INDUSTRIAL ECONOMICS & FOREIGN TRADE

Mr. Biju George
Asst. Prof. &HOD
Department of Science & Humanities
Viswajyothi College of Engineering and Technology

SYLLABUS
Module 2 (Production and cost)

- Production function – law of variable proportion.
- Economies of scale – internal and external economies.
- Isoquants, iso cost line and producer’s equilibrium – Expansion path.
- Technical progress and its implications – Cobb-Douglas production function.
- Cost concepts – Social cost: private cost and external cost – Explicit and implicit cost – sunk cost.
- Short run cost curves & long run cost curves.
- Revenue (concepts) – Shutdown point – Break-even point.

Module 2 – Production & Cost

Production

Production may be defined as the transformation of inputs in to outputs.

It is the creation or addition of utilities to things.

Eg. Raw Cotton + Capital + Labor = Cloth

Inputs and Outputs

The factors used in production or what are put in to production is called inputs.

What is turned out due to input is known as output.

Production Function

- Production function refers to the functional relationship between inputs and output.
- Production function shows the maximum output which can be obtained with a certain combination of inputs.

Production function can be written as;

Q = f (x1, x2, x3..........xn)

where,

Q = Physical quantity of a product,
f = functional relationship,
x1, x2, x3......xn = Various inputs needed to produce output Q

Short run production function/ Variable Proportion

In the short run output can be increased by increasing the quantities of the variable factors in production.

In the short run certain factors like **machinery, building etc. are considered as fixed.** Their quantities cannot be changed in the short period.

On the other hand **labor, raw material etc. are considered as varia**ble. In the short run production can be increased by increasing the quantities of these variable factors.

Long Run Production Function/ Fixed Proportions

In the long run all factors are variable. It is the period which is sufficient to increase the quantities of all the factors.

Hence **output can be increased by increasing the quantities of all the factors in the same proportion.**

Concept of TP, AP, and MP

1. Total Product (TP): Total product refers to total output at a particular level of employment of a variable input, keeping all other inputs constant.

2. Average Product (AP): Average product is the output produced per unit of a variable input. This can be obtained by dividing the total product by the number of units of the variable factor.

$$AP = \frac{\text{Total Product}}{\text{No of units of variable factor}}$$

3. Marginal Product (MP): Marginal Product is the addition to total product by the employment of an additional unit of a factor.

$$MP = \triangle Q / \triangle X$$

Where, $\triangle Q$ = Change in Output

$\triangle X$ = Change in Input

LAW OF VARIABLE PROPORTIONS
[Law of Diminishing Returns or short run Law of production]

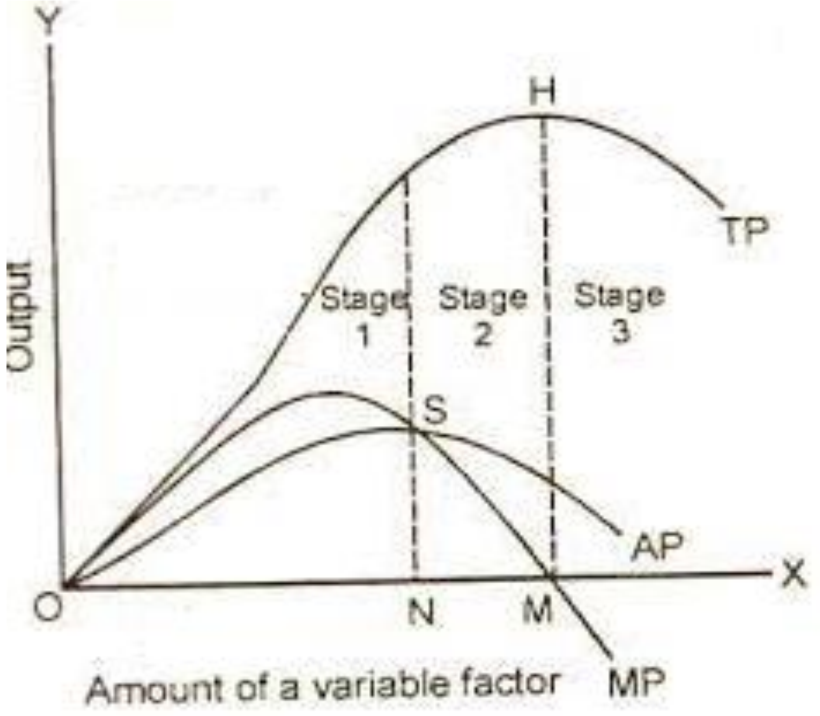
- Law of Variable Proportion explains the production function in the short run. It may be stated in the following words.
- *"When more and more units of variable factor are combined with fixed quantities of other factors, the increase in total production after a point become smaller and smaller."*
- **The law of variable proportion states that as we employ more and more units of a variable input, keeping other inputs fixed, the total product initially increases at an increasing rate then increases at a declining rate, and finally starts falling.**

This law is applicable to all lines of production like agriculture, industry etc.

