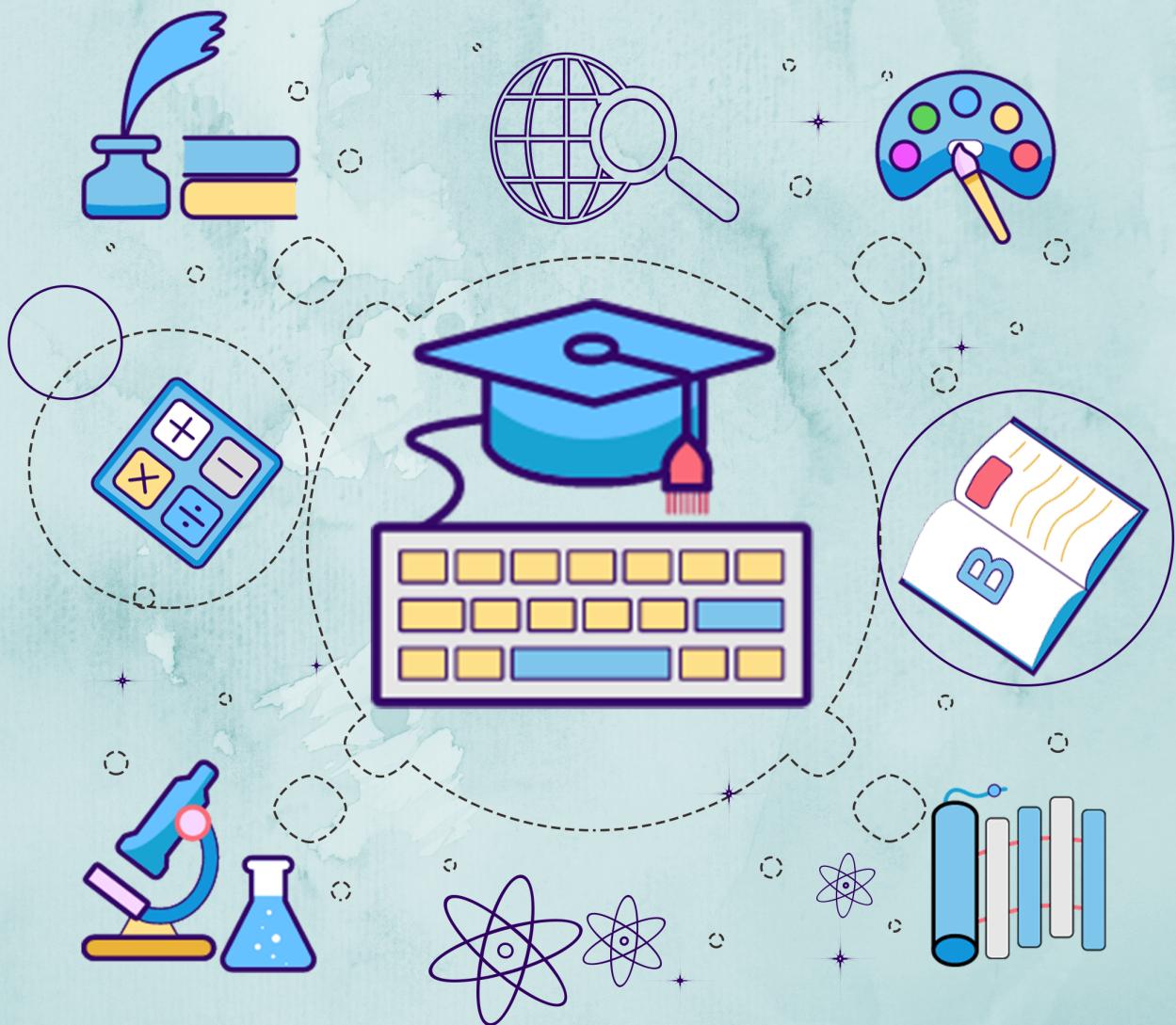


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Module – 2

Production and Cost

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Production

- It is the process of transformation of inputs into output.
- Input > Factors of production

Production Function

It is defined as the technical relationship which shows maximum level of output producible from given input

$$Q = f(L_a, L, K, O)$$

Types of Production Function

- Based on the availability of inputs production function has been classified into two
 - 1.) The law of Variable Proportion (Short Run)
 - 2.) The law of Fixed Proportion (Long Run)

Variable Proportion

It is the arrangement where the quantity of a single input varies, keeping the quantities of other inputs constant . It happens in short run due to unavailability of all inputs.

Fixed Proportion

It is the arrangement where the quantities of all inputs are varied in the same and equal proportion. It happens in long run.

Basic Production Concepts

Total Product (TP) / Total Physical Product (TPP)

It refers to the total amount of a commodity produced during given period of time with each set of inputs. It is also known as Total Returns.

Average Product (AP)

It is the output produced using per unit of the variable factor input.

$$AP = TP / L \text{ OR } Q / L$$

(L is the variable factor in most of the cases)

Marginal Product (MP)

- It is the addition to the total product from the use of an additional unit of variable factor input
- $MP = TP_n - TP_{n-1}$
- $MP = \frac{d(TP)}{d(L)}$ OR $\Delta TP / \Delta L$

