# -:- Industrial Engineering -:-

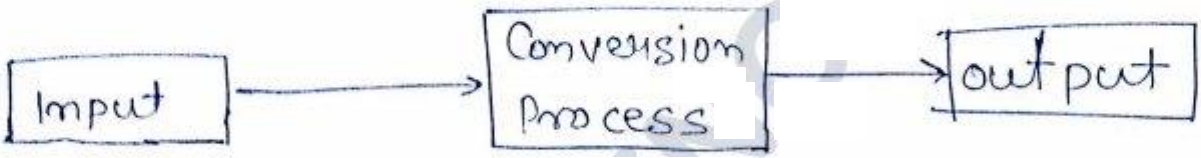
- (1.) Introduction & BEA
- (2.) Inventory ** (70-75%) these topics
- (3.) Sequencing
- (4.) PERT - CPM **
- (5.) forcasting **
- (6.) line balancing
- (7.) Queuing
- (8.) linear Programming **
  - Graphical, simplex, transportation, Assignment
- (9.) MRP
- (10.) Reliability (IES)
- (11.) PPC & Plant layout (Notes)

Books (Not necessary)

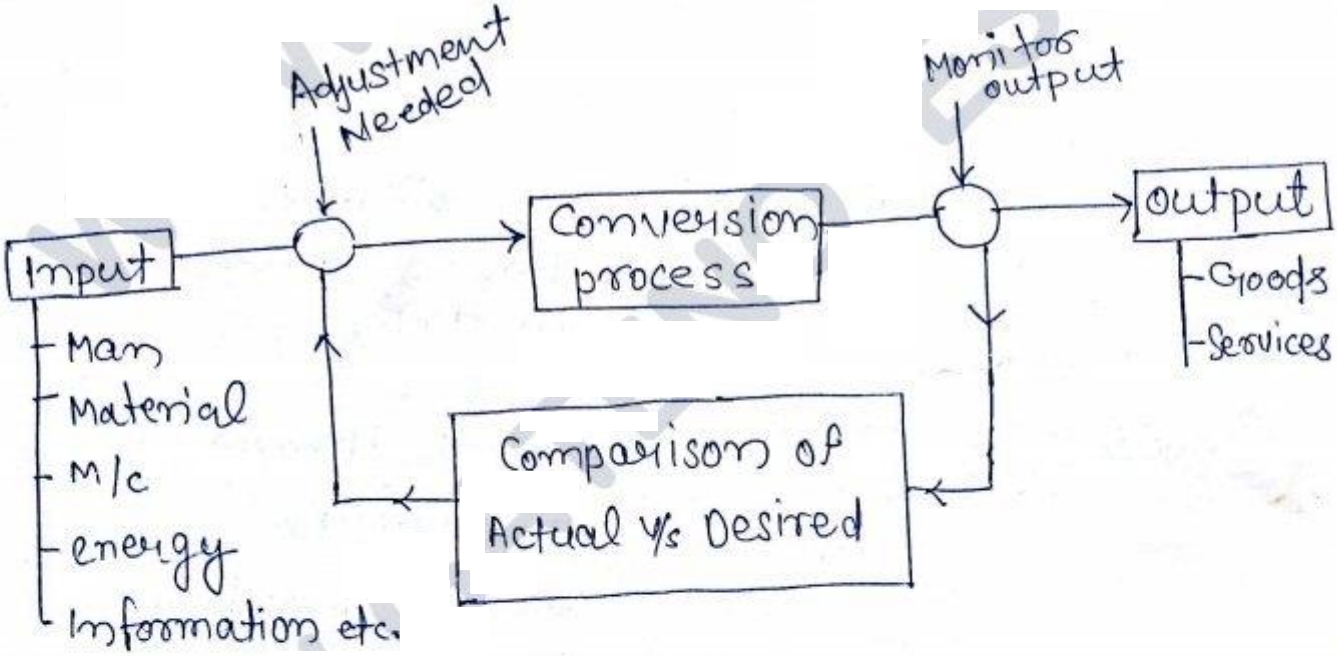
operational Research (OR) - Hira & Gupta
- kanti & swarup
- ND Vohra

Industrial Engineering (I.E.) - O.P. khanna
- mahajan
- Ravi shankar

Production- it is a step by step value addition process of converting one form of material into another form to increase the utality of the product for the user.