LAW OF VARIABLE PROPORTIONS

<u>Three stages of the law.</u>

When more and more units of a variable factor are applied, while keeping the fixed factor constant, the total product passes through three stages.



LAW OF VARIABLE PROPORTIONS

Stage 1 (stage of increasing returns):

In the first stage Total Product (TP) increases at an increasing rate; Marginal Product (MP) also rises. It will be maximum at this stage and Average Product (AP) goes on rising. The stage 1 ends when Average Product reaches its highest point.

Stage 2 (Stage of Diminishing returns):

In stage 2, Total Product continues to increase at a diminishing rate until it reaches its maximum point, both Marginal Product and Average Product of the variable factors are diminishing but are positive. At the end of this stage Marginal Product(MP) is zero.

Stage 3 (Stage of Negative Returns):

Total Product declines, Marginal Product becomes negative and average product is declining in the third stage.

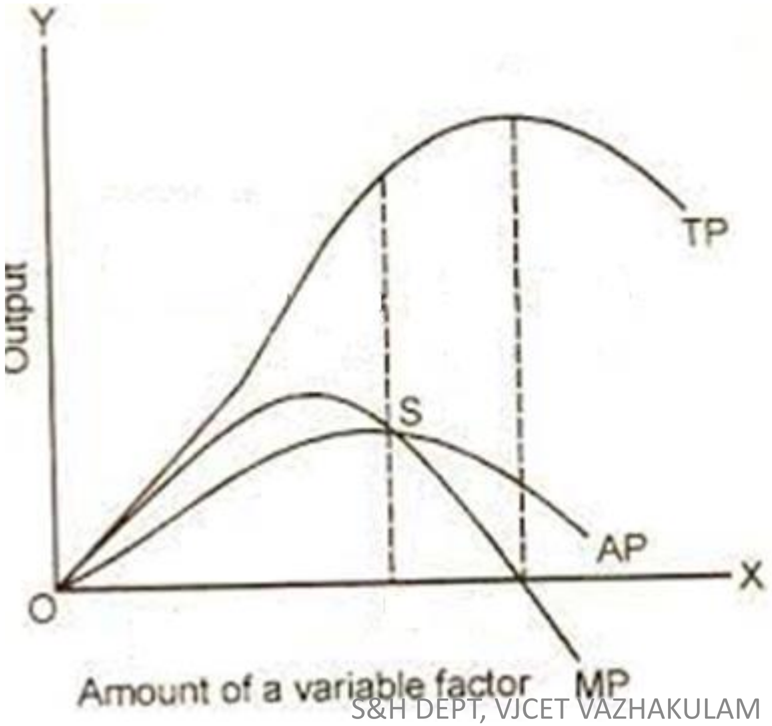
LAW OF VARIABLE PROPORTIONS

Assumptions of the Law

1. Technology remains constant.
2. All units of the variable factor employed are equally efficient.
3. The proportion of inputs can be varied.

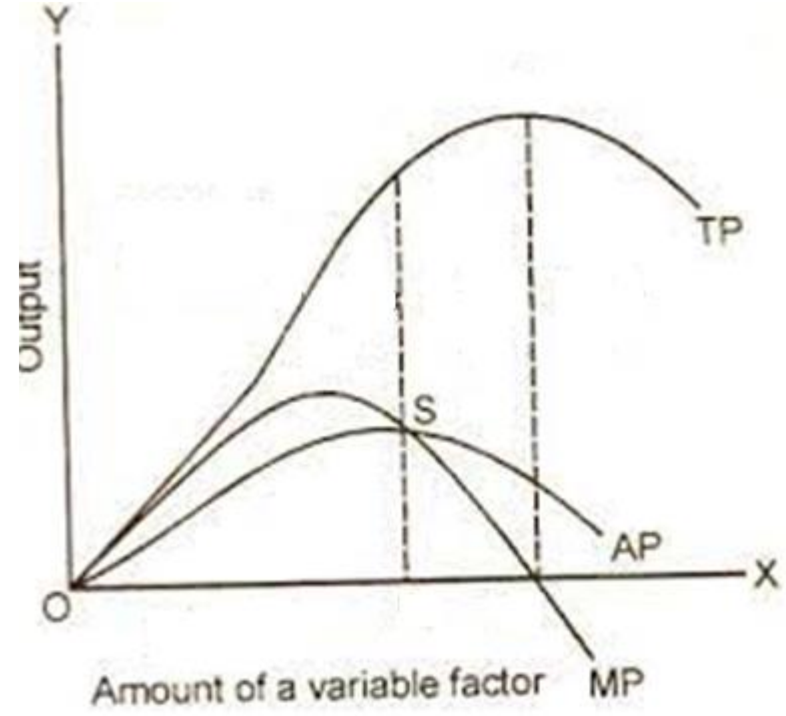
Relation between MP and TP

1. When MP increases TP increases at an increasing rate.
2. When MP decreases but remains positive TP increases at a decreasing rate.
3. When MP becomes negative TP declines.