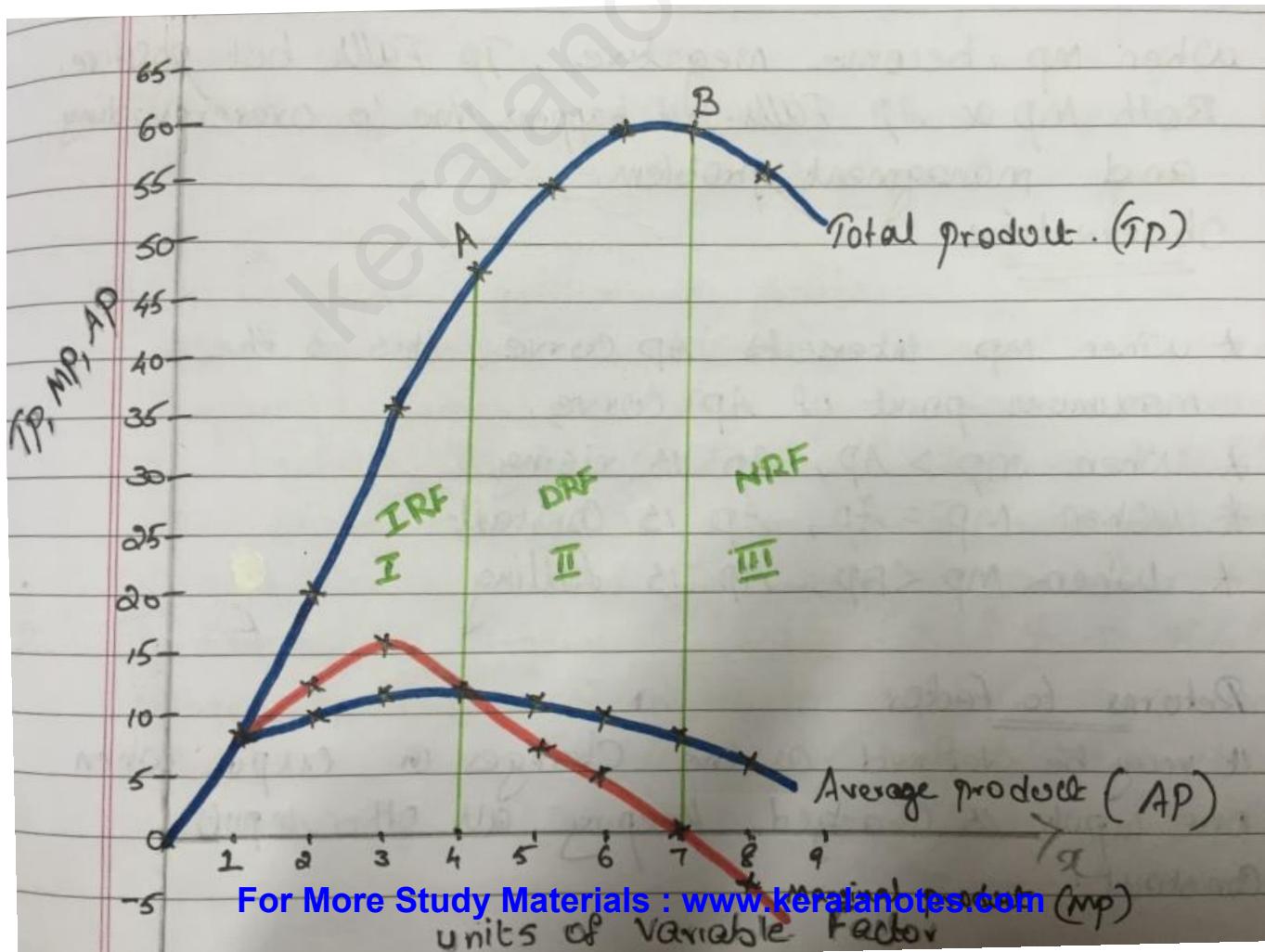
The Law of Variable Proportion

- It is also known as Law of Diminishing Returns, Returns to Factor , Short run Production Function
- The law examines the short run relationship between one variable input and output produced, while keeping all other factor inputs constant

Statement of Law

The law of variable proportion states that as more and more units of a variable factor are applied to a given quantity of a fixed factor , the total product increase at an increasing rate initially , but eventually it will increases at a diminishing rate.

Variable Factor Employed	TP	AP	MP	STAGES
0	-	-	-	-
1	8	8	8	Stage 1 (IRF)
2	20	10	12	Stage 1 (IRF)
3	36	12	16	Stage 1 (IRF)
4	48	12	12	Stage 2 (DRF)
5	55	11	7	Stage 2 (DRF)
6	60	10	5	Stage 2 (DRF)
7	60	8.6	0	Stage 3 (NRF)
8	56	7	-4	Stage 3 (NRF)



STAGE 1 : Increasing Returns to Factor (IRF)

- TP , AP , MP increases at an increasing rate in the initial stage of production .
- This is due to fuller utilization of fixed factors and division labour

STAGE 2 : Diminishing Returns to Factor (DRF)

- Most relevant stage in production
- MP falls and TP increases at a diminishing rate
- At the end of second stage , TP reaches max and MP reaches zero
- AP also falls

STAGE 3 : Negative Returns to Factor (NRF)

- MP becomes negative ,TP falls but remains positive.
- AP remains falling

Observations

- When $MP > AP$, AP Rises
- When $MP = AP$, AP remains constant
- When $MP < AP$, AP falls

Returns to Factor

- Single factor input varies
- Short run
- Factor quantity Varies
- It is the change in output when one input varies while keeping all other inputs constant

Returns to Scale

- It describes the change in output when all inputs are changed in same and equal proportion
- All factor input varies
- Long run

We have 3 stages in Returns to Scale:

- 1.) Increasing Returns to Scale
- 2.) Constant Returns to Scale
- 3.) Diminishing Returns to Scale

Economies of Scale

- It means advantages of large scale production which help in reducing the average cost of production.
- It can be broadly classified into two:
 1. Internal Economies
 2. External Economies

Internal Economies

- Labour Economies
- Technical Economies
- Managerial Economies
- Marketing Economies
- Financial economies

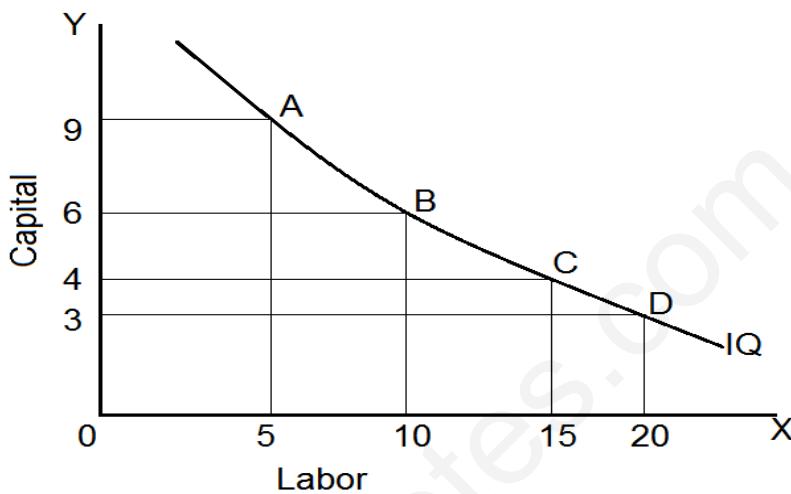
External Economies

- Economies of localization
- Economies of Information
- Economies of vertical disintegration
- Economies of by - product

Isoquants

- It is a curve which shows various combinations of two factor inputs which give the same level of output.
- ISO means equal and QUANT means quantity.
- It is also called Isoproduct curves and Equal product curves.