Production System: it is an orgnized process of converting row material into final product with a feedback loop.




Productivity!

$$\text{Productivity} = \frac{\text{Output}}{\text{Input}}$$

- ↑ simply Ratio of output to input
- it may be more then 100%. but efficience always less than 100%

it is a quantative ratio between what we produce and what we use as resources to produce them. Every organisation always want to increase productivity by applying new techniques and methods

Industrial Engineering :- I.E. concern with design, instalation and improvement of production system. its objective is to eliminate unproductive operation from the production system inorder to increase productivity

Production manager: production manager is concern with planning controlling and directing the day to day working of production system. is objective is to produce Goods and services of right quality and quantity and pre-determine time and cost

Costs in production :-

1) Prime or Direct Cost = Direct material + Direct labour + Direct expenses

2) Factory overhead or Factory expenses = Indirect material + Indirect labour + Indirect expenses

Indirect material - Not a part of final product
e.g.- Cutting fluid, Lubricant, Grease Cotton, jute, Stationary items etc.

Indirect labour - e.g.. watchman, supervisor higher officers etc.

Indirect expanses - Rent, land, telephone bills, facility development, electricity bills etc.

Electricity use to run machine (Direct expanses)

3) Factory Cost = Prime Cost + factory overhead

Cost to make a product inside factory.

4) Total Cost :- Factory Cost + Marketing, Advertising takes, transportation cost etc.

5) Selling Cost : = Total Cost + Profit

## Break Even Analysis (BEA)

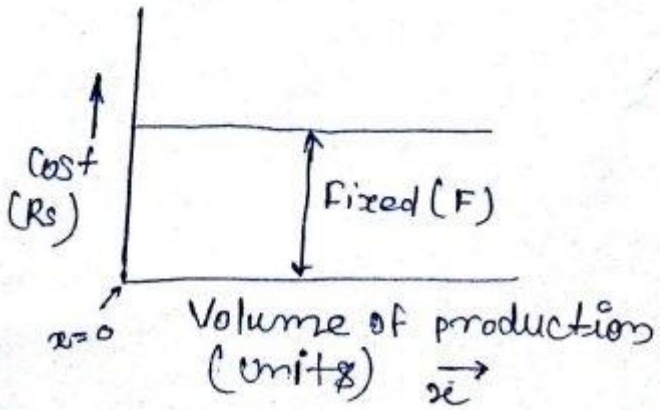
(1)

BEA is the relation among them
- Total Cost
- Selling Cost
- Volume of production (Quantity)

It is an important tool used by production manager to analyse the potential profit or loose possible in future.

(1) Total Cost - it indicates the expenditure made in order to produce certain number of units and it is the sum of fixed and variable cost

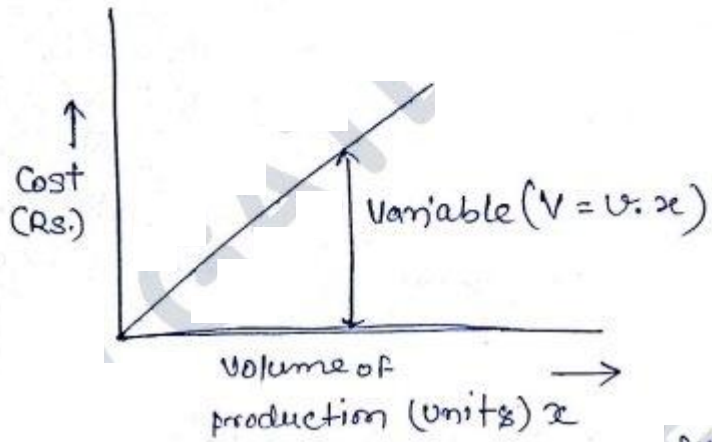
(i) Fixed Cost (F)

