value of L at which output will be maximum.
4. Value of L at which average product is maximum

$$Q = 8L^2 - 0.4L^3$$

Soln: $M.P_L = \frac{dQ}{dL} = 16L - 1.2L^2$

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* $A.P_1 = \frac{Q}{L} = \frac{8L^2 - 0.4L^3}{L}$

$= 8L - 0.4L^2$

* $\frac{d\,M.P.}{dL} = 0$

$\Rightarrow 16L - 1.2L^2 = 0$

$\Rightarrow 16\cancel{L} = 1.2L^{\cancel{2}}$

$\Rightarrow L = \frac{\cancel{160}\,40}{\cancel{12}\,3} \Rightarrow 16.67$

$M.P = 0$

$\Rightarrow 16L - 1.2L^2 = 0$

$\Rightarrow 16\cancel{L} = 1.2L^{\cancel{2}}$

$\Rightarrow L = \frac{\cancel{160}\,40}{\cancel{12}\,3}$ $\boxed{= 16.67}$

* $\frac{d(A.P)}{dL} = 0$

$\Rightarrow 8 - 0.8L = 0.$

$\Rightarrow 8 = 0.8L \Rightarrow L = 8/0.8 = \boxed{10}$

Q) From the following shortrun production function find out :-

- M.P function.
- A.P function.
- Find x at which output will be maximum
- Find x at which a A.P is max.

$Q = 6x^2 - 0.5x^3$

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Sol^n: $\frac{dQ}{dx} = 12x - 1.5x^2 = M.P.$

$A.P = \frac{Q}{x} = 6x - 0.5x^2$

$\frac{d(M.P)}{dx} = \phi$

$\Rightarrow 12 - 3x = \phi$

$M.P_L = 0$

$\Rightarrow 12x - 1.5x^2 = 0$

$\Rightarrow 12\cancel{x} = 1.5x^{\cancel{2}}$

$\Rightarrow \boxed{x = 8}$

$\frac{d(A.P)}{dx} = 0$

$\Rightarrow 6 - 1x = 0$

$\Rightarrow \boxed{x = 6.}$

Date 17 / 10 / 2019

Law of Returns to Scale :

It is a longrun homogeneous production function which shows the relationship between output and all the variable inputs.

Types of returns to scale :

1. Increasing returns to scale.
2. Constant returns to scale.
3. Decreasing returns to ~~sa~~ scale.

★ Increasing returns to ~~sa~~ scale :

when the rate of change in output is more than the rate of change in input or doubling of input results in more than doubling of output it is called increasing returns to scale

Eg :

C	K	Q
20	30	200
40	60	600

Constant returns to scale

when the rate of change in output is equal to the rate of change in input or doubling of input results in doubling of output it is called constant returns to scale.

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C	K	Q
20	30	200
40	60	400

★ Decreasing returns to scale.

when the rate of change in output is less than the rate of change in input or doubling of input results in less than doubling of output, it is called decreasing returns to scale.

Eg :

C	K	Q
20	30	200
40	60	300

★ I sco quant

It refers to those curves which shows var combination of two variable factors producing same level of output.

Combination	L	K	Q
A	1	22	200
B	2	17	200
C	3	13	200
D	4	11	200
E	5	10	200

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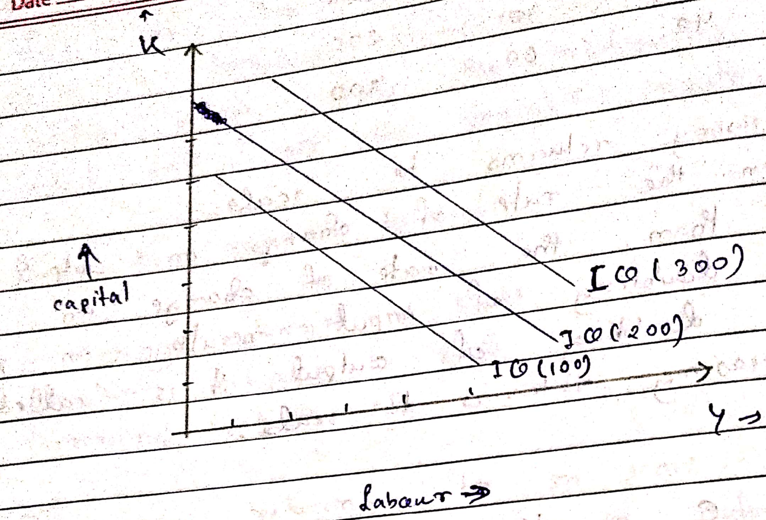
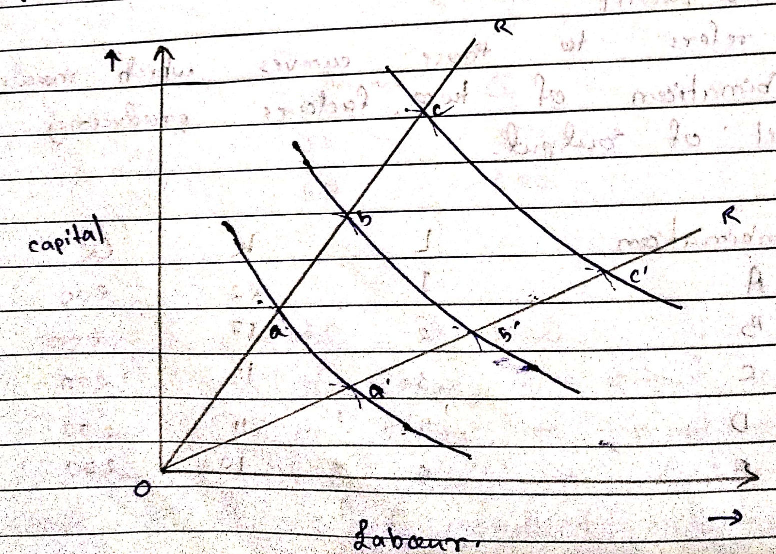


Isocline :
It refers to the locus of points on various isoquants.



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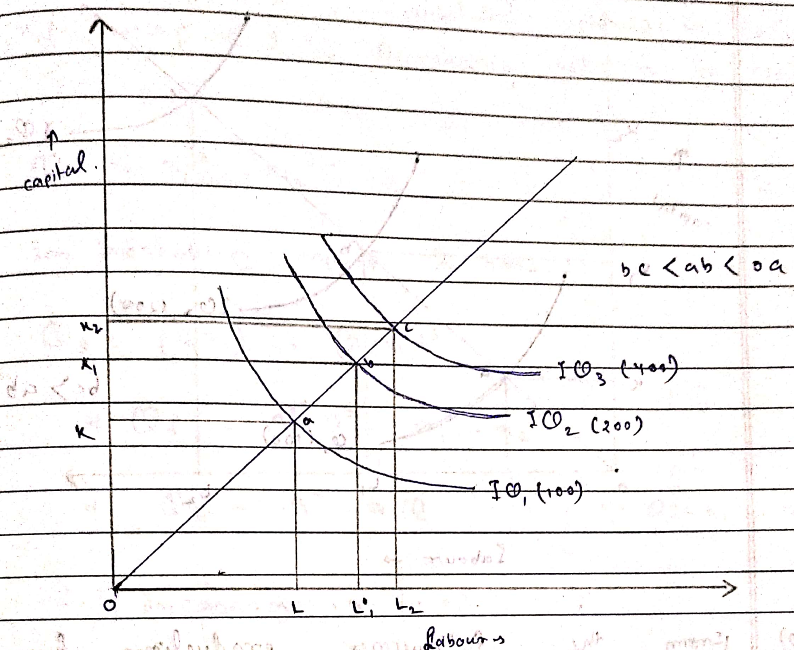
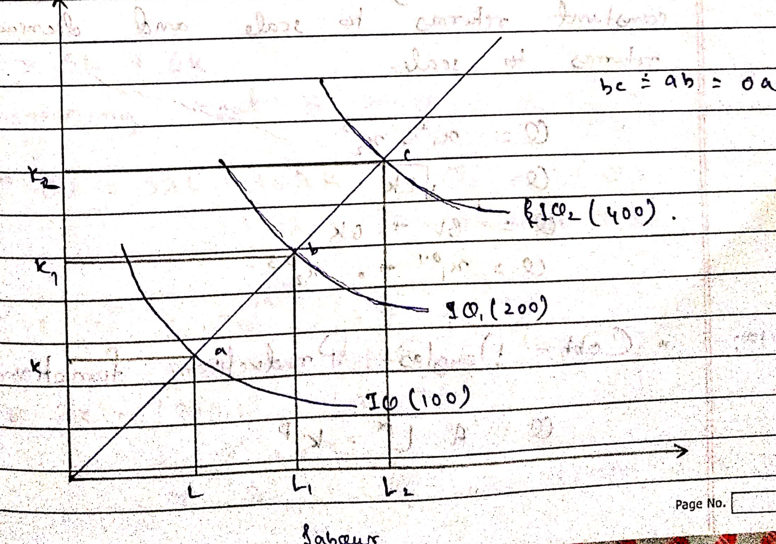
Increasing returns to scale :



Constant returns to scale :