Combinations of Labor and Capital	Units of Labor (L)	Units of Capital (K)	
A	5	9	100
B	10	6	100
C	15	4	100
D	20	3	100

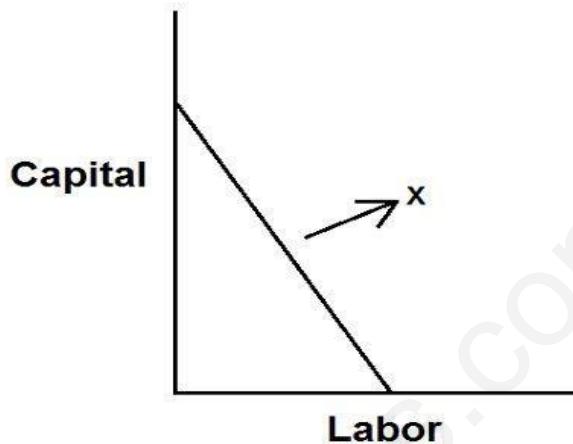


Properties of Isoquants

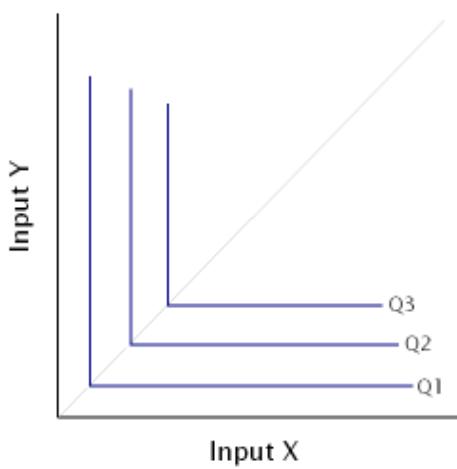
- Isoquants are negatively sloped
- Isoquants are convex to the origin
- Two isoquants cannot cut each other
- An isoquant lying above and to the right of another isoquant represents a higher level of output.
- Isoquants need not be parallel

Types of Iso-quant Curves

- **Linear Iso-quant Curve:** perfect substitutability between the factors of production.



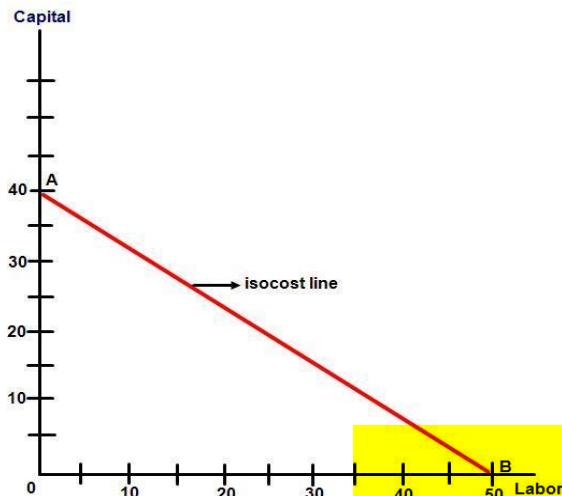
Right Angle Iso-quant Curve ; complementarity



Isocost line

- An isocost line is a graphical representation of various combinations of two factors (labor and capital) which the firm can afford or purchase with a given amount of money or total outlay.