Relation between MP and AP

1. When MP >AP, AP increases
2. When MP = AP, AP is maximum
3. When MP <AP, AP decreases.



Economies of Scale

- **Economies of scale refer to the cost advantage experienced by a firm when it increases its level of output.**
- ***Economies of Scale means advantages of largescale production which help in reducing the average cost of production.***

The economies of scale can be broadly classified as

i) Internal economies and ii) External Economies

i. **Internal Economies :** Internal economies depend on the size of the firm. These advantages emerge within the firm itself as its scale of production increases. There are different forms of internal economies.

a. Labour economies: Increased production allows division of labour and it increases efficiency and productivity of workers. Further large firms can attract more efficient labour because of the better prospects it can offer to the workers.

Economies of Scale

b. Technical economies: As a firm expands it can use the latest technology and machinery. This increases efficiency and reduces cost of production.

c. Marketing economies: These are economies of buying (of raw materials) and selling (of produced goods.) When a firm purchase a large quantity of raw materials, it can get the raw materials at a cheaper rate. Similarly, largescale marketing will reduce average marketing expenses.

d. Financial economies: Large firms going for large volumes of production may be able to raise capital from the market with much less difficulties than small firms.

Economies of Scale

ii. External Economies: External economies of scale are business-enhancing factors that occur outside a company but within the same industry.

The following are the important types of external economies.

a. Economies of localization: When number of firms in the Industry are located in one place, all of them derive mutual advantages. This can be in the form of availability of skilled labour, provision of better transport facilities etc.

b. Economies of Information: In an industry, research work can be done jointly. Statistical, technical, and other market information becomes more readily available when a large number of firms are located at one place.

c. Technological advancement: A large growing industry would encourage investment in research and would result in development of better technology of production.

Economies of Scale

d. Easier access to cheaper raw materials: Suppliers would have large market to cater to and therefore, the availability of raw material would be easier.

e. Economies of by-product: The availability of waste material in large quantity from the industry may facilitate the starting up of firms in the area which produce by-products by using this waste materials.

Diseconomies of Scale

Diseconomies of scale means disadvantages of large production.

The following are the important types of diseconomies.

a. Difficulties of management: As a firm expands problems of management arises. Beyond a limit, it will be very difficult for the manager to control the organization. Supervision becomes complex and it leads to mismanagement and wastage.

b. Difficulties of coordination: In a big organization there will be a number of departments. When the size of the organization becomes too large, proper coordination between these department will be difficult.

c. Communication problems: In a large firm it is very difficult to communicate the decision taken by the top management to the lower levels.

d. Marketing Diseconomies: When the firms expand competition becomes very stiff. It necessitates huge expenses on advertisement and other sales promotion activities.

Cobb- Douglas Production Function

Cobb-Douglas production function is widely used to represent the technological relationship between the amounts of two inputs, particularly capital and labour, and the amount of output that can be produced by those inputs.

It was proposed by **Knut Wicksell** and tested empirically by **Charles W. Cobb** and **Paul H. Douglas** in 1928.

The Cobb- Douglas production function is represented as:

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

Where, Q = Output

K = Capital

L = Labour

A is the technological parameter, α and β are positive constants

Properties of Cobb-Douglas Production function

1. The marginal product of capital and labour depends only on the quantities of capital and labour used in the production process. The equation for the marginal product of capital is given by

$$MP_K = \alpha (AP_K)$$

Where,

AP_K = The average product of capital.

Similarly, the equation for the marginal product of labour is given by

$$MP_L = \beta (AP_L)$$

Properties of Cobb-Douglas Production function

2. In a cobb-Douglas production function **factor intensity is measured by the ratio β/α.** The higher this ratio the more labor intensive the technique. Similarly, the lower the ratio β/α the more capital intensive the technique.

3. The sum of the two exponents (α and β) shows returns to scale.

- ✓ When (α + β) = 1, the production function exhibits constant returns to scale.
- ✓ When (α + β) > 1, It exhibits increasing returs to scale, and
- ✓ When (α + β) < 1, It exhibits decreasing returs to scale

Importance of Cobb-Douglas Production Function

1. This function is convenient for international and inter-industry comparisons.
2. It helps us to study the different laws of returns to scale.
3. It helps us to determine the prices of various factors of production,

Cobb- Douglas Production Function - Problems

Problems

1. a) In a production function, $Q = 2L^{1/2}K^{1/2}$. If $L = 36$, how many units of capital are needed to produce 60 units of output?