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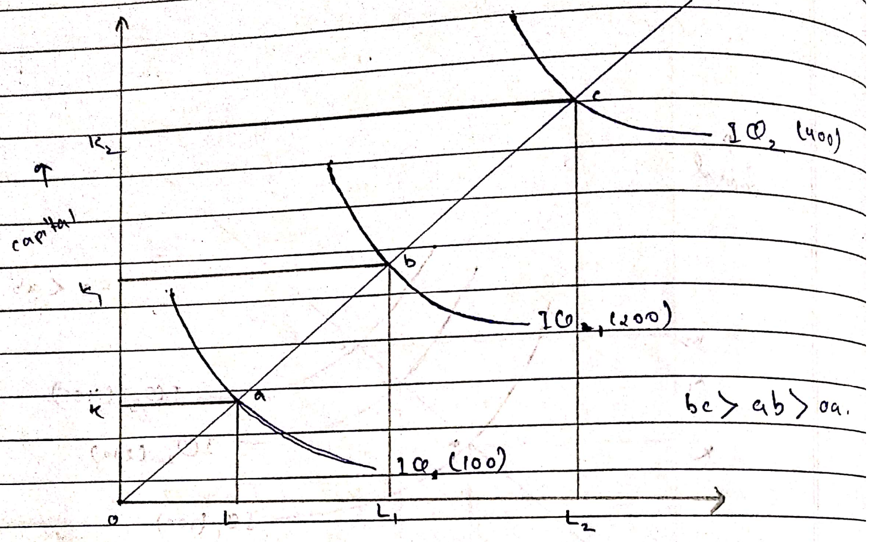
Decreasing returns to scale :



Q) From the following production function find out the prodn functions that shows increasing returns to scale, constant returns to scale and decreasing returns to scale.

$Q = x_1^2 \cdot x_2^3$

$Q = \sqrt{Lk}$

$Q = 3L + 6K$

$Q = x_1^{0.1} \cdot x_2^{0.3}$.

soln: * Cobb - Douglas Production function.

$Q = A \cdot L^{\alpha} \cdot k^{\beta}$.

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if $\alpha + \beta > 1$, Increasing returns to scale.

if $\alpha + \beta = 1$, constant returns to scale

if $\alpha + \beta < 1$, Decreasing returns to scale,

* $Q = x_1^2 \cdot x_2^3$

Increasing inputs λ time

$Q_* = (\lambda x_1)^2 \cdot (\lambda x_2)^3$

$\Rightarrow Q_* = \lambda^2 \cdot \lambda^3 \cdot x_1^2 \cdot x_2^3$.

$\Rightarrow Q_* = \lambda^5 \cdot Q$ $\quad \left\{ \because Q = x_1^2 \cdot x_2^3 \right.$

$\therefore$ Increasing r. t. s.

* $Q = \sqrt{Lk} = L^{1/2} \cdot k^{1/2} \Rightarrow \alpha + \beta = 1$

so, constant r. s.

* $Q = 3L + 6K$

Increasing input λ times

$\Rightarrow Q_* = 3\lambda L + 6\lambda k \Rightarrow Q_* = \lambda(Q)$

$\therefore$ constant r. s.

* $Q = x_1^{0.1} \cdot x_2^{0.3}$.

increasing input λ times.

$\Rightarrow Q_* = (\lambda \cdot x_1)^{0.1} \cdot (\lambda x_2)^{0.3}$

$\Rightarrow \lambda^{0.4} * (x_1^{0.1} \cdot x_2^{0.3})$ Decreasing r.s.

$\Rightarrow \lambda^{0.4} * (Q)$

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★ Properties of cobb - Douglas Production function :-

1. The ratios of marginal product and average product gives its exponents. $\left(MP_L/AP_L = \alpha\right)$ & $\left(MP_K/AP_K\right) = \beta$.

2. Elasticity of output is equal to the respective exponents.

Proof :

$$Q = A \cdot L^{\alpha} \cdot K^{\beta}.$$

$$\frac{dQ}{dL} = A \cdot \alpha \cdot L^{\alpha-1} K^{\beta}.$$

$$\Rightarrow \frac{dQ}{dL} = \alpha \cdot \frac{A L^{\alpha} \cdot K^{\beta}}{L}$$

$$\Rightarrow \frac{dQ}{dL} = \alpha \frac{Q}{L}$$

$$\Rightarrow \frac{dQ}{dL} = \alpha \, AP_L$$

$$\Rightarrow MP_L = \alpha \, AP_L$$

$$\Rightarrow \frac{MP_L}{AP_L} = \alpha,$$

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$$Q = A L^{\alpha} K^{\beta}$$

$$\frac{dQ}{dK} = \beta A L^{\alpha} K^{\beta-1}$$

$$\Rightarrow MP_K = \beta \frac{Q}{K} \quad \left\{ Q = A L^{\alpha} K^{\beta} \right.$$

$$\Rightarrow MP_K = \beta \cdot AP_K$$

$$\Rightarrow \frac{MP_K}{AP_K} = \beta.$$

Karma.

Elasticity of Output.

$$= \frac{\text{Proportionate change in output}}{\text{Proportionate change in input}}.$$

$$E_L = \frac{dQ}{dL} \times \frac{L}{Q}$$

$$= MP_L \times \frac{1}{AP_L} = \frac{MP_L}{AP_L}$$

$$\boxed{E_L = \alpha}.$$

$$E_K = \frac{dQ}{dK} \times \frac{K}{Q}$$

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$$= MP_K \times \frac{1}{AP_K}$$

$$\Rightarrow \frac{MP_K}{AP_K} = \beta$$

$$\boxed{\therefore E_K = \beta}$$

(3) From the following product" fun" , find out M.P. function (short run prod" fun" if the fixed quantity of capital is 10000 units.

$$Q = L^{0.75} K^{0.25}$$

Sol:

$$\alpha = 0.75, \quad \beta = 0.25$$

Marginal production function.

MP/F :

★ $MP_L = \frac{dQ_L}{dL} = 0.75 \, L^{-0.25} K^{0.25}$

★ $MP_K = \frac{dQ_K}{dK} = 0.25 \cdot L^{0.75} K^{-0.75}$

★ $Q = L^{0.75} K^{0.25}$

$= L^{0.75} (10000)^{0.25}$

$= 10 \, L^{0.75}$

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From the following prod" fun", find out M.P. fun" and A.P." & also find out elasticity of output w.r.t input.

$$Q = 1.50 \, L^{0.75} K^{0.25}$$

Sol":

★ $M.P_L = 1.50 \times 0.75 \times L^{0.75 - 0.25} K^{0.25}$

$= 1.125 \, L^{-0.25} K^{0.25}$

$M.P_K = 0.375 \, L^{0.75} K^{-0.75}$

★ $\frac{M.P_L}{A.P_L} = \alpha \Rightarrow AP_L$

★ $\Rightarrow A.P_L = \frac{M.P_L}{\alpha} = \frac{1.125 \, L^{-0.25} K^{0.25}}{0.75}$

$= 1.5 \, L^{-0.25} K^{0.25}$

$AP_K = \frac{M.P_K}{\beta} = \frac{0.375 \, L^{0.75} K^{-0.75}}{0.25}$

$= 1.5 \, L^{0.75} K^{-0.75}$

★ $E_L = \alpha = 0.75 = dQ/dL \times L/Q = \frac{MP_L}{AP_L}$

$E_K = \beta = 0.25 = dQ/dK \times K/Q = \frac{MP_K}{AP_K}$

Date 28/10/2019

Short run production function with two variable input.

Producer's Equilibrium :

→ Output maximisation.
→ Cost minimisation.

① Iso-quant / Iso-product curves.
② Marginal Rate · Technical substitution.

Iso-quant / Iso-product curves.

It refers to those curves which shows various comb^n of two factors · producing same level of output.

Marginal Rate · Technical Substitution

It refers to the rate at which number of units of one factors substituted to have one more unit of another factor.

$MRTS_{LK}$

It refers to the rate at which number of units of capital substituted to have one more unit of labour.

$MRTS_{KL}$

It refers to the rate at which the number of units of labour substituted to have one more unit of ~~labour~~. capital

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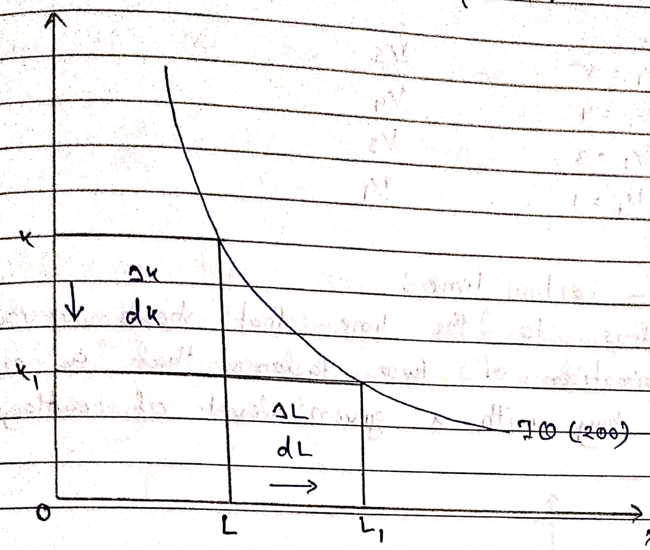
Slope of the isoquant.



$$MRTS_{LK} = \frac{dK}{dL} = \frac{MP_L}{MP_K}$$

$$MRTS_{KL} = \frac{dL}{dK} = \frac{MP_K}{MP_L}$$

(Q) From the following table find out $MRTS_{LK}$ and $MRTS_{KL}$.