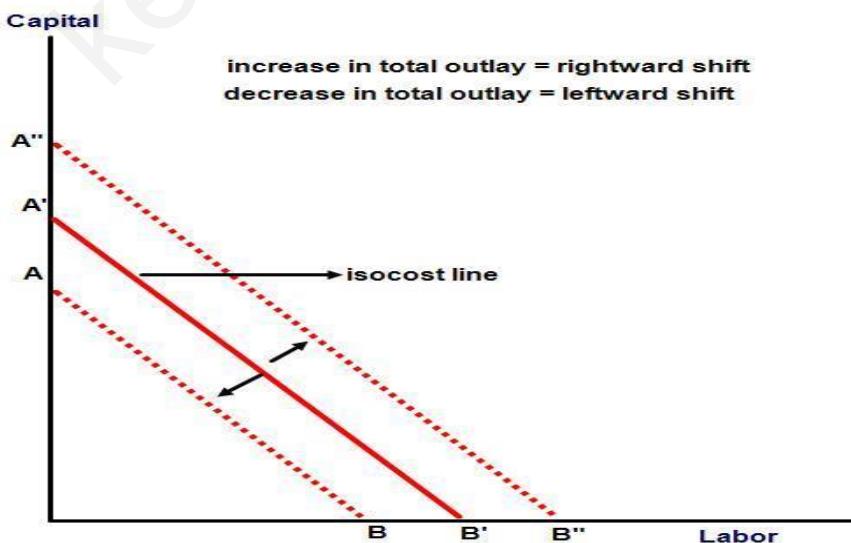
$$C = wL + rK$$



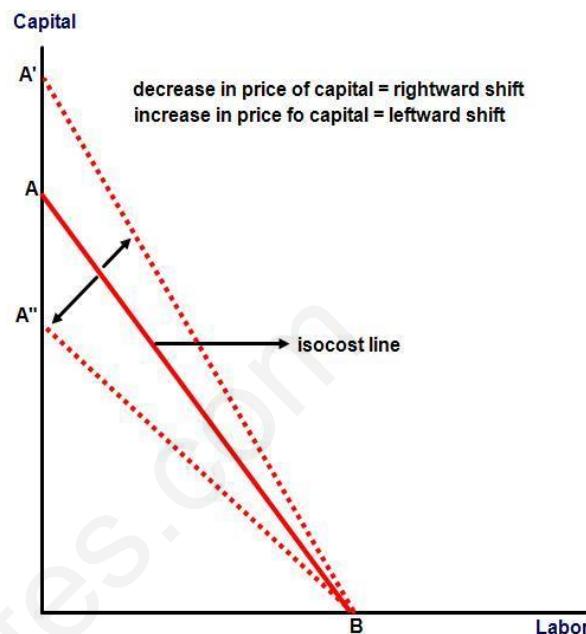
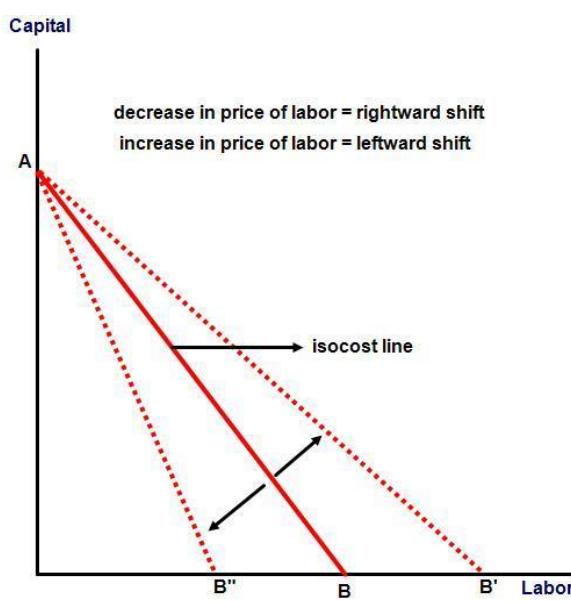
Slope of AB = $\frac{\text{price of labor}}{\text{price of capital}}$
 $= \frac{w}{r}$

Shift in Isocost Line

- Change in total outlay to be made by the firm

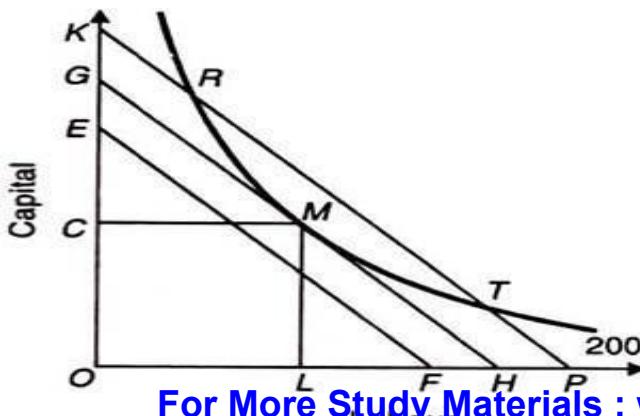


- Change in price of a factor-input



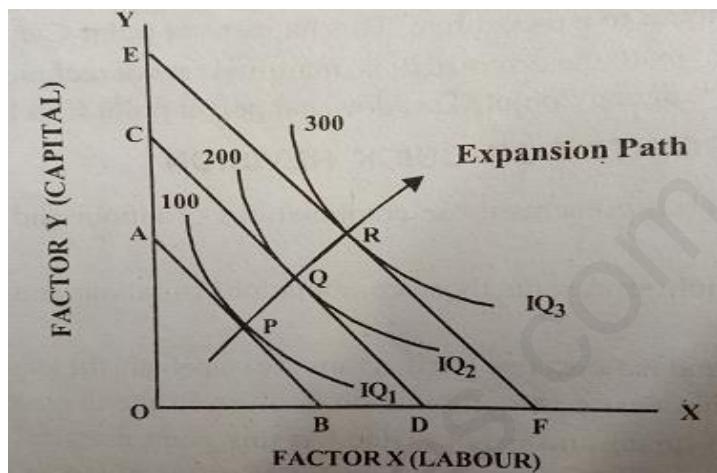
Producer's Equilibrium / Least cost combination

- The point of least-cost combination of factors for a given level of output is where the isoquant curve is tangent to an iso-cost line.
- $W/r = MP_L/MP_K = MRTS_{LK}$



Expansion Path

- Expansion path shows the path on which a rational producer would prefer to increase scale of production in his firm.



Technical Progress

- When there is a change in technical progress, the production function will change.
- Technical progress may be embodied (investments in new equipment) and disembodied (Research and Development)

Cobb – Douglas Production Function

- It was proposed by **Wickseed** for the first time
- It was statistically tested by **Charles .W. Cobb** and **Paul. H. Douglas** in **1928**
- They used the data from **manufacturing sector** of USA for the years 1899 to 1922

The cobb - Douglas production function describes as follows :-

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

$Q \rightarrow$ Qty of output produced

$A \rightarrow$ Technology

$L \rightarrow$ Labour / $K \rightarrow$ capital

$\alpha \rightarrow$ Output elasticity with respect to Labour

$\beta \rightarrow$ Output elasticity with respect to capital.

As the input quantity rises, the returns to scale expands to three stages

① $\alpha + \beta = 1$ Constant Returns to scale.

② $\alpha + \beta > 1$ Increasing Returns to scale.

③ $\alpha + \beta < 1$ Decreasing Returns to scale.

- Output elasticity measures the responsiveness of output to a change in levels of either labor or capital used in production.
- C - D Production function is a homogenous production function
- C - D Production function always exhibits constant returns to scale

$$\underline{\alpha + \beta = 1}$$

- Consider the following production function
$$Q = 150 K^{0.7} L^{0.5}$$
 where
 - 1.) $K = 1, L = 1$
 - 2.) $K = 2, L = 2$
 - 3.) $K = 4, L = 4$

Find the value of Q and identify the returns to scale of production .

- Suppose the production function is given as
$$Q = 2K^{1/2} L^{1/2}$$
.
- a.) What will be the output when $K = 16$ and $L = 36$
 - b.) What is the marginal product of labour when $K = 16$ and $L = 36$
 - c.) What is the average product of capital when $K = 16$ and $L = 36$
 - d.) Find the number of units of capital required to produce 40 units of output if $L = 25$?

Cost of Production (Concepts)

- Cost is the expenditure incurred by a firm in the production of a commodity.