b) In the production function, $Q = 2L^{1/2}K^{1/2}$ determine the percentage increase in output if labour is increased by 10% assuming capital is held constant. (*Jan*, 2017)

Cobb- Douglas Production Function - Problems

Solution :

(a) Given that, $Y = 2K^{½} L^{½}$, $L = 36$ and $Q = 60$

$$\text{i.e., } Y = 60 = 2 \times K^{\frac{1}{2}} \times L^{\frac{1}{2}} = 2 \times K^{\frac{1}{2}} \times L^{\frac{1}{2}}$$

Squaring both sides, we have, $Y^2 = \left(2 \times K^{\frac{1}{2}} \times L^{\frac{1}{2}}\right)^{\frac{1}{2}} = 4 \times K \times L$

Substituting values of Y and L, we get, $60^2 = 4 \times K \times 36$

$$\therefore K = 25$$

(b) 10% increase in value of $L = 36 \times \frac{110}{100} = 39.6$

Given that, $Y = 2 \times K^{\frac{1}{2}} \times L^{\frac{1}{2}}$ and K is constant = 25.

$$Y = 2 \times 25^{\frac{1}{2}} \times 39.6^{\frac{1}{2}}$$

$$\therefore Y = 62.92$$

% increase in output $= \frac{(62.92 - 60)}{60} \times 100 = 4.88 \simeq 5\%$.

Cobb- Douglas Production Function - Problems

2. Assume the production function $Q = 2L^{1/2} K^{1/2}$

i) If $L = 100$, $K = 200$, what is the maximum quantity that can be produced?

ii) If the firm changes the amount of labour and capital by 10 times what will happen to the output? Why? (*May*, 2017)

Solution:

Given that, $Y = 2 \times K^{\frac{1}{2}} \times L^{\frac{1}{2}}$, $L = 100$, $K = 200$

i) $Y = 2 \times K^{\frac{1}{2}} \times L^{\frac{1}{2}}$ i.e., $Y = 2 \times 100^{\frac{1}{2}} \times 200^{\frac{1}{2}} = 282.84 \cong 283$

ii) For the increase of labour and capital by 10 times, the change in output is calculated as follows.

$$Y = 2 \times 1000^{\frac{1}{2}} \times 2000^{\frac{1}{2}} = 2828.427 \cong 2828$$

Cobb- Douglas Production Function - Problems

3. Suppose the production function is $Y = 2K^{1/4}L^{3/4}$ and $K = L = 1$. How much output is produced? If we reduced L by 10%, how much would K need to be increased to produce the same output?

Solution:

Given that, $Y = 2K^{1/4}L^{3/4}$ and $K = L = 1$

$$\text{i.e., } Y = 2 \times K^{\frac{1}{4}} \times L^{\frac{3}{4}} = 2 \times 1^{\frac{1}{4}} \times 1^{\frac{3}{4}} = 2$$

10% reduction in value of $L = 1 \times \dfrac{90}{100} = 0.9$

To produce the same output of 2, change to be made on $K =$ i.e., $2 = 2 \times K^{\frac{1}{4}} \times 0.9^{\frac{3}{4}}$

$$\therefore K = 1.3717$$

Cobb- Douglas Production Function - Problems

4. Consider the augmented production function, $Y = K^{\frac{1}{3}} \times (H \times L)^{\frac{2}{3}}$. If $K = 10$, $H = 10$ and $L = 5$, what is the *Average Product of labour*? How much does the Average Product increase if H rises to 12?

Solution:

Given, $K = 10$, $H = 10$ and $L = 5$ and $Y = K^{\frac{1}{3}} \times (H \times L)^{\frac{2}{3}}$

$$Y = K^{\frac{1}{3}} \times (H \times L)^{\frac{2}{3}} = 10^{\frac{1}{3}} \times (10 \times 5)^{\frac{2}{3}} = 29.24$$

$$Average\ Product\ of\ Labour,\ AP_L = \frac{Y}{L} = \frac{29.24}{5} = 5.848$$

If H rises to 12, $Y = K^{\frac{1}{3}} \times (H \times L)^{\frac{2}{3}} = 10^{\frac{1}{3}} \times (12 \times 5)^{\frac{2}{3}} = 33.019$

$$Average\ Product\ of\ Labour,\ AP_L = \frac{Y}{L} = \frac{33.019}{5} = 6.60$$

Cobb- Douglas Production Function - Problems

5. Suppose the production function is given as $Q = 3L^{½} K^{½}$. Find average and marginal product of labour when Labour equals 9 and K (capital) equals 4. (*June, 2019*)

Solution:

Given that, $Q = 3L^{1/2} K^{1/2}$ and $K = 4, L = 9$

$$\therefore Q = 3 \times L^{\frac{1}{2}} \times K^{\frac{1}{2}} = 3 \times 9^{\frac{1}{2}} \times 4^{\frac{1}{2}} = 18$$

$$Average\ Product\ of\ Labour,\ AP_L = \frac{Q}{L} = \frac{18}{9} = 2$$

$$Marginal\ product\ of\ labour,\ MP_L = \tfrac{1}{2} \times AP_L = 1$$

$$Marginal\ product\ of\ capital,\ MP_K = \tfrac{1}{2} \times AP_K = \tfrac{1}{2} \times 4.5$$

$$= 2.3$$

COST CONCEPTS

Cost is the expenditure incurred by a firm in the production of a commodity. To produce a commodity a firm needs raw materials, labour, building etc. The expenses of these items are termed as cost.