Combination.	L	K	Q	$MRTS_{LK}$
A	1	25	200	25
B	2	20	200	10 16.
C	3	16	200.	16/3
D	4	13	200	13/4
E	5	12	200.	12/5

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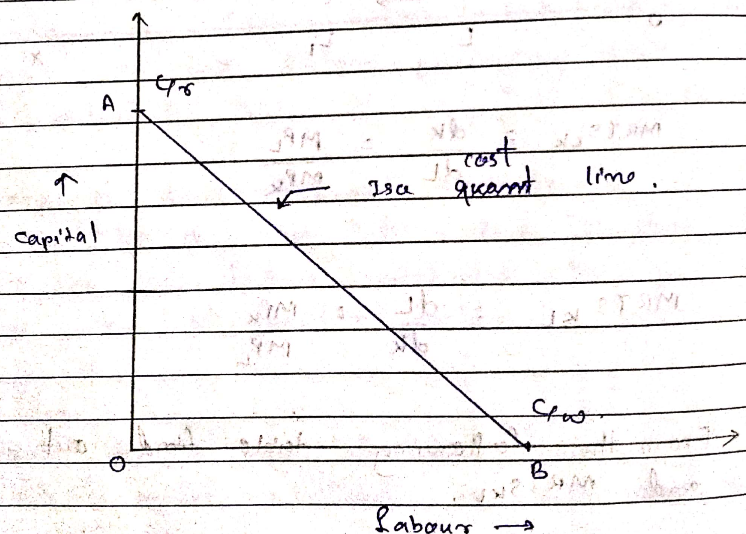
MRTS$_{LK}$	MRTS$_{KL}$
—	—
5/1 = 5	1/5
4/1 = 4	1/4
3/1 = 3	1/3
1/1 = 1	1/1

Iso-cost line:

It refers to the line that shows various combination of two factors that a producer can buy with a given level of outlay



Equation of the iso-cost line:

$$C = wL + rK$$

L = No. of units labour used.

w = wages of the labour.

K = No. of units of capital used

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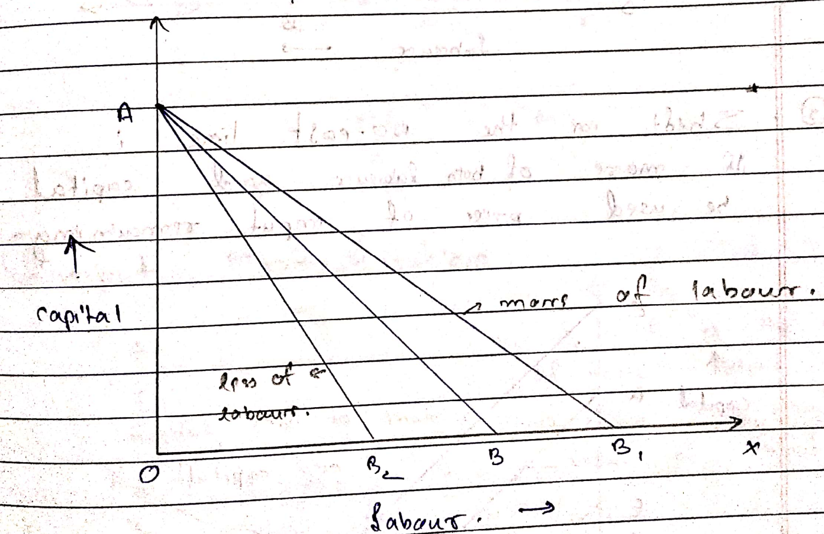
r = Price of capital.

Slope of the iso-cost line.

$$\frac{OA}{OB} = \frac{C/r}{C/w} = w/r.$$

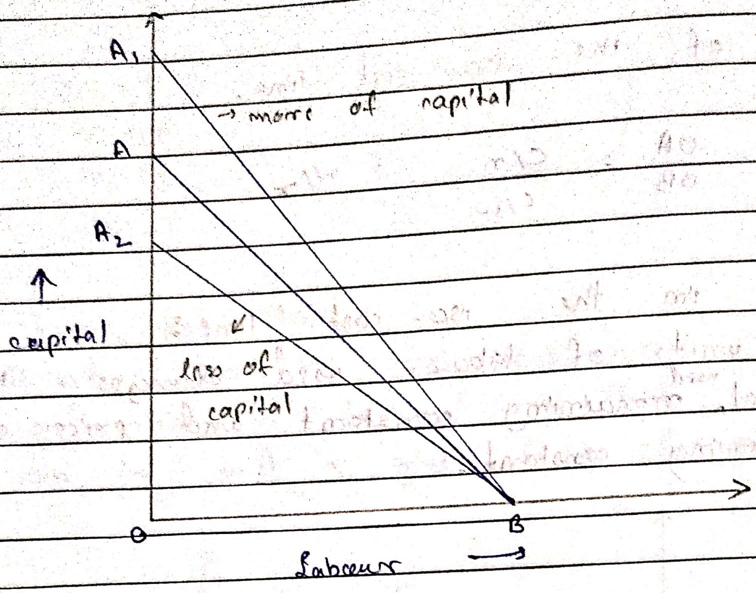
1. Shift in the iso-cost line:

If units of labour used changes that of capital used ~~remaining~~ remaining constant and price of input ~~remaining~~ remaining constant.

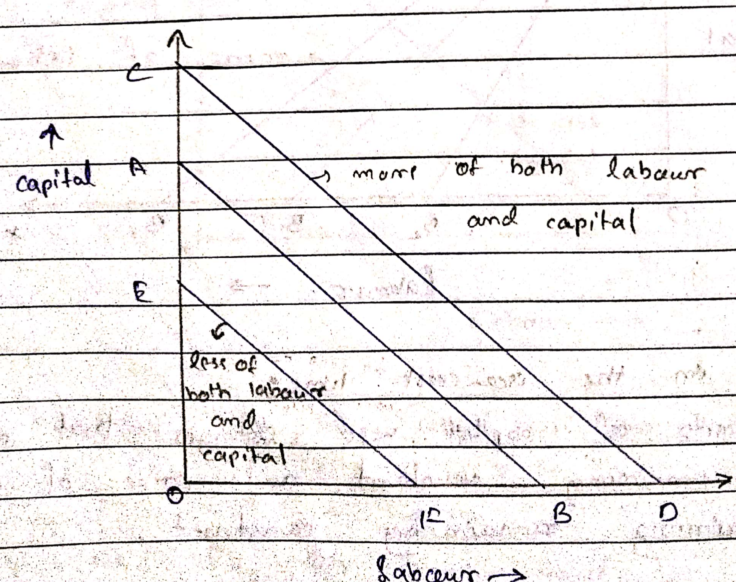


2. Shift in the iso-cost line:

If units of capital used changes that of labour used ~~remaining~~ remaining constant and price of input ~~remaining~~ ~~remaining~~ constant.



③ Shift in the iso-cost line : If more of both labour and capital will be used price of input remaining constant



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Conditions for the producer to be in equilibrium.

① The slope of the iso-quant should be equal to the slope of iso-cost line.

② The iso-quant should be convex at equilibrium point.

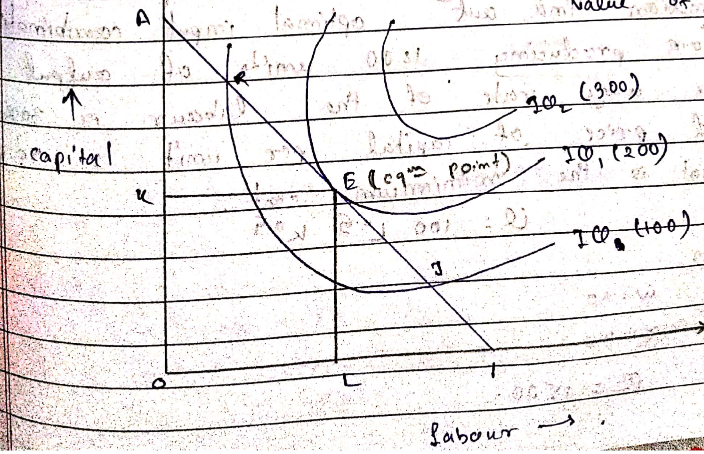
condition 1:

$$MRTS_{LK} = \frac{dk}{dL} = \frac{MP_L}{MP_K} = \frac{w}{r}.$$

$$\Rightarrow \frac{MP_L}{w} = \frac{MP_K}{r}.$$

Output Maximisation.

E is the point of max^m output because it shows the max^m value of output possible.