Cost Concepts

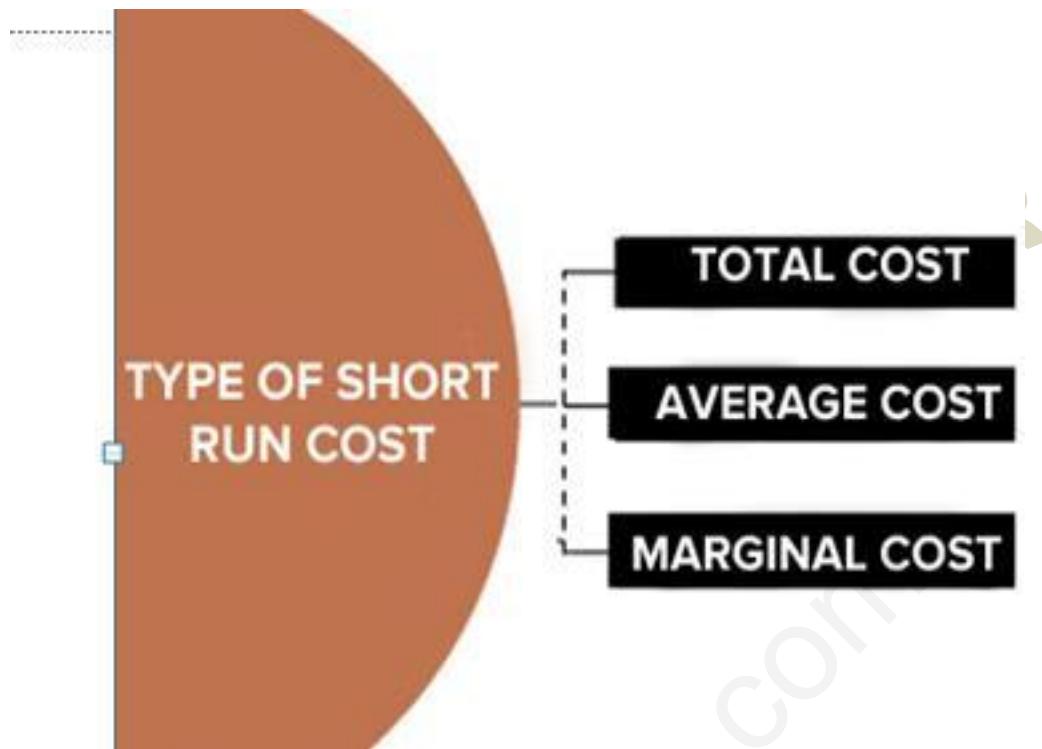
Explicit Cost: it is the expenses actually met by the producer while producing a commodity.
(Raw materials)

Implicit Cost: is the opportunity cost of the factor services supplied by the firm itself.
(Rent)

- **Accounting Costs** – this is the monetary outlay for producing a certain good. Accounting costs will include your variable and fixed costs you have to pay.
- **Sunk Cost**: These are costs that have been incurred and cannot be recouped. (Adv cost)
- **Social Costs**. This is the total cost to society. It includes private costs plus any external costs.
- **Private cost**: It is the cost incurred by the producer in the production of a good.
- **External Cost**: When a commodity is produced it may cause damages to the environment in the form of fair pollution, water pollution etc.
- **Replacement cost** is the amount of money required to replace an existing asset with an equally valued or similar asset at the current market price.

Types of Cost

- **Short run cost** : Cost refers to a certain period of time where at least one input is fixed while others are variable.
- **Long run cost** : The long run is a period of time in which all factors of production and costs are variable.



Short Run Cost

$$TC = TFC + TVC$$

Total Cost (TC)

Total expense incurred during production

TFC / FC

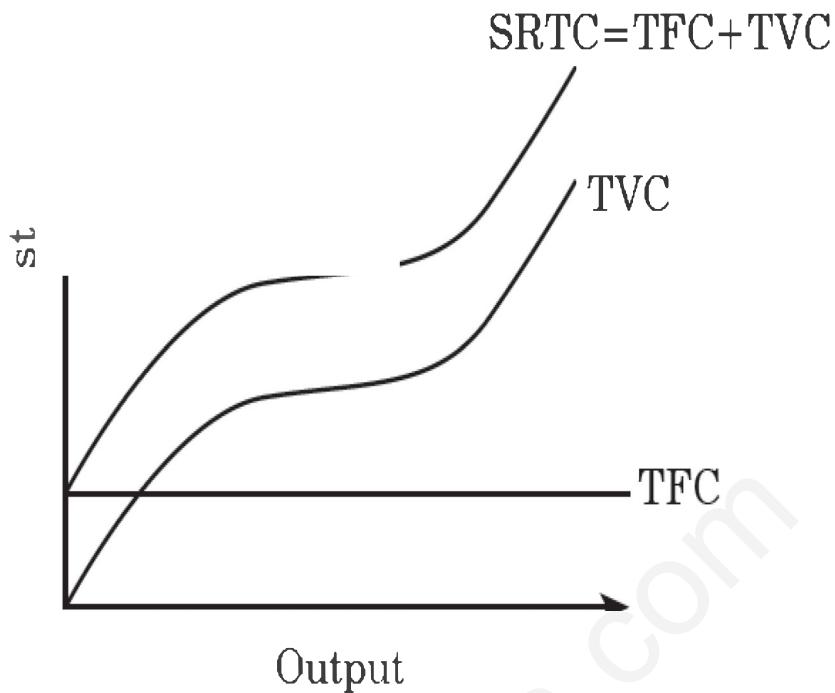
Cost that do not vary with output.

Eg: salary , rent

TVC / VC

Cost that vary according to change in output

Eg: Raw materials



Average Cost (AC) / Average Total Cost (ATC)

$$AC = TC / Q$$

$$TFC + TVC / Q$$

$$AFC + AVC$$

Average Variable Cost (AVC)

$$AVC = TVC / Q$$

Average Fixed Cost (AFC)