Types of Cost

1. *Explicit and Implicit cost*

- **Explicit cost** is the expenses actually met by the producer while producing a commodity. In other words, **explicit costs are those expenses which are actually paid by the firm.**
- These costs appear in the accounting records of the firm. The payments for wages and salaries, materials, insurance premium, etc., are examples of explicit costs.

Types of Cost

- **Implicit costs** are costs that do not involve actual payment or cash outflow by the firm. In other words, implicit cost is the opportunity cost of the factor services supplied by the organization itself.

- A typical example of implicit costs would be a self-owned firm in which the owner of the firm who is also the manager and no salary is paid to him/her for the job. Other examples include rent gave up on use of own property, interest on use of own capital, etc.

- The explicit costs are important for calculation of profits and losses, but for economic decision making, firms' takes into account both the explicit as well as the implicit costs.

Types of Cost

2. ***Sunk cost***

- ***Sunk cost*** is the cost which has already been incurred and cannot be recovered.
- It is a cost incurred in the past and that cannot be changed by current decisions and therefore cannot be recovered.
- For example, suppose that a firm must purchase a 1 *lakh rupee* government license before it can legally produce a product and that the government will not buy back the license or allow it to be resold. The 1 *lakh rupee* the firm spends to purchase the license is a sunk cost.

Types of Cost

3. Private cost

The private cost is **any cost that a person or firm pays in order to buy or produce goods and services**.

For a firm, all the actual costs, both explicit and implicit, are private costs. Examples of private costs are the payments made and expenditure on raw materials incurred by the producing agent concerned.

Types of Cost

4. Social cost

- **Social cost** is the sum of private cost and external cost. Private cost is the cost incurred by the producer in the production of a commodity. These are the expenses of the producer in buying or hiring factor services.
- When a commodity is produced it may cause damages to the environment in the form of air pollution, water pollution etc. These are the **external cost** and it is met by the society.

Types of Cost

5. Short-run costs- (Fixed costs and variable cost)

- Short-run costs are the costs in the short period. In the short-run, there are fixed costs and variable costs. In the long run there is only variable costs.
- Fixed costs are those costs which remain fixed. Fixed costs do not change with output. Examples of fixed costs are rent on land and building, salaries to permanent employees, insurance premium etc.
- Variable costs are those costs that vary with output. As output increases, variable costs increase. If output is zero, variable cost is zero. Examples of variable costs are cost of raw materials, expenditure on fuels, transportation costs etc.

Comparing fixed cost and variable cost

SL. No.	***Fixed cost***	***Variable cost***
1.	Fixed costs are incurred on the fixed factors of production like machines, buildings, insurance etc.	Variable costs are incurred on variable factors of production like labour, raw materials, transport, etc.
2.	Fixed costs do not change with the change in the level of output.	Variable costs changes with changes in the level of output.
3.	Fixed costs cannot be changed during short-run	Variable costs can be changed during short-run.
4.	Fixed costs is never zero even when production is stopped.	Variable cost is zero when production stops.

Average Variable Cost(AVC)

Average Variable Costs is the variable costs per unit of output. AVC is calculated by dividing TVC (Total Variable Cost) by the number of units of output

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

Average Fixed Cost(AFC)

Average Fixed Cost(AFC) is the fixed cost per unit of output. AFC is calculated by dividing TFC by the number of units of output.

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

Average cost/ Average total cost (AC)

Average cost (AC) is the cost per unit of output. AC is calculated by dividing TC by the number of units of output.

$$AC = \frac{TC}{Output} \quad \text{or} \quad AC = AFC + AVC$$

Marginal Cost (MC)

Marginal cost is the additional cost. It is the addition made to total cost by producing an additional unit of the commodity.

$$MC = \frac{\Delta TC}{\Delta Q}$$

Where, ΔTC = Change in Total cost

ΔQ = Change in output

Problems :

1. Complete the following table (round each answer to the nearest whole number).

Output	*TC*	*VC*	*FC*	*MC*	*AC*	*AVC*	*AFC*
0	30						
1	35						
2	60						
3	110						
4	200						
5	320						
6	600						

Solution:

Output	*TC*	*VC*	*FC*	*MC*	*AC*	*AVC*	*AFC*
0	30	0	30	–	–	–	–
1	35	5	30	5	35	5	30
2	60	30	30	25	30	15	15
3	110	80	30	50	37	27	10
4	200	170	30	90	50	43	8
5	320	290	30	120	64	58	6
6	600	570	30	280	100	95	5

2. Complete the following schedule

No of Units of Output	TC	TFC	TVC	MC
0	100	……..	……..	……..
1	150	……..	……..	50
2	……..	……..	……..	40
3	……..	……..	120	……..