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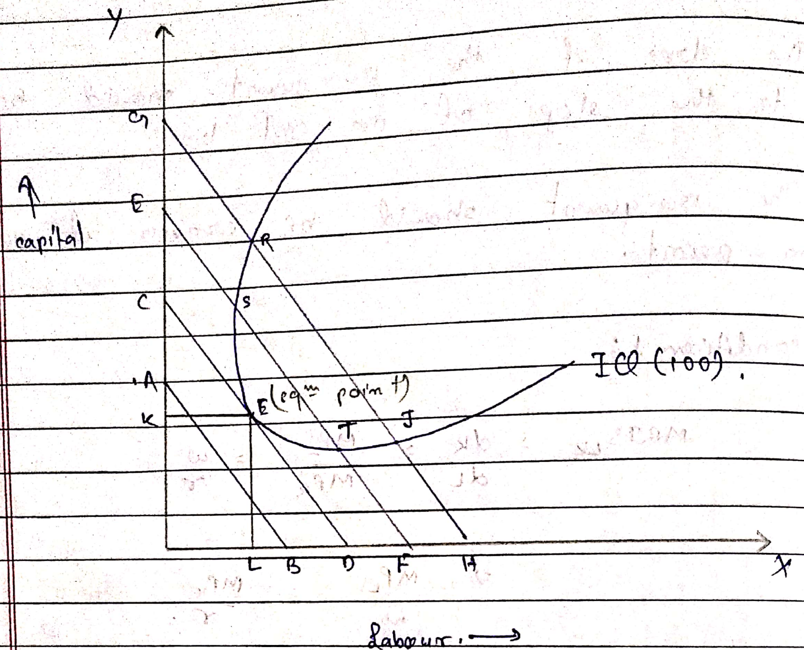
Cost Minimisation :



* E is the point of minimum cost because it lies ~~of~~ on CD which ~~the~~ shows minimum cost of input possible.

Q) From the following short run production function find out optimal input combination for producing 1500 units of output if the wage rate of the labour is 30Rs and price of capital per unit is 40 Rs what is the minimum cost.

$$Q = 100\, L^{0.5}\, K^{0.5}$$

soln: Given,

$w = 30$

$r = 40$.

$Q = 1500$.

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Mp

$$MP_L = \frac{dQ}{dL} = 50\, L^{-0.5}\, K^{0.5}$$

$$MP_K = \frac{dQ}{dK} = 50\, L^{0.5}\, K^{-0.5}$$

now, $\dfrac{MP_L}{MP_K} = \dfrac{w}{r}$.

$$\Rightarrow \frac{\cancel{50}\, L^{-0.5}\, K^{0.5}}{\cancel{50}\, L^{0.5}\, K^{-0.5}} = \frac{3}{4}.$$

$$\Rightarrow L^{-1} \cdot K^{1} = 3/4$$

$$\Rightarrow \frac{K}{L} = \frac{3}{4}.$$

~~now~~, so, $1500 = 100 \times L^{0.5} \times \left(\dfrac{3L}{4}\right)^{0.5}$

$$\Rightarrow 1500 = 100 \times L^{0.5} \times 0.866 \times L^{0.5}$$

$$\Rightarrow L = \frac{1500}{100 \times 0.866} = 17.32 \approx 17.$$

$$K = 17.32 \times \frac{3}{4} = 12.99 \approx 13.$$

so,

$C = wL + rK$

$\Rightarrow C = (30 \times 17) + (40 \times 13)$

$\Rightarrow C = 1030.$

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For output max^m

From the following prod^n fun^n find out the quantity of labour and capital that the company should use in order to maximise output and also find max. output

$w = 30.$

$r =$

$C = 1300.$

* Fixed cost can never be zero.
* variable cost can be zero.

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Cost

It refers to the amount of money incurred on a thing.

Cost of Production.

It refers to the expenditure incurred on factors of production to produce the output.

Types of cost:

1. Fixed cost.
2. Variable cost.
3. Marginal cost.
4. Sunk cost.

Fixed cost:

It refers to those cost which remain fixed or remain independent of the level of output or which doesn't change with level of output.

Variable cost:

It refers to those cost which changes in direct proportion to the level of output.

Fixed cost: Eg → cost of machine installation.

Output	Cost of machine.
100	10,000
200	10,000
500	10,000
50	10,000.

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Variable cost :

Output	cost of raw material.
100	10,000.
200	20,000.
500	50,000
50.	5000.

Marginal cast :
It refers to the net addition to the total cost for producing an extra unit of output.

Output	Total cost.
20	200
21	210

$MC_n = TC_n - TC_{n-1}$.

$MC = \frac{d(TC)}{dQ}$..

Sunk Cost :
It refers to those cost which can't be recovered.

★ Total cost = TFC + TVC

TFC → Total fixed cost
TVC → Total variable cost.

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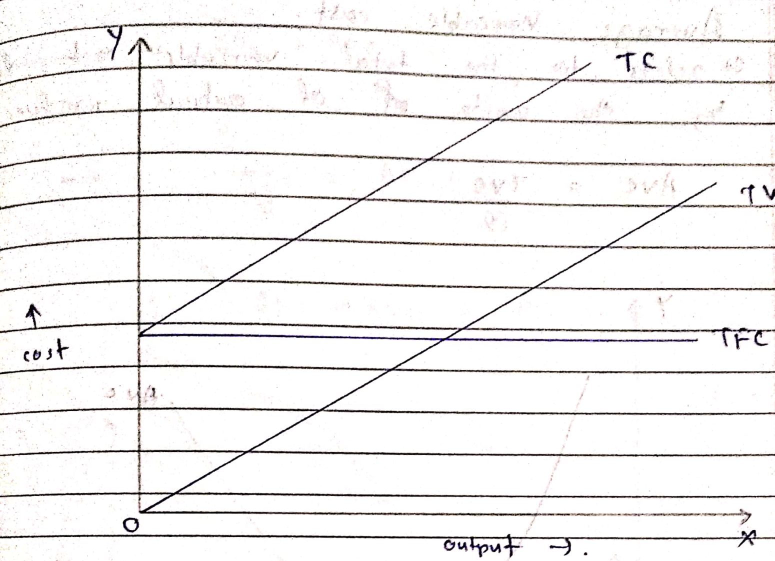
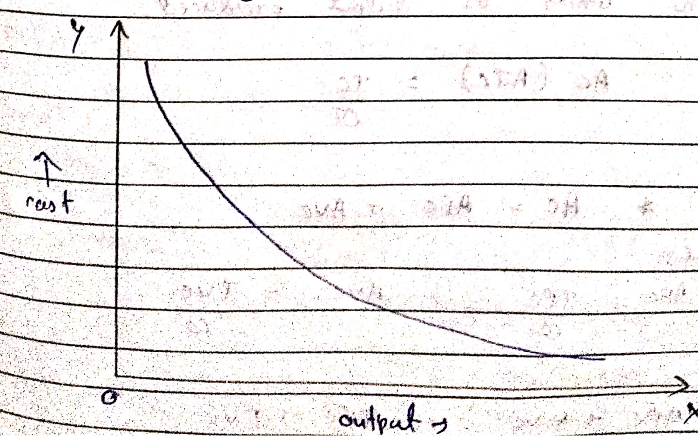


① Average Fixed cost (AFC).
It refers to the total fixed cost divided by units of output produced.

$AFC = \frac{TFC}{Q}$



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Average variable cost.

It refers to the total variable cost divided by the units ~~of~~ of output produced

$$AVC = \frac{TVC}{Q}$$

Averageage Total cost.

It refers to total cost units divided by the units of output produced.

$$AC\ (ATC) = \frac{TC}{Q}$$

★ $AC = AFC + AVC$

Proof:

$AFC = \frac{TFC}{Q}$ $AVC = \frac{TVC}{Q}$.

$AFC + AVC = \frac{TFC + TVC}{Q}$

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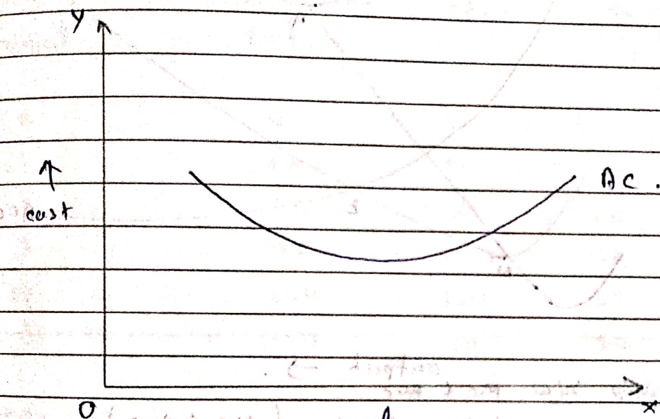
~~It refer~~ $\Rightarrow AFC + AVC = \frac{TC}{Q}$

&

whr $\frac{TC}{Q} = AC\ (ATC)$

$\therefore AFC + AVC = AC.$



~~Proo~~

$MC_n = TVC_n - TVC_{n-1}.$

Proof:

$MC_n = TC_n - TC_{n-1}.$

$\Rightarrow MC_n = \cancel{TFC_n} + TVC_n - \cancel{TFC_{n-1}} - TVC_{n-1}.$

($\because TFC$ remains constant)