$$AFC = TFC / Q$$

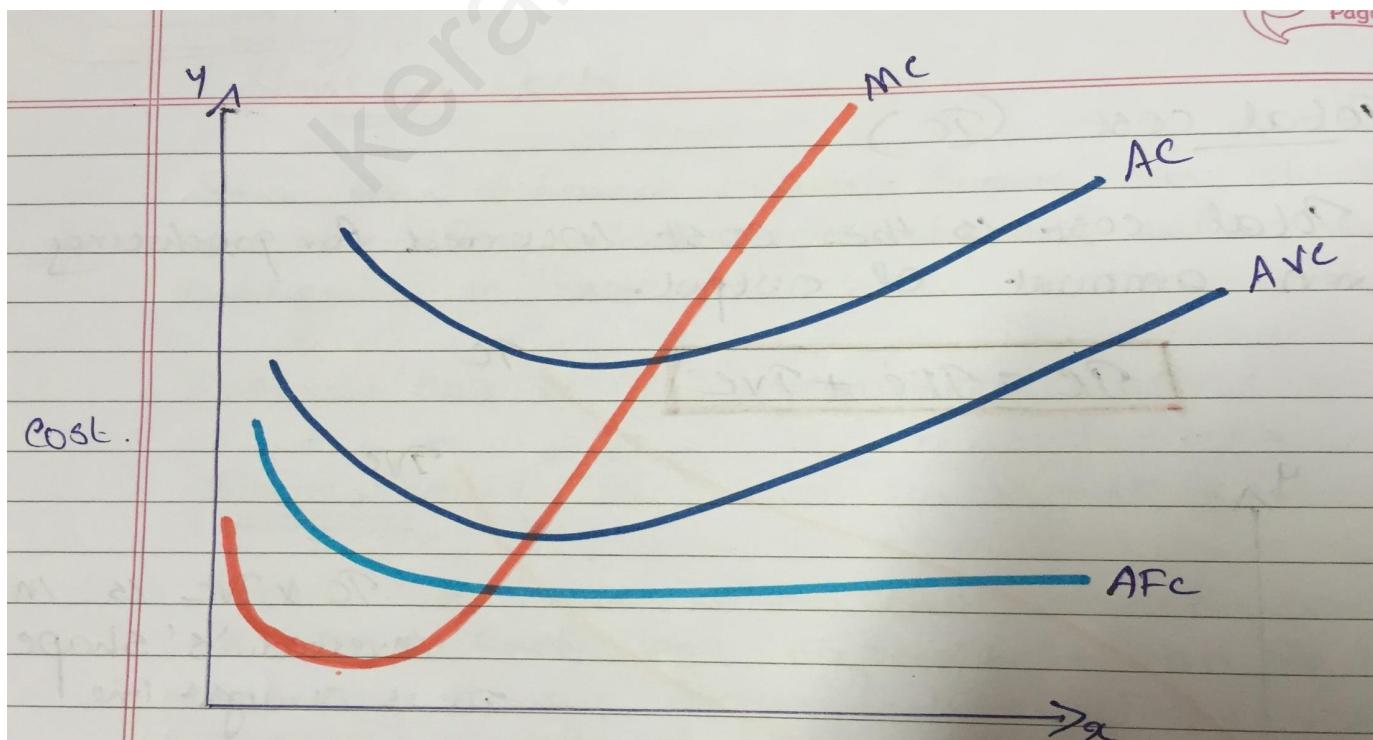
Marginal Cost (MC)

- It is the addition to total cost for producing an additional unit of a commodity

$$\underline{MC = TC_n - TC_{n-1}}$$

$$\underline{MC = d(TC)/ d(Q)}$$

Position of Short Run Cost Curves



Long Run Cost

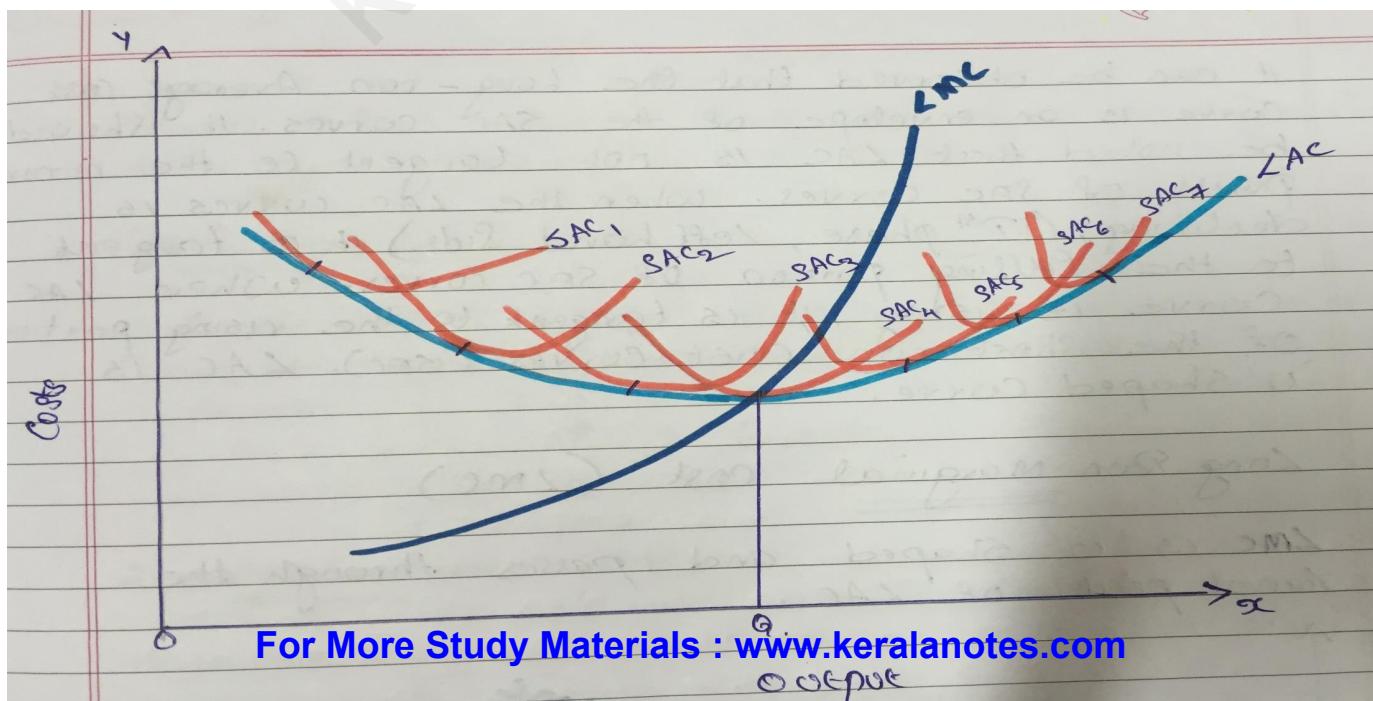
- In long run all costs varies
- There is no fixed cost in long run

Long Run Average Cost (LAC)