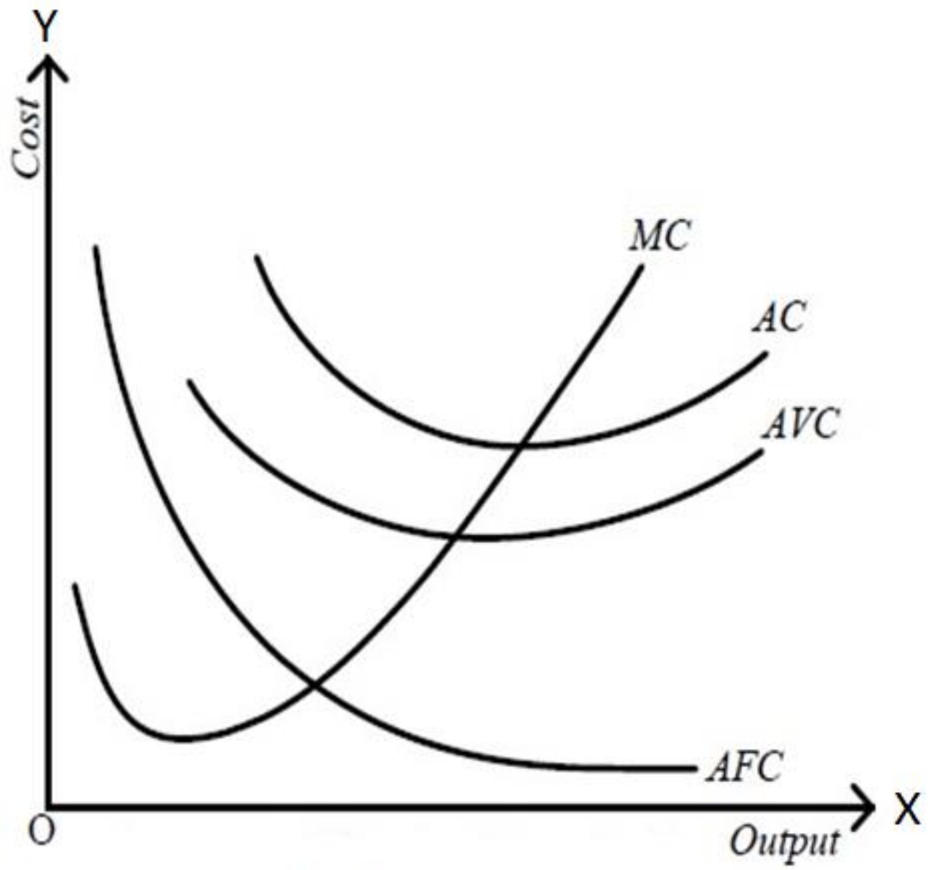
Answer

No of Units of Output	TC	TFC	TVC	MC
0	100	100	0	-
1	150	100	50	50
2	190	100	90	40
3	220	100	120	30

Average cost curves

The slopes of AC, AFC, AVC and MC can be graphically shown as follows.

As output increases *AFC* is declining throughout. However, *AVC* is declining up to a point and later starts to rise. Therefore, *AC* is declining rapidly when both *AFC* and *AVC* are declining; whereas the gap of rise narrows as *AFC* continues to decline and *AVC* rises. Graphically, it is obtained by vertical addition of the *AFC* and *AVC* curves. Therefore, *AC* curve is U-shaped.