$\Rightarrow MC_n = TVC_n - TVC_{n-1}.$

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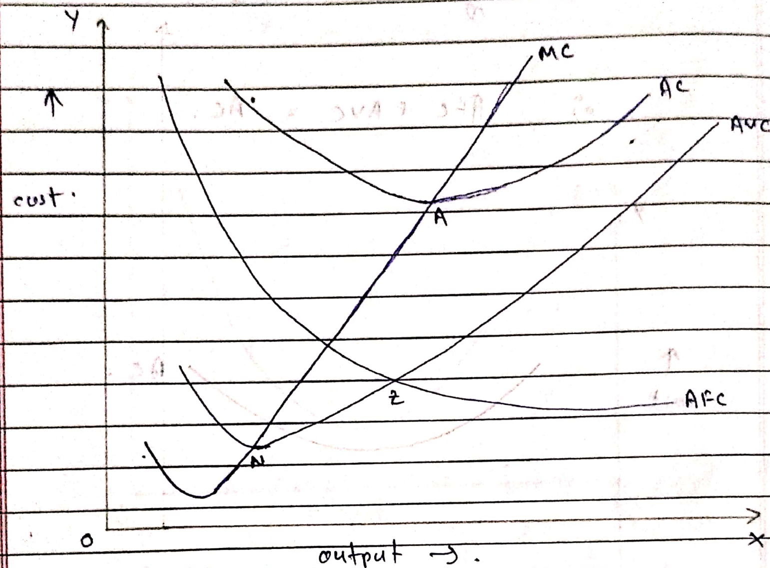
so,

$$MC = \frac{d(TVC)}{dQ}.$$



Relationship b/w MC & AVC

★ If MC is below AVC. (MC < AVC)
AVC decreases.

★ If MC is above AVC
MC > AVC, AVC is increasing.

★ If MC = AVC
AVC is constant

Relationship of b/w MC & AC.

★ If MC < AC, AC is decreasing.

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★ If MC > AC, AC is increasing.

★ If ~~AE~~ MC = AC, AC is constant on minimum.

★ Relationship b/w AVC, AFC, AC

Q) From the following table find out AVC, AFC, AC, MC if the fixed cost is 50.

units of output	Total variable cost	AFC.	AVC	AC	~~MC~~
0	0	–	–		
1	20	50.	20	70	
2	40	25	20	45	~~FC/5~~
3	90	16.67	30	46.67	~~16.67~~
4	120	12.5	30	42.5	4
5.	150	10	30	40	

TFC	TC	MC
50	50.	–
50	70	20
50	90	20
50	140	50
50	170.	30
50.	200	30.

Q) From the following cost function find out MC function, AVC function, AC function and also find out at what level of output AVC & MC is minimum. if fixed cost is. 200.

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$TVC = 300Q - 12Q^2 + 0.25Q^3$

$TC = 300Q - 12Q^2 + 0.25Q^3 + 200.$

Sol^n: ★ $MC = \frac{d(TVC)}{dQ}$

$\Rightarrow MC = 300 - 24Q + 0.75Q^2$ $\cancel{200}$.

★ $AVC = \frac{TVC}{Q}$

$\Rightarrow AVC = 300 - 12Q + 0.25Q^2$

★ $AC = \frac{(TC)}{Q}$.

$= 300 - 12Q + 0.25Q^2 + \frac{200}{Q}$.

★ $\frac{d(MC)}{dQ} = 0$.

$\Rightarrow -24 + 1.5Q = 0$

$\Rightarrow Q = \frac{24}{1.5} = \frac{\cancel{240}\ 48}{\cancel{15}\ 3} = 16.$

$\Rightarrow Q = 16.$

★ $\frac{d(AVC)}{dQ} = 0$.

$\Rightarrow -12 + 0.5Q = 0$

$\Rightarrow Q = 24.$

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Market.

It refers to the place where not only goods are purchased or sold but there is a contact b/w buyers and sellers who agreed at a common price.

Types of market:

- Perfect competition / perfectly competitive market.
- Imperfect competition
  - Monopoly (Railway)
  - Oligopoly (cement industry, textile industry)
  - monopolistic ~~mark~~ competition.

Perfectly competitive market (not possible in real world)

It refers to that type of market where.

① There are large number of buyers and sellers.

② There is free entry and free exit.

★ Uniform Price.

③ ~~Buyers~~ and sellers are producing and selling homogeneous products.

④ Buyers and sellers have knowledge about the actual price of the product prevailing in the market.

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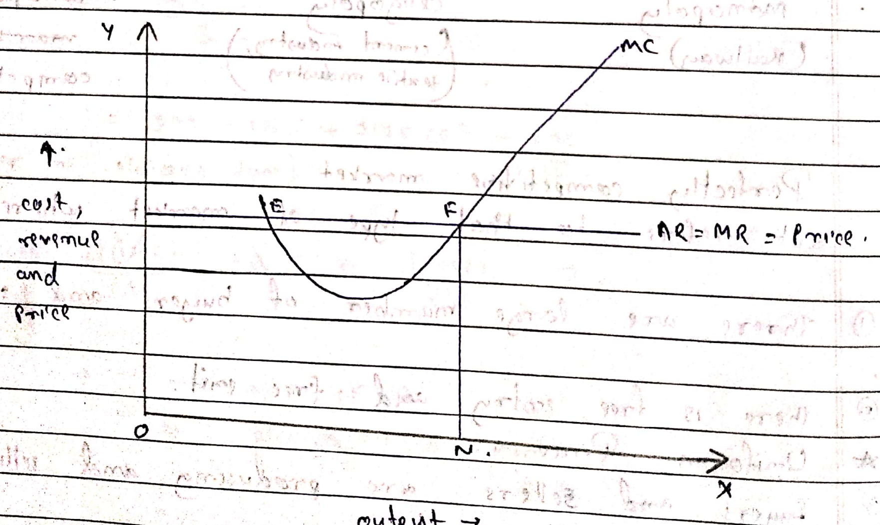
Equilibrium of the firms under perfectly competitive market.

(1) Short run equilibrium of the firm.
(2) Long-run eqm of the firm.

Condition of for the firms to be in eqm in the short run under perfectly competitive market.

(1) MR = MC
(2) MC must be increasing at equilibrium point.



F shows the eqm point because it satisfies both the condition, i.e MR = MC & MC is increasing.

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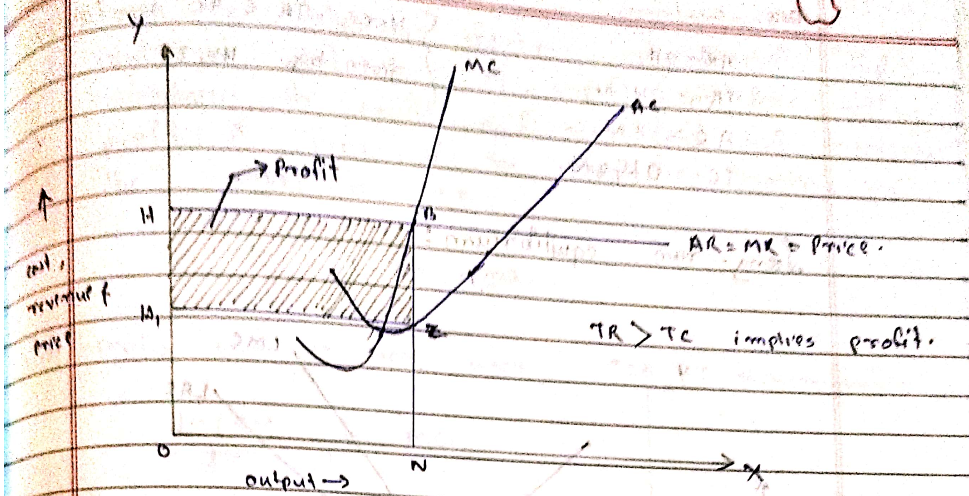
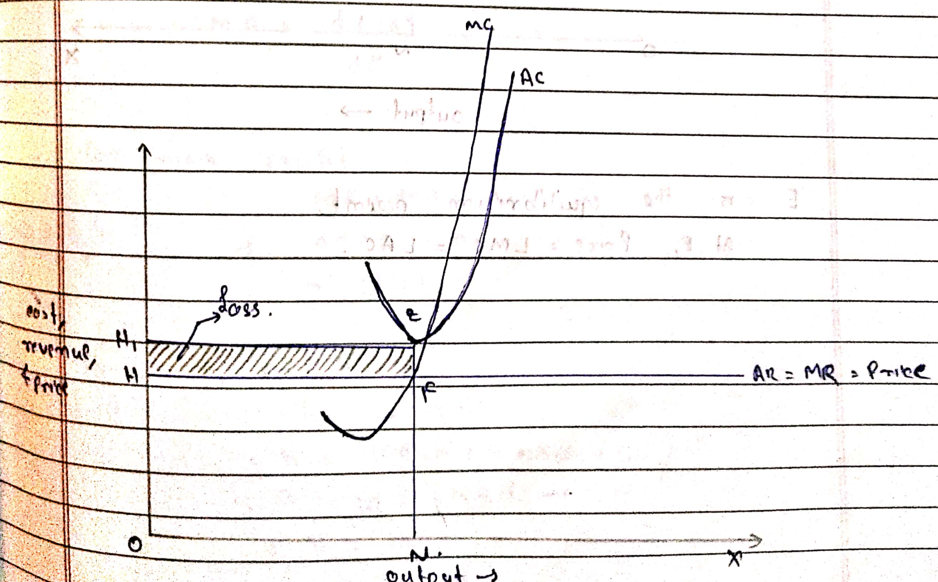


π = TR − TC.