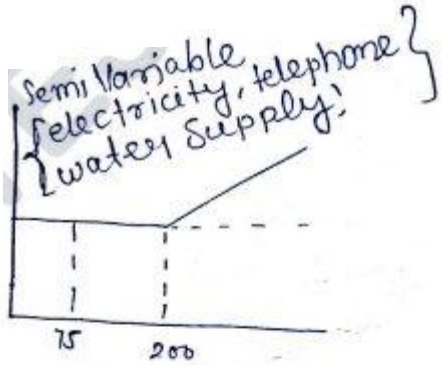


This cost remain fixed or constant irrespective of volume of production it include cost of machine, rent of building, Salary of watch man, higher officers, Advertisement cost, setup cost, intrest insurence cost etc.

(ii) Variable Cost ($V = v.x$)






This Cost is directly proportional to volume of production and it include direct material, direct labour, and running Cost.

## Notations

F - Fixed Cost in Rupee (Rs)

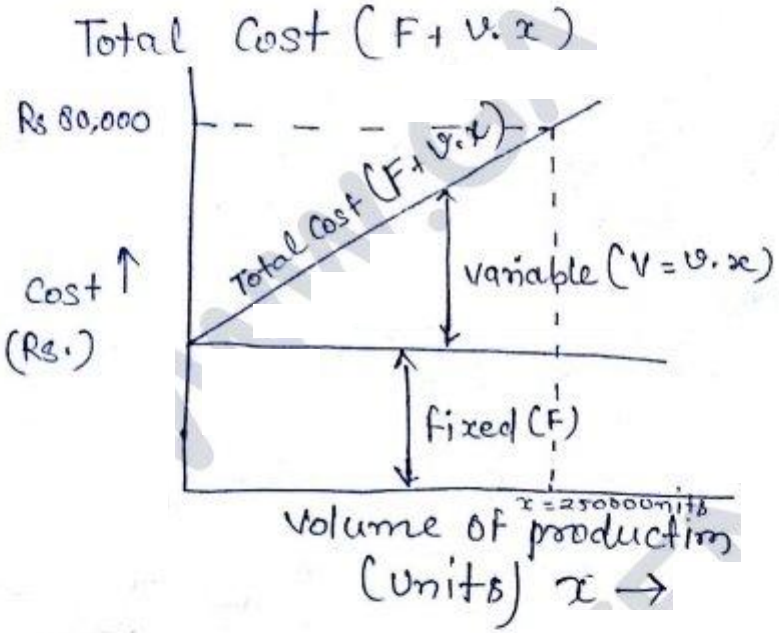
$x$ - No. of units produced

$v$ - variable cost per unit (Rs/unit)

V - total variable cost (Rs) $V = v.x$

s - selling cost per unit (Rs/unit)