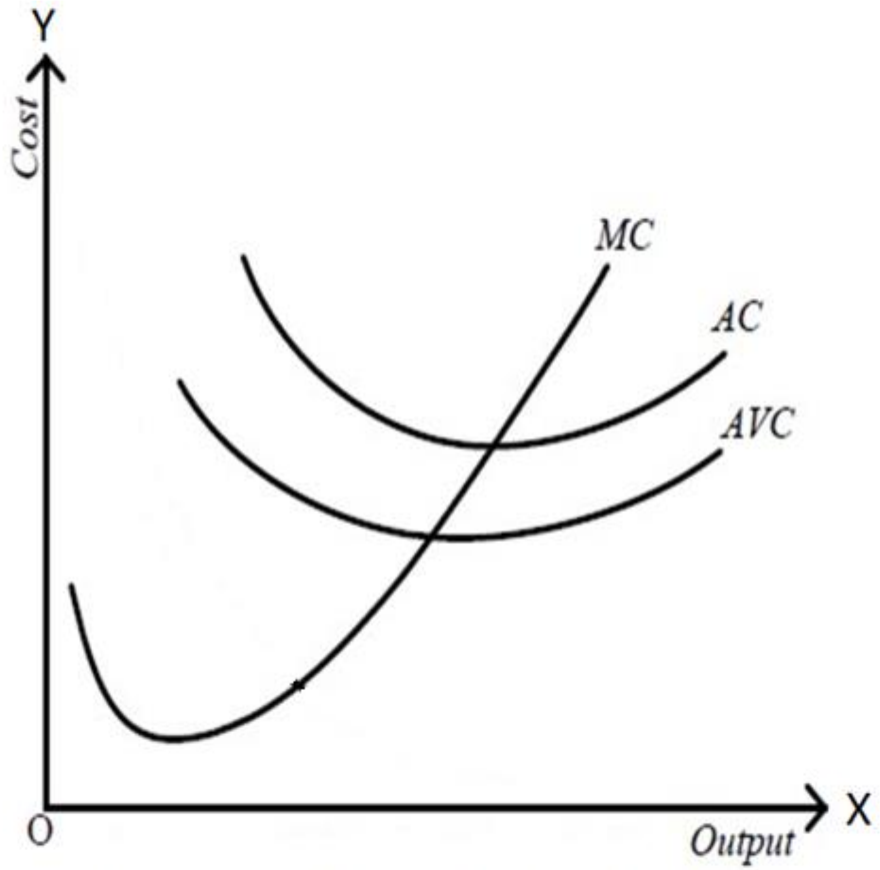
Average and Marginal Cost of a firm

Relationship between AC and MC (or MC and AVC)

The following are the relation between MC and AC.

1. When MC < AC, AC decreases.
2. When MC = AC, AC is the minimum.
3. When MC > AC, AC increases.

The same relations exist between MC and AVC.



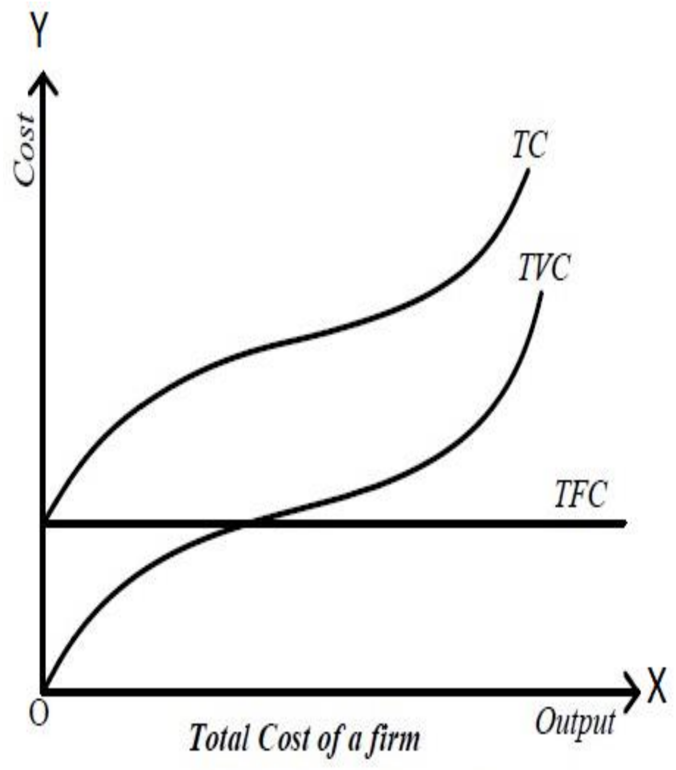
Average and Marginal Cost of a firm

Total Fixed Cost, Total Variable Cost, and Total Cost

Total Cost is the sum total of all costs incurred in production. It is calculated by adding total fixed cost and total variable costs.

TC = TFC + TVC

TFC curve is drawn as a straight line parallel to the X-axis because TFC remains fixed at all levels of production. The TVC curve starts from the origin of axis because, when output is zero, TVC also is zero. It can be seen that both TVC and TC curves are sloping upwards.



Long run Costs

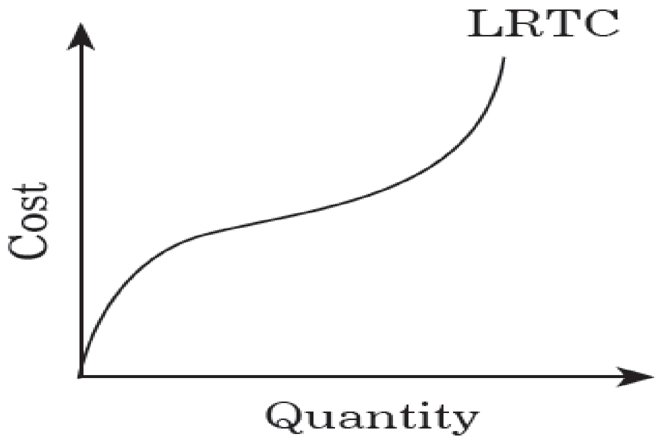
Long run average costs (LAC) and Long run Marginal Cost (LMC)

Long run cost

Long run is a period which is sufficient to increase the quantities of all the factors such as building, machinery, labor, raw materials etc. Hence all the factors are variable in the long run and therefore, there is no fixed cost.