If AR > AC → super normal profit
If AR = AC → normal profit.

AR = OH or BN.
TR = OHBN (i.e Ar OHBN = OH × ON)
TC = OH_1ZN.



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AR = OH

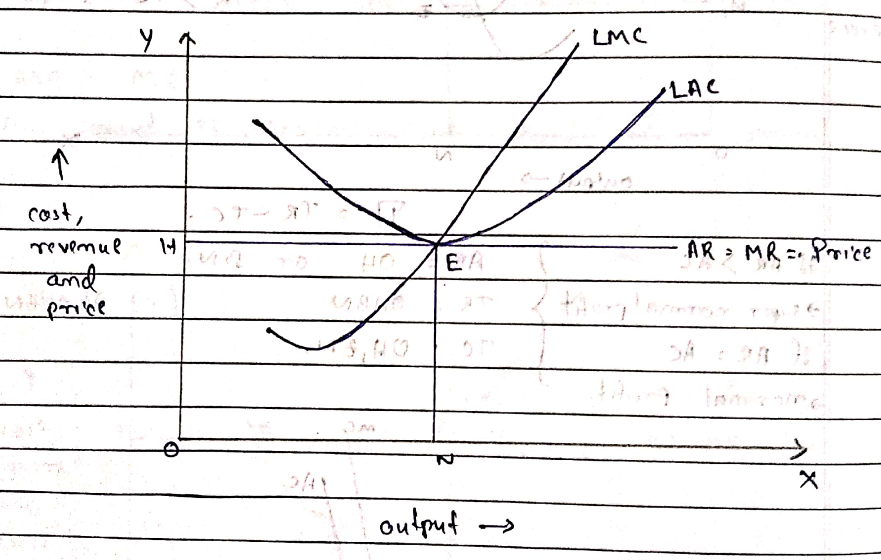
TR = OHFN.

AC = ZN.

TC = OH, ZN.

{ Here, TR < TC so, loss. given by HH, ZF

Long-run equilibrium :



E is the equilibrium point,

At E, Price = LMC = LAC.

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Q) From the following short run cost function find out at what level of output, the firm will maximise its profit and also find out maximum profit if price of the product prevailing in the market is 10 Rs.

$$TC = 4 + 8Q + Q^2$$

Soln: Profit will be max. when TC is minimum.

$$\frac{d(TC)}{dQ} = MC$$

$\Rightarrow MC = 8 + 2Q.$

★ ~~MR~~ T.R = 10 × Q

$\therefore$ $M.R = \frac{d(TR)}{dQ} = 10.$

For max. profit,

$MR = MC$

$\Rightarrow 8 + 2Q = 10.$

$\Rightarrow Q = 1.$

For max, profit.

$\pi = TR - TC$

$\Rightarrow \pi = 10Q - (4 + 8Q + Q^2)$

$\Rightarrow \pi = 10 - (4 + 8 + 1)$

$\Rightarrow \pi = 10 - 13.$

$\Rightarrow \pi = -3.$

$\therefore$ Profit = −3.

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Q) From the following cost function and revenue fun^n find out max. profit of the firm under perfectly competitive market in the short run.

$$TR = 12Q$$

$$TC = 2000 + 4Q + 0.02\,Q^2$$

Sol^n: $MR = \frac{d(TR)}{dQ} = 12$

$$MC = \frac{d(TC)}{dQ} = 4 + 0.04\,Q.$$

At equilibrium,

$$MR = MC$$

$$\Rightarrow 12 = 4 + 0.04\,Q$$

$$\Rightarrow Q = \frac{12-4}{0.04}$$

$$\Rightarrow Q = \frac{8}{0.04} = 200.$$

now,

$$\pi = TR - TC$$

$$\Rightarrow 12Q - (2000 + 4Q + 0.02\,Q^2)$$

$$\Rightarrow (12 \times 200) - (2000 + 800 + 800)$$

$$\Rightarrow 2400 - (3600)$$

$$\Rightarrow \pi = -1200.$$

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Shutting Down Point.

Conditions for the short shut down of a firm under perfectly competitive market in short run.

Price = AVC = MC

Q) From the following total variable cost fun^n in the short run under perfectly competitive market, find out the price at which the firm should shut down its production.

$$TVC = 150Q - 20Q^2 + Q^3$$

sol^n: $AVC = \frac{TVC}{Q} = 150 - 20Q + Q^2$

~~MC~~ ⇒

★ Minimum AVC

$$\frac{d(AVC)}{dQ} = 0.$$

$$\Rightarrow -20 + 2Q = 0.$$

$$\Rightarrow Q = 10.$$

∴ ~~Price = (AVC)min~~

=

$$\therefore AVC = 150 - 20Q + Q^2$$

$$= 150 - (20 \times 10) + 100$$

$$= 150 - 200 + 100$$

$$\Rightarrow 50.$$

So, Price at which firm shut down is 50.

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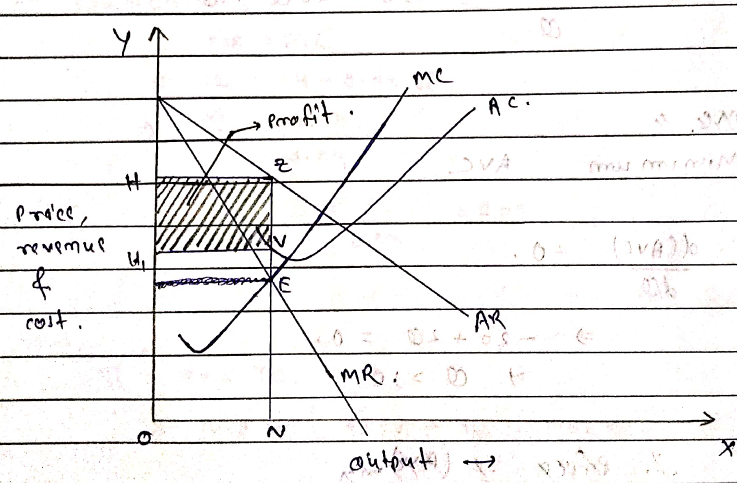
Monopoly :

It refers to that type of market where there is a single seller and large number of buyers and, there is restriction for the new firms enter into the industry and firms are producing selling the goods which have no close substitute.

Condition for the monopolist to be in equilibrium in the short run.

① MR = MC.

② MC must cut MR from below.



AR = OH

∴ TR = OHZN (OH × ON)

AC = OH₁

∴ TC = OH₁VN (OH × ON).

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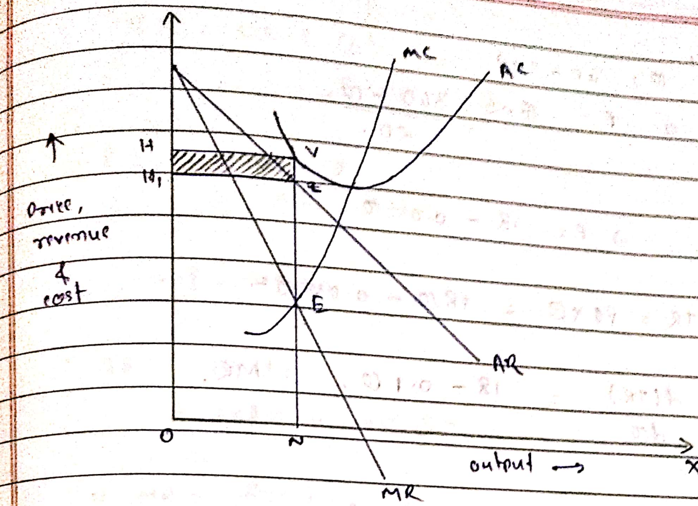

AR = OH₁

TR = OH₁ZN (OH₁ × ON)

AC = OH

TC = OHVN (OH × ON)

Q) From the following short run cost function and demand function find out max. profit of the monopolist in the short run.

$$TC = 60 + 0.05\,Q^2$$

$$Q = 360 - 20P$$

P → Price
Q → quantity demand.

Soln. $MC = \frac{d(TC)}{dQ} \Rightarrow \frac{dc}{dQ}$

$\Rightarrow MC = 6 + 0.1\,Q$

now, $TR = P \times Q = 360P - 20P^2$

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now,

$Q = 360 - 20P$

$\Rightarrow P = \dfrac{360 - Q}{20}$

$\Rightarrow P = 18 - 0.05Q$

$\therefore TR = P \times Q = 18Q - 0.05Q^2$

$\Rightarrow \dfrac{d(TR)}{dQ} = 18 - 0.1Q = MR$

For eqm:

$MR = MC$

$\Rightarrow 18 - 0.1Q = 6 + 0.1Q$

$\Rightarrow 0.2Q = 12$

$\Rightarrow Q = \dfrac{120}{2} = 60$

now,

$\pi = TR - TC$

$\Rightarrow \pi = \left(18Q - \dfrac{Q^2}{20}\right) - 6Q - 0.05Q^2$

$\Rightarrow \pi = 360$

(Q) From the following cost and demand funⁿ find the eqm price and quantity for the monopolist and also find out max profit.