- LAC is derived from short run AC
- LAC is termed as the collection of SAC

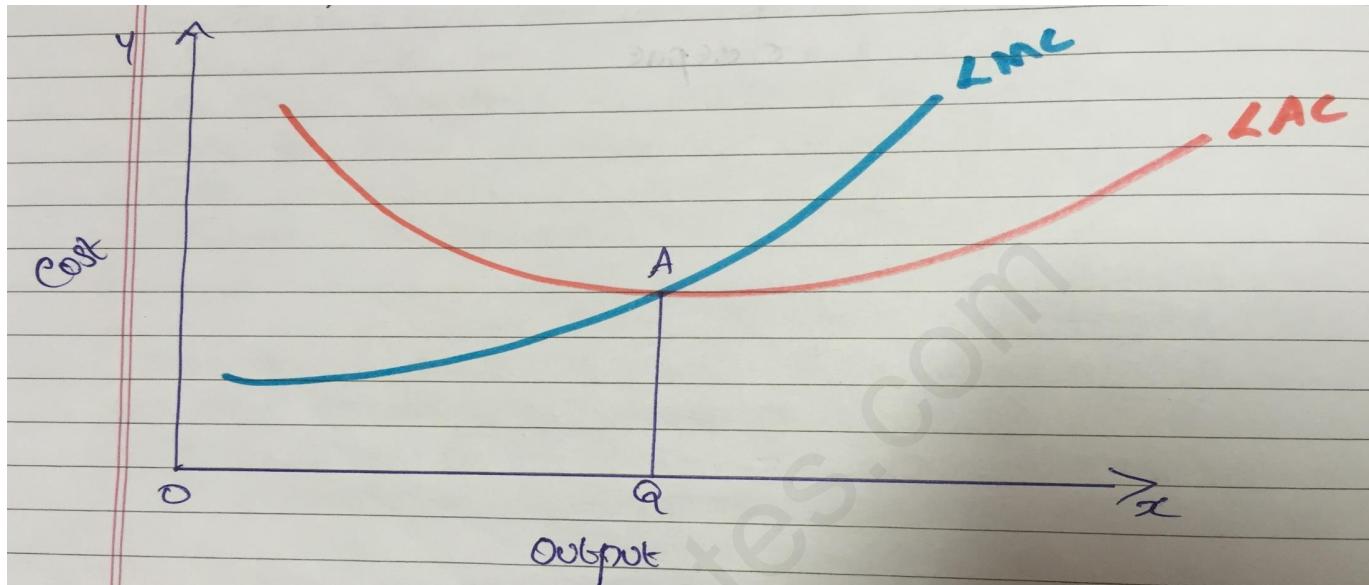
Long Run Average Cost (LAC)

It is also known as **Envelope Curve** or **Planning curve**



Long Run Marginal Cost Curve (LMC)

- LMC is 'U' shaped curve
- LMC passes through the lowest point of LAC



The total cost function of a firm is given as

$$TC = 1000 + 10Q - 6Q^2 + Q^3$$

- Derive TVC, MC, AVC and AC
- What is TFC when output equals to 500 units?
- What is MC when output is 100 units?

- If the Total Cost function of a firm is given as $TC = 162 + 3Q + 2Q^2$. find the average cost at an output level of 6 Units ?
-
- If a firm's Total Revenue function is given as $TR = 110Q - 5Q^2$ and Total Cost function is given as $TC = 10Q - Q^2 + 0.33Q^3$
 - Find MR and AR
 - Find MC And AC

Complete the following Table

OUTPUT	TC	TFC	TVC	AFC	AVC	AC	MC
0							
1	200		100				100
2	290				95		
3						123	
4						110	71
5			420	20	84		80

Revenue

- Revenue means receipts from sale of output by a firm in a given period

Total Revenue (TR)

- It is the total amount of money received by a firm from the sale of goods and services during a certain period

$$\text{TR} = Q \times P \quad \text{i.e. } PQ$$

Q = Quantity

P = Price

Average Revenue (AR)

- $AR = TR/Q$
- $P \times Q / Q = P$

$$\text{i.e } AR = P$$

Marginal Revenue (MR)

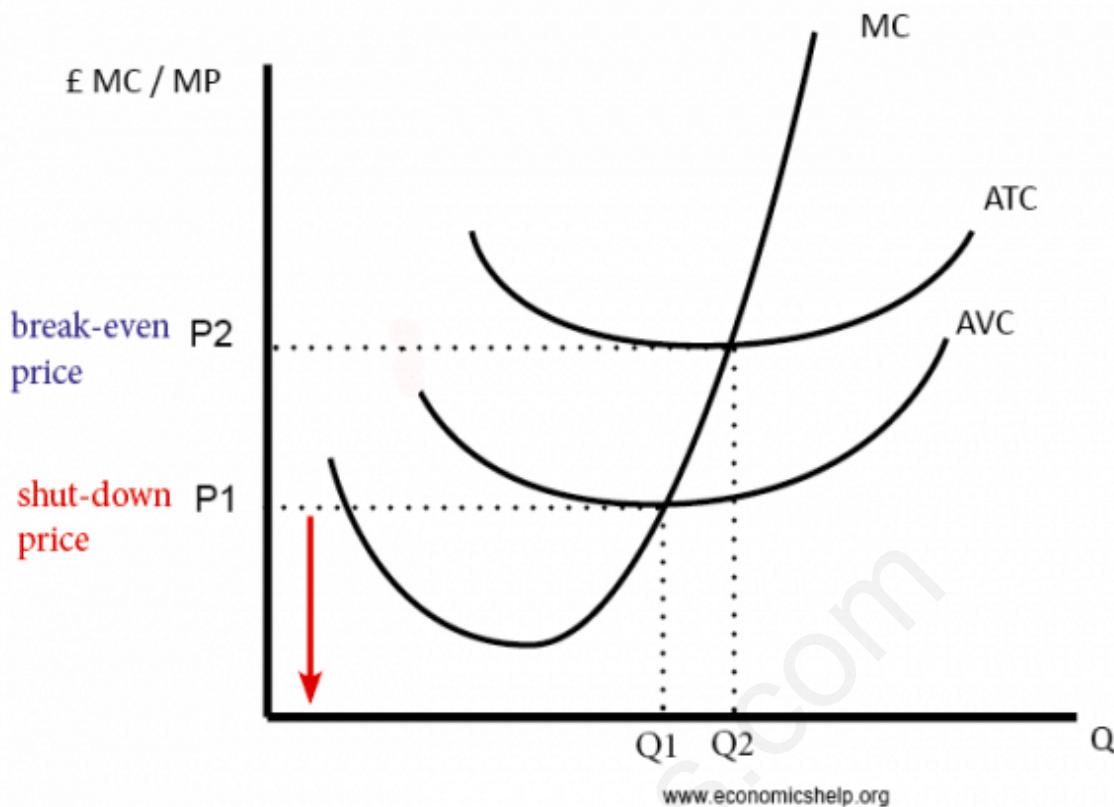
It is the addition to total revenue from the sale of an additional unit of output

$$MR = TR_n - TR_{n-1}$$

$$MR = d(TR) / d(Q)$$

Shut down Point

- A shut down point is a point where the firm experience no benefit in continuing operations or productions.
- Shutdown point is defined as that point where the market price of the product is equal to the AVC in the short run
- $P = AVC$