S - total sell or Revenue (Rs.) $S = s.x$




Eg:-

$F = 30,000$

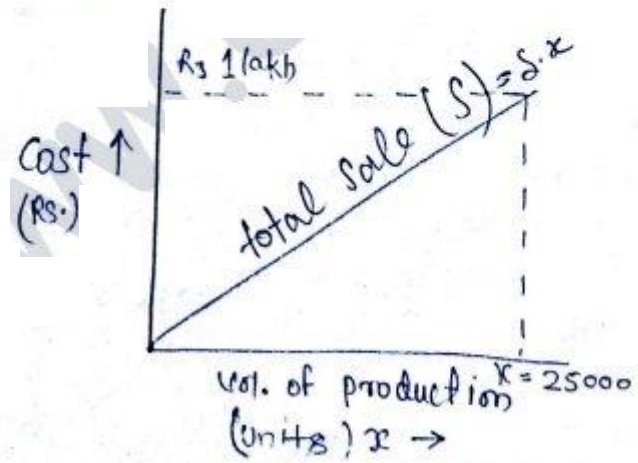
$v = 2$/unit

$TC = F + v.x$

$TC = 30000 + 2 \times 25000$

$TC = 80,000$ Rs

## Total sells or Revenue ($S = s.x$)



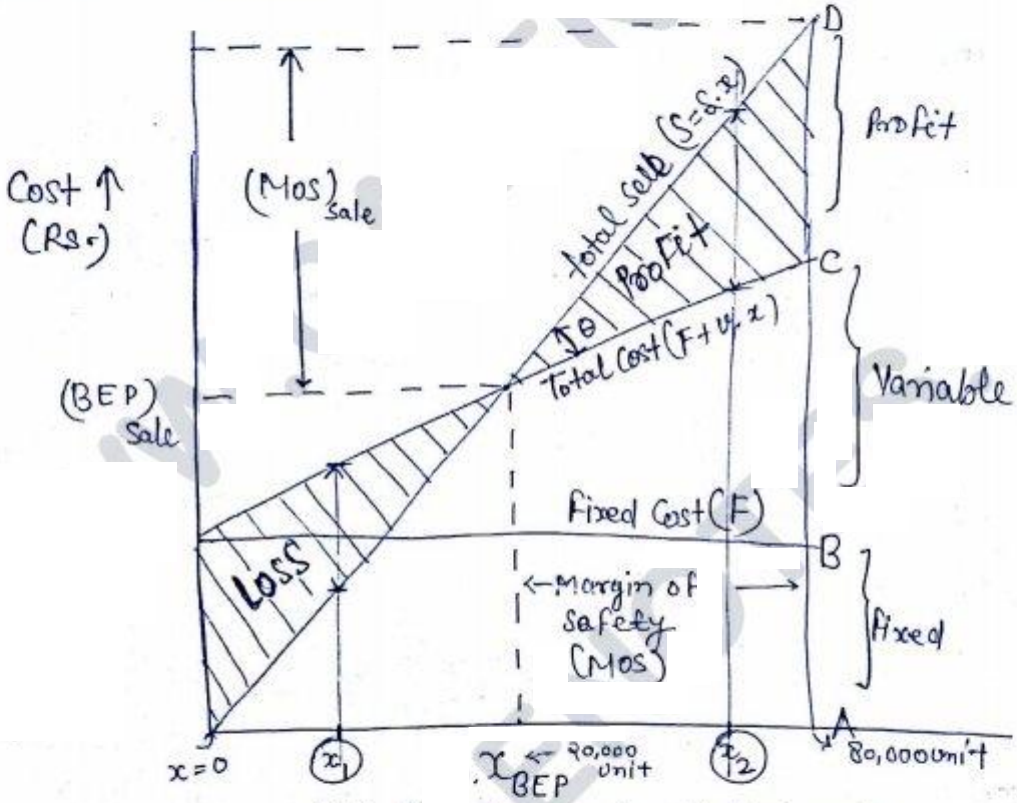

$s = 4$/unit

$S = 4 \times 25000$

$S = 1,00,000$

it indicates return obtain by selling out the quantity produced and it is directly proposal to volume of production.

## Break even chart




- Break even point of sale
- Break even point of units

$x_{BEP} = 20,000$ unit

$s = Rs\ 5/unit$

$(BEP)_{sale} = 1$ lakh Rs

$x_A = 80,000$ unit

$(BEP)_{A,sale} = 4$ lakh

$(Mos)_{unit} = 80000 - 20000 = 60,000$ unit

$(Mos)_{sale} = (4-1)$ lakh $= 3$ lakh Rs.