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$Q = 400 - 20P$

$TC = 5Q + \dfrac{Q^2}{50}$

$P = \dfrac{400 - Q}{20}$

$\Rightarrow P = 20 - 0.05Q$

$\therefore TR = P \times Q$

$= 20Q - 0.05Q^2$

$\Rightarrow MR = \dfrac{d(TR)}{dQ} = 20 - 0.1Q$

★ $MC = \dfrac{d(TC)}{dQ} = 5 + \dfrac{Q}{25}$

For eqm:

$MR = MC$

$\Rightarrow 20 - 0.1Q = 5 + \dfrac{Q}{25}$

$\Rightarrow 15 = 0.1Q + 0.04Q$

$\Rightarrow 15 = 0.14Q$

$\Rightarrow Q = 107.14$

$\therefore \pi = TR - TC$

$= \left(20Q - 0.05Q^2 - 5Q - \dfrac{Q^2}{50}\right)$

$\Rightarrow \pi = 803.57$

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Depriciation.

It refers to the loss in the value of any asset due to its constant use.

Methods:

1. Straight line method.
2. Declining Balance method.
3. Sum-of-the-year digit method.
4. Sinking fund method.

Straight line method:

It refers to that method of depriciation where a fixed rate of depriciation is changed directly on the initial value of asset on various year.

1. Depriciation amount per year $(D) = \frac{I - S}{N}$.

$I \to$ initial value of the asset.
$S \to$ salvage value / reduced value of asset.
$N \to$ number of year life of the asset.

2. Rate of depriciation (d)

$= \frac{D}{I} \times 100$.

3. Book value $(B_t) = I - (t \times D)$ $\{$or $B_{t-1} - D_t\}$

$t \to$ the number of years. the asset has been used.

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Q) An equipment has been purchased at 80,000 Rs if estimated salvage value of the equipment at the end of the ~~life~~ of ~~the equipment~~ 10th year ~~lif~~. of life of equipment is 1000. find out depriciation amount and book value of the asset after 5th year. with the help of straight line method.

Sol^n:
$I = 80,000$.
$S = 1000$.
$N = 5$

$D = \frac{I - S}{N}$.

$\Rightarrow D = \frac{80,000 - 1000}{10} = \cancel{15800}.\ 7900$ Rs.

* Book value $= I - (t \times D)$

$\Rightarrow 80,000 - (5 \times 7900)$.

$\Rightarrow 40500$. Rs.

* Rate of depriciation

Q) If initial value of a machine is 50,000 Rs with estimated salvage value of 5000 Rs at the end of its service life of 8 years find out depriciation amount and book value of various / ~~ey~~ every year.

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End of year	D	B_t
0	~~0~~ 0	50,000
1	5625	~~50,000~~ 44375
2	5625	~~44375~~ 38750
3	5625	~~38750~~ 33125
4	5625	~~33125~~ 27500
5	5625	~~27500~~ 21875
6	5625	~~21875~~ 16250
7	5625	1
8	5625	

Given,

$I = 50,000$

$S = 5000$

$N = 8$

$$D = \frac{50,000 - 5000}{8} = \frac{45,000}{8}$$

Declining Balance method.

It refers to that method of depreciation where a fixed rate of depreciation is charged on the declining year for various years.

(1) $D_t = k \times B_{t-1}$

k = fixed percentage.

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(2) $B_t = B_{t-1} - D_t$.

Q) If a machine has been purchased at 90,000 rs. find out its depreciation amount and book value for every year till the end of the 7th year of the life of the machine if the fixed rate of depreciation is 30%. using declining balance method.

Soln:

End of the year	D_t	B_t
0	—	90,000
1	27000	63,000
2	18900	44,100
3	13230	30870
4	9261	21609
5	~~[illegible]~~ 6482.7	15126.3
6	4537.89	10588.41
7	3176.523	7411.887

★ Sum of the year digit method of depreciation:

(1) Sum of the year $= \frac{N(N+1)}{2}$

(2) $D_t = \text{Rate}\,(I - S)$

$$\text{Rate} = \frac{\text{Rank}}{\text{sum of the year}}$$

(3) $B_t = B_{t-1} - D_t$.

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Q) If an asset has been purchased at 2,00,000 with estimated salvage value of 40,000 at the end of its service life of 10 yrs. Find out depreciation amount and book value at the end of various years with the help of sum of the year digit method.

Sol^n: $I = 2,00,000$ Rs. Sum of the year $= 10 \times 11/2 = 55$

$S = 40,000$. $D_t = \frac{10}{55}(I - S)$.

$N = 10$.

End of the year.	rank.	D_t	B_t.
0			200000.
1	10	29090.90.	170909.1
2	9	26181.81	144727.29
3	8	23272.727	121454.563
4	7	20363.636	101090.927
5	6	17454.545	83636.382
6	5	14545.454	69090.928
7	4	11636.363	57454.565
8	3	8727.272	48727.293
9	2	5818.181	42909.112
10.	1	2909.090.	40000.022

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Sinking Fund Method.

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

② $D_t = A \cdot (1+i)^{t-1}$

③ $B_t = B_{t-1} - D_t$

Q) If $I = 100000$, $S = 20,000$, $n = 4$ yrs. Find out depreciation amount and book value for various yrs if $i = 12\%$ compounded anually with the help of sinking fund method.

Sol^n: $I = 1,00,000$.

$S = 20,000$. $i = 0.12$

$n = 4$.

$\Rightarrow A = (I - S)\left[\frac{i}{(1+i)^n - 1}\right]$.

$\Rightarrow A = (100000 - 20,000) \times \left[\frac{0.12}{(1.12)^4 - 1}\right]$

$\Rightarrow A = 16738.7549$ Rs.

$\Rightarrow D_t = A\,(1+i)^{t-1}$

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End of year	A	D_t	B_t.
0	16738.754	—	1,00,000.
1	16738.754	16738.754.	83261.246.
2	16738.754	18747.404	64513.842
3	16738.754	20997.093	43516.749
4	16738.754	23516.744	20,000.

Break-Even Analysis.

It refers to that analysis which discusses the behaviour of total revenue and total cost as the level of output changes.

Break-Even point (BEP)

It refers to that point where TR = TC.
It is also called point of no profit.

TR = TRC ~~R~~ $\quad\left\{ \begin{array}{l} \because \pi = TR - TC \\ \pi = 0. \end{array} \right.$

so, $\pi = 0$

Methods of ~~cal~~ calculating BEP:

① Graphical method.
② Algebraic method.

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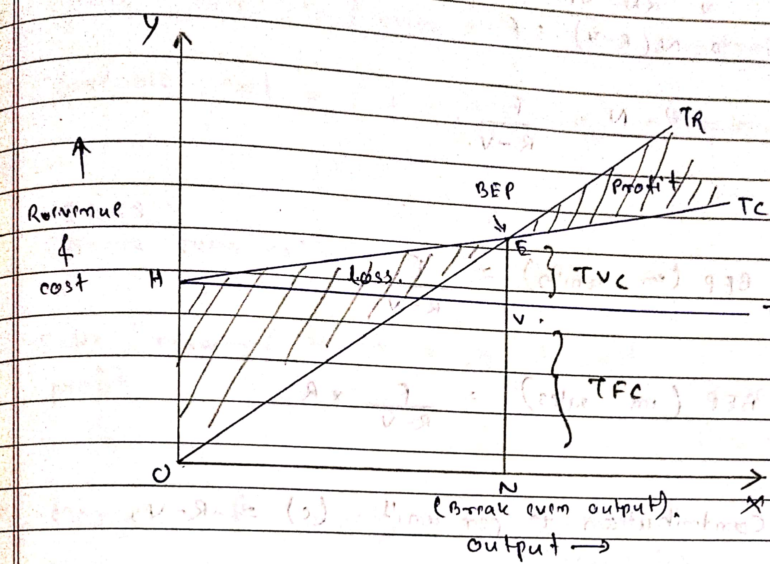
① Graphical method:



Algebraic method:

R → selling price per unit.
N → number of units of output sold.
V → Variable cost per unit.
~~TR → Total~~
F → Total Fixed cost.

At BEP,
TR = TC. —— ⑴
• TR = P × Q
• TR = R × N.
• TC = TFC + TVC
• TC = ~~TF~~ F + VN.

From ①
∴ R×N = F + VN.