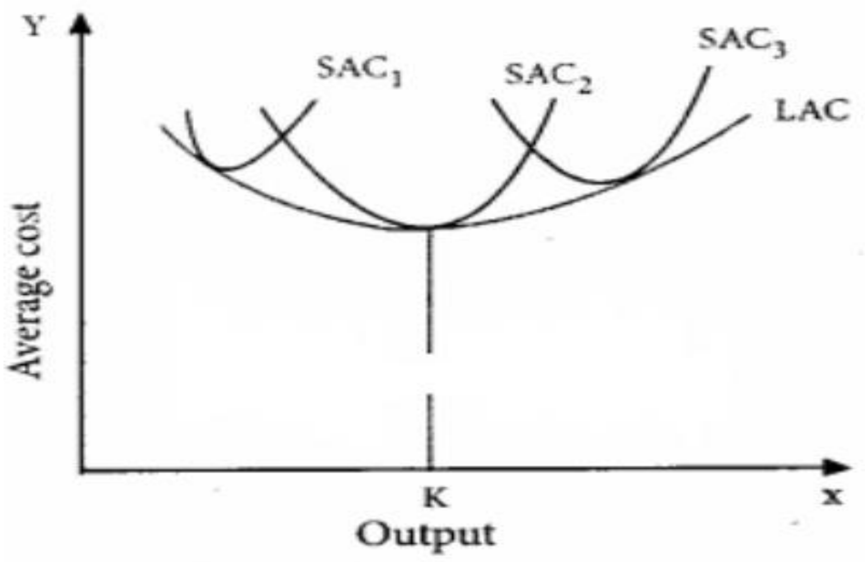
Long run total cost (LTC)

It is the minimum cost at which a given level of output can be produced in the long run.



Long run average cost (LAC)

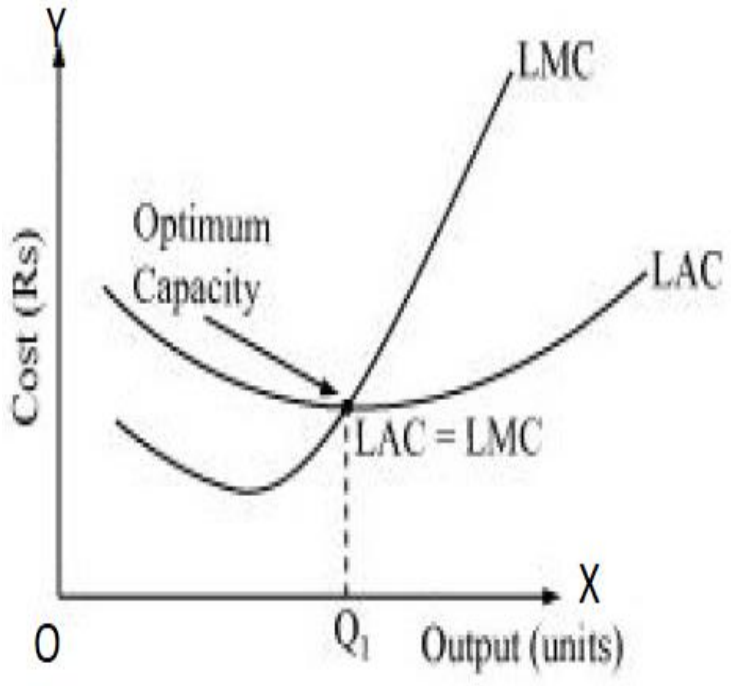
LAC is the cost per unit of output in the long run. It is derived from short run average cost curves (SACs)



Long run marginal cost (LMC)

It is the addition to total cost when one more unit of output is produced in the long run.

In the long run LAC and LMC are ‘U’ shaped. The LMC curve cuts the LAC curve at its minimum point.



Revenue

Revenue is the income from the sale of output.

Total Revenue (TR)

It is the total receipts from the sale of a given quantity of output. It is obtained by multiplying quantity sold (Q) by price per unit(P)

$$TR = P \times Q$$

Average Revenue (AR)

It is the revenue per unit of output sold. AR is obtained by dividing TR by the number of units of output sold (Q)

$$AR = \frac{TR}{Q}$$

Marginal Revenue (MR)