**Break Even Point :-** BEP is a volume of production where an organization neither profit nor suffers from loss. it is also known as no profit no loss point

Total sale = Total cost + profit

Total Sale $S = s.x$

Total Cost $F+V = F + v.x$

Profit $= P$

$$\boxed{S = F + V + P}$$

$$\boxed{s.x = F + v.x + P}$$

$$\boxed{x = \frac{F+P}{(s-v)}} \rightarrow \text{unit}$$

$x$ no. of unit for profit P

at break even point

$x$

$$\boxed{x_{BEP} = \frac{F}{s-v}} \text{ unit}$$

$$\boxed{(BEP)_{Sale} = x_{BEP} \cdot s = \frac{F}{(s-v)} \cdot s} \text{ Rs.}$$

Few terms in BEA

1) Angle of Incidence ($\theta$) - it is angle at which total sale line cuts the total cost line. larger this angle better the working condition will be

2) Contribution Margin (CM)

CM = Total Sale - Total Variable Cost

$$\boxed{CM = S - V = (s - v)x}$$

$$\boxed{\text{Contribution} = s - v}$$

Change in profit by a unit $\begin{cases} F = 25{,}000 \\ v = 4/\text{unit} \\ s = 7/\text{unit} \end{cases}$

$= 7 - 4$

$= 3/\text{unit}$

$$S = F + V + P$$

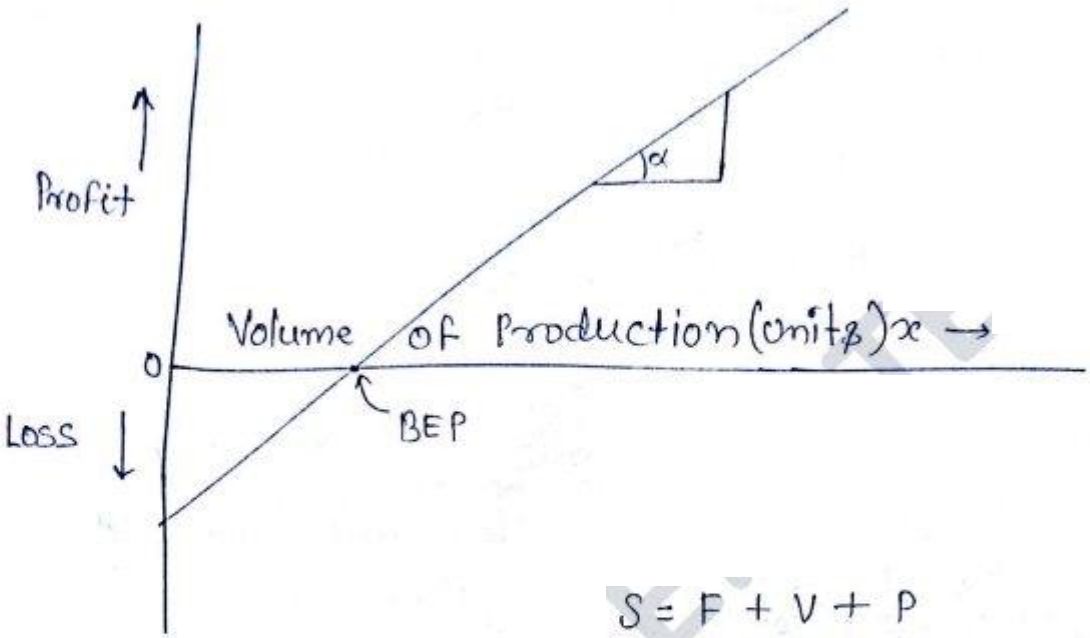
$$S - V = F + P$$

$$CM = F + P = (s - v).x$$

$$\boxed{P = CM - F}$$

↳ Marginal Profit
or
Gross Margin

3) Profit Volume Graph :-




Slope of line ($\alpha$) = $S - V$
= Contribution

$S = F + V + P$

$S.x = F + V.x + P$

$$P = (S - V).x - F$$

a) At $x = 0$

$P = -F$

b) At BEP $x_{BEP} = \frac{F}{(S-V)}$

$P = 0$

4) Profit Volume Ratio $\left(\frac{P}{V}\right)_{Ratio}$ :-

it is a term used to represent profitibility related to sales and it is normaly preffered when the organisation deals in multiproduct. This Ratio always remain constant for a perticulay product. It is the Ratio of Contribution Margin to the Volume of Sales.