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$\Rightarrow RN - VN = F.$

$\Rightarrow N(R-V) = F.$

$\Rightarrow N = \frac{F}{R-V}.$

① BEP (in units) $= \frac{F}{R-V}.$

② BEP (in sales) $= \frac{F}{R-V} \times R$

③ Contribution ~~to~~ per unit (c) $= R-V.$

④ Profit = Total contribution $- F.$

⑤ Total contribution $= F+P.$

⑥ Units required to have a ~~two~~ targeted profit $= \frac{F+P \to \text{targeted profit}}{R-V}.$

⑦ Sales required to have a targeted profit

$= \frac{F+P}{R-V} \times R$

⑧ Margin of safety = Actual sales − BES.

⑨ P/V ratio $= \frac{\text{Contribution per unit}}{\text{selling price per unit}}.$

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⑩ Fixed cost = (sales × P/V ratio) − Profit.

⑪ Variable cost $= \left(1 - \frac{P}{V} \text{ ratio}\right) \times$ sales.

⑫ BES (Break even sales) $= \frac{F}{P/V \text{ ratio}}$

⑬ Sales required to have a targeted profit $= \frac{F+P}{P/V \text{ ratio}}$

⑭ Margin of safety $= \frac{\text{Profit}}{P/V \text{ ratio}}.$

⑮ P/V ratio $= \frac{\text{change in profit}}{\text{change in sales}} \times 100.$

Q) From the following information calculate.

BEP, P/V ratio.

Selling price / unit = 30 Rs

variable cost / unit = 20 Rs

Total Fixed cost = 20,000.

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sol^n: Given, $R = 30$ Rs.
$V = 20$ Rs.
$F = 20,000$.

★ BEP (sales) $= \frac{F}{R-V} \times R = \frac{20,000}{(30-20)} \times 30 = 60,000$ Rs.

★ BEP (in units) $= \frac{F}{R-V} = \frac{20000}{10} = 2000$ units.

★ P/V ratio $= \frac{R-V}{R} \times 100 = \frac{10}{30} \times 100 = 33.33\%$

(c) P/V ratio, Fixed cost, variable cost in 2010, BEP (in sales), sales required to earn a profit of 20,000 Rs.

Year	Sales	Cost
2010	1,20,000	1,11,000
2011	1,40,000	1,27,000.

sol^n: Given, Profit.
$R =$ 20,000 Rs. 9,000
13,000.

sol^n: P/V ratio $= \frac{\text{change in Profit}}{\text{change in sales}} \times 100$.

$\Rightarrow$ P/V ratio $= \frac{\cancel{4000}}{\cancel{20000}_{5}} \times 100$.

$\Rightarrow$ P/V ratio $= 20\%$.

★ Fixed cost $=$ (sales $\times$ P/V ratio) $-$ Profit

$= (1,20,000 \times 0.2) - 9,000$.

$= 15,000$ Rs.

★ variable cost $= (1 -$ P/V ratio$)$ sales.

$= (1 - 0.2) \times 1,20,000$.

$= 96,000$ Rs.

★ BEP (sale) $= \frac{F}{\text{P/V ratio}} = \frac{15,000}{0.2}$

$= 75,000$ Rs.

★ sales to ~~have~~ earn a profit of 20,000

$= \frac{15,000 + 20,000}{0.2}$

$= 1,75,000$ Rs.

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Topic name, & roll no., name, submitted to.

① Topic name,

② Certificate.

③ Acknowledgement.

④ Index.

⑤ Introduction.

⑥ Topic. (photos). (10 pages → write up & diagram)

⑦ Conclusion.

(Q) From the following information find out i) P/V ratio : ii) BEP iii) Profit when the output is 50,000 units.

$F = 1,20,000$, $V = 3$, $R = 7$

Sol^n: i) P/V ratio $= \frac{R-V}{R} \times 100 = \frac{4}{7} \times 100 = 57.143\%$

ii) BEP (units) $= \frac{F}{R-V} = \frac{1,20,000}{4} = 30,000$ units

iii) BEP (sales) $=$ BEP (units) $\times$ ~~30,000~~ 7

$= 2,10,000$ Rs

iv) Given, units required to have a target profit $= 50,000$

$\Rightarrow 50,000 = \frac{F+P}{R-V}$

$\Rightarrow P = 50,000 \times (4) - 1,20,000$

$\Rightarrow P = 80,000$ Rs.

Date 07/10/19

Inflation

It refers to a substantial and continuous rise in price level which reduces purchasing power of money.

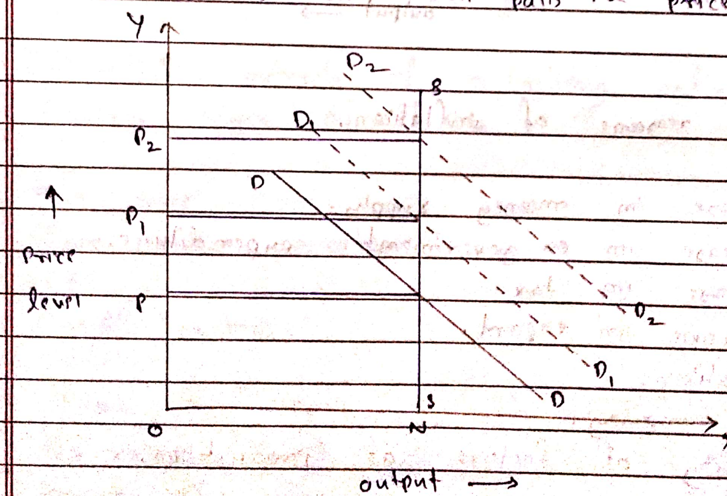
Causes of inflation :

① Demand-Pull inflation.

② Cost-Push inflation.

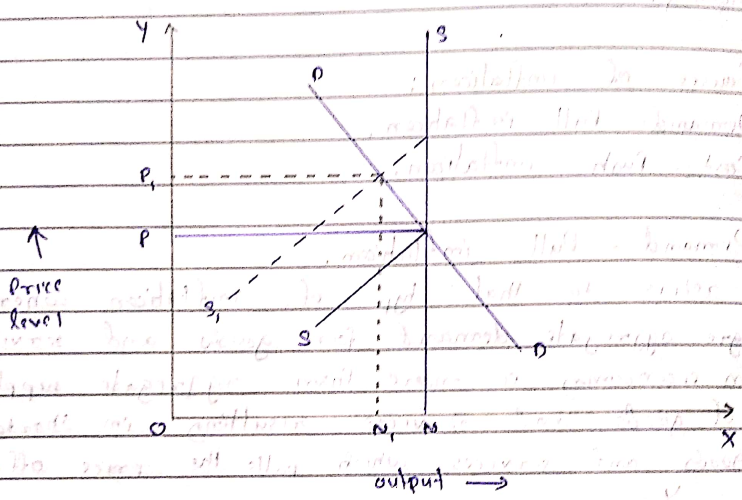
Demand - Pull inflation.

It refers to that type of inflation where ~~agre~~ aggregate demand for goods and services of an economy is more than aggregate supply of goods and services resulting in shortage of goods and services, which pulls the price off.



Cost - Push inflation.

It refers to that type of inflation which results from increase in the cost of production because of which instead of increasing the price, producer reduces the quantity supplied to the market.



Other reasons of inflation.

1. Increase in money supply.
2. Increase in ~~en~~ government expenditure.
3. Decrease in tax.
4. Increase in export.
5. Population.
6. Black money.
7. Scarcity of factors of production.
8. Trade union

Factors of controlling inflation.

1. Monetary Policy.
2. Fiscal Policy.

Monetary policy.

1. Increase in bank rate.
2. sale ~~and purchase~~ of government securities.
3. Increase in cash reserve ratio (C.R.R.).
4. Credit control.

Fiscal Policy:

1. Increase in tax.
2. Decrease in government expenditure.
3. Increase in public borrowing.

Quantitative methods of controlling inflation by Reserve Bank of India

1. Bank rate.
2. Open market operation.
3. CRR.
4. Credit control.

Q) From the following information find out P/V ratio, Fixed cost, BES, variable cost, Margin of safety.

Particulars	2006	2007
Sales	1,50,00000	2,00,00,000
Profit	30,00,000	60,00,000

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Sol^n:

☆ $P/V \text{ ratio} = \frac{\text{change in profit}}{\text{change in sales}} \times 100$

$= \frac{20,00,000}{50,00,000} \times 100$

$= \frac{2}{5} \times 100 = 40\%$

☆ Fixed cost = (sales × P/V ratio) − Profit.

$= (1,50,00,000 \times 0.4) - 30,00,000$

$= 30,00,000$ Rs.

☆ $BES = \frac{\text{Fixed cost}}{P/V \text{ ratio}} = \frac{30,00,000}{0.4}$

7,50,00,000. Rs.

☆ Margin of safety = $\frac{\text{Profit}}{P/V \text{ ratio}}$

$= \frac{30,00,000}{0.4} = 75,00,000$

☆ ~~Variable cost~~ $MOS_{2007} = \frac{50,00,000}{0.4}$

$= 1,25,00,000$ Rs.

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☆ ~~VC~~

☆ $V_{2006} = (1 - P/V \text{ ratio}) \times \text{sales}$

$= (1 - 0.4) \times 1,50,00,000$

$= 90,00,000$ Rs.

☆ $V_{2007} = (1 - 0.4) \times 2,00,00,000$

$= 1,20,00,000$ Rs.