Break Even Point

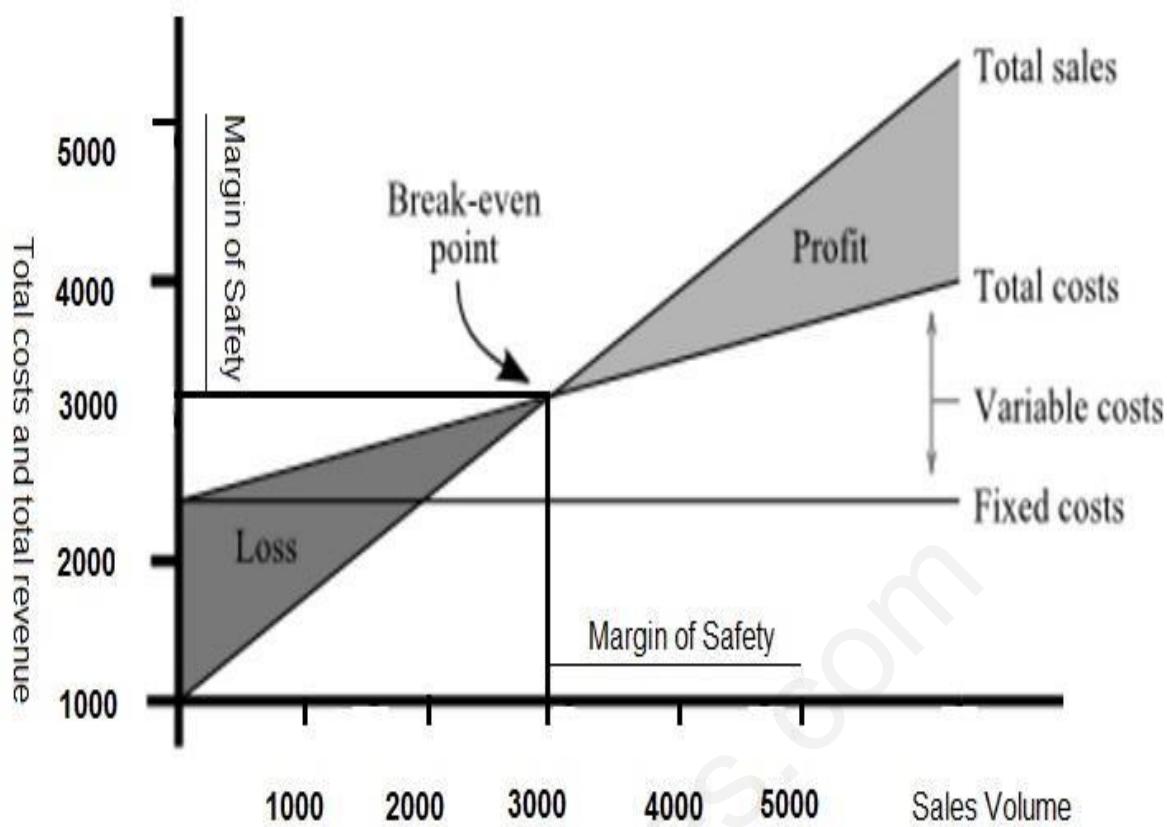
- It is method used to study the relationship between TC and TR
- **Break even point (BEP)** is used to understand this relationship
- BEP is the point where **TC equals to TR**. No profit , no loss (zero profit)

$$\text{BEP: } \text{TC} = \text{TR}$$

$$\text{Profit / Loss} = \text{TR} - \text{TC}$$

$$\text{Profit / Loss} = (\text{P} \times \text{Q}) - (\text{TFC} + \text{TVC})$$

$$\text{BEP} = \frac{\text{TFC}}{\text{P} - \text{AVC}}$$



PV Ratio

- PV Ratio (Profit Volume Ratio) is the ratio of contribution to sales.
- P/V Ratio = Sales – Variable cost (V)/Sales (S)

$$S - V/S$$
- or, P/V Ratio = Fixed Cost + Profit/Sales

$$F + P/S$$
- Using PV Ratio, we can find BEP

$$\text{BEP} = \text{TFC} / \text{PV Ratio} \quad \text{OR} \quad \text{TFC} * S / S - V$$

Margin Of Safety

- Margin of safety is how much output or sales level can fall before a business reach it's BEP

Margin of Safety = Excess of Sales – BEP

Advantages of BEP

- To know the cost revenue relationship
- To plan future business expansion
- To plan future production
- To target sale
- It helps in managerial decision making

- The financial details of a company are as below. Variable cost per unit is Rs.30 , selling price per unit is Rs.40 , fixed expenses are Rs.100000.

Calculate 1.) Break even units

2.) Margin of safety considering the actual sales as 15000 units.

3.) The selling price per unit , if BEP is brought down to 8000 units.

- A company sells their product at Rs.650 per unit , the fixed cost is Rs 82000 and variable cost is Rs.240 per unit.
 - A.) What is BEP
 - B.) what volume is needed to generate profit of rs.10250

Suppose a firm makes candles and every month it has to pay Rs. 3000 as rent and Rs. 3000 as interest charges. If the selling price of a candle is Rs. 5 and variable cost per candle is Rs. 2

- Estimate the break even level of output
- If the sales is 5000 candles, what will be the profit.
- To get a profit of Rs.15000 how many candles are to be produced
- If the sales is 5000 candles what is the MOS
- Estimate profit volume ratio and break even sales
- If the firm wants to bring down the break even output to 1500 units what should be the price charged?