$$\left(P/V\right)_{Ratio} = \frac{CM}{S} = \frac{(S-v)\cdot x}{S\cdot x} = \frac{S-v}{S}$$

$$\left(P/V\right)_{Ratio} = \frac{F+(P)^{\uparrow}}{(S)\uparrow} = \frac{S-v}{S}$$

$$\boxed{\frac{F+P_1}{S_1} = \frac{F+P_1}{S_2}}$$

At BEP, $P=0$

$$\boxed{\left(P/V\right)_{Ratio} = \frac{F}{S_{BEP}}}$$

Remain Constant throughout

Approximated Value

$$\left(P/V\right)_{Ratio} = \frac{\Delta P}{\Delta S}$$

e.g. - Three items have $\left(P/V\right)_{Ratio}$ = 0.25, 0.24, 0.33
(↓ sale) (↑ sale)

Note:- If there is option of increasing the sale highest $\left(P/V\right)_{Ratio}$ product prefered.
if there option of Decreasing the Sale lowest $\left(P/V\right)_{Ratio}$ product should prefered.

5) Margin of Safety (MOS) :- it is the difference of output at full capacity compared to output at Break-even-point

$$(MOS)_{sale} = (Sale)_x - (Sale)_{BEP}$$

$$\boxed{(MOS)_{Sale} = S_x - S_{BEP}}$$

$$(MOS)_{Sale} = S.x - S.x_{BEP}$$

$$= S\left[x - \frac{F}{S-v}\right]$$

$$= S\left[\frac{(S-v)x - F}{(S-v)}\right]$$

$$(Mos)_{Sale} = \frac{P}{\left(\frac{S-v}{S}\right)}$$

$$\boxed{(Mos)_{Sale} = \frac{P}{(P/x)_{ratio}}}$$

In terms of Percentage

$$\boxed{MOS\ \% = \left(\frac{S_x - S_{BEP}}{S_x}\right) \times 100}$$

Changes In Break Even Point when -

1) Fixed Cost Increases, Break even point will increase

$F \uparrow$ ; $x_{BEP} \uparrow$ $\quad x_{BEP} = \frac{F}{S-v}$

2) Variable Cost ($v$) increase, BEP increase

$v \uparrow$ , $x_{Bep} \uparrow$

3) selling price ($S$) increase, BEP decrease

$S \uparrow$, $x_{BEP} \downarrow$

Problem (1) A product can be produced by four process as given below. in order to produce 100 unit which process should be prefered?

| Process | F(Rs.) | v(Rs/unit) | x=100 | x=5 |
|---|---|---|---|---|
| I | 20 | 3 | 320 | 35 |
| II | 40 | 1 | 140 | 45 |
| III | 10 | 4 | 410 | 30 |
| IV | 30 | 2 | 230 | 40 |

$x = 100$
$TC = F + v \cdot x$

for 100 unit II process
for 5 unit III process

Problem (2) (IAS 2014) A product can be produced by three process as given below Plot the total cost curve for all the three process and determine the economic feasibility if the requirment of 8000 units which process should be prefered and the crosponding cost.

| Process | F(Rs) | V(Rs/unit) |
|---|---|---|
| Automatic (A) | 2,50,000 | 10 |
| Semi Automatic (S) | 1,50,000 | 20 |
| Manual (M) | 50,000 | 40 |

at $x = 8000$ unit

Sol$^n$ for process (A) $F = 2,50,000$ Rs

$v = 10$ Rs/unit

$x = 8000$ Unit

$T.C_o = 2,50,000 + 80000$

$= 3,30,000$ Rs

for process (S) $F = 1,50,000$ Rs

$v = 20$ Rs/unit

$T.C_o = 1.50000 + 20 \times 8000$

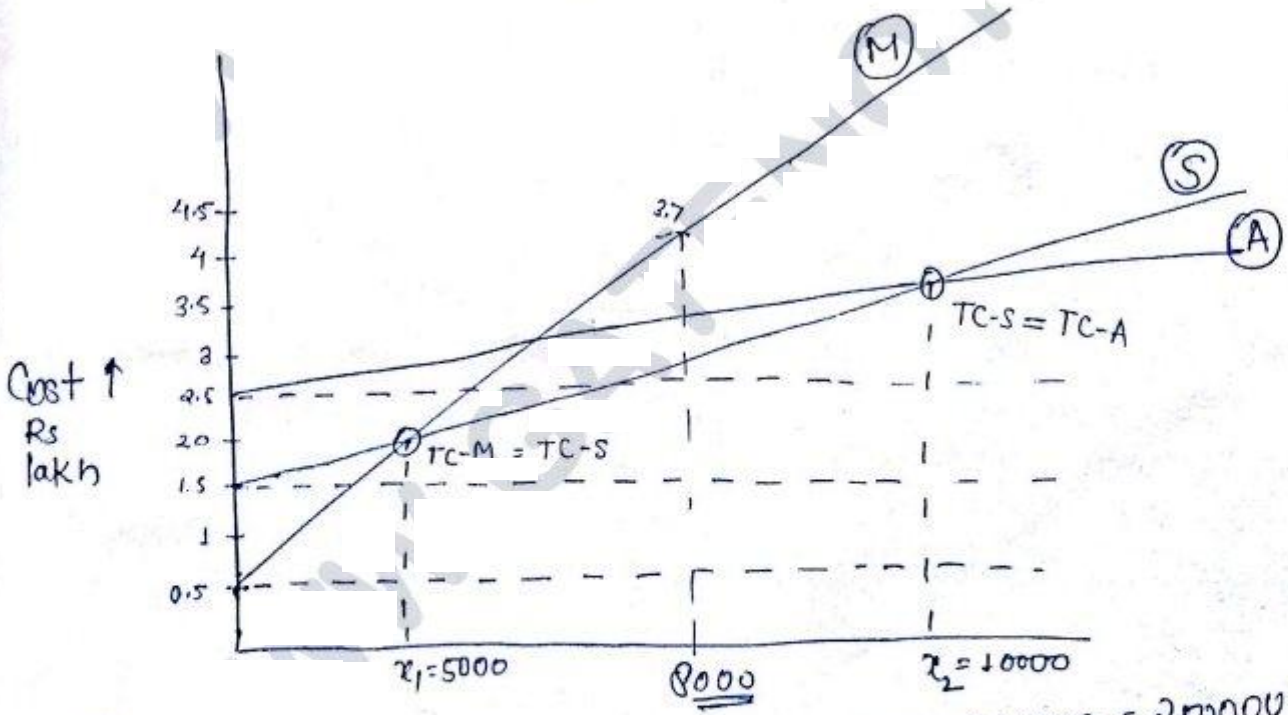
$= 3,10,000$ Rs.

for process (M) $F = 50,000$

$v = 40$ Rs/unit

$T.C_o = 50,000 + 40 \times 8000$

$= 3,70,000$ Rs




$50,000 + 40x_1 = 150000 + 20x_1$

$x_1 = 5000$ units

$150000 + 20x_2 = 250000 + 10x_2$

$x_2 = 10000$ Units

Semi-Automated (S) should be preferred for 8000 units

**Problem (3)** (ESE 2007) For a production system

$F$ = Rs 10 lakh

$v$ = Rs 60/unit

$S$ = 100/unit

Due to inflation fixed cost increases by 5% and variable cost increase by 10% in order to keep BEP safe determine the percentage (%) increase require in selling price per unit.

**Sol$^n$**

$F$ = Rs 10 lakh $\quad F' = Rs\ 10.5$ lakh

$v$ = Rs 60/unit $\quad v' = Rs\ 66$/unit

$S$ = 100/unit $\quad S' = ?$

$$\frac{F}{S-v} = \frac{F'}{S'-v'}$$

$$\frac{10}{100-60} = \frac{10.5}{S'-66}$$

$$S' = Rs\ 108/unit$$

$$\left(\frac{S'-S}{S}\right) \times 100 = \left(\frac{108-100}{100}\right) \times 100 = 8\%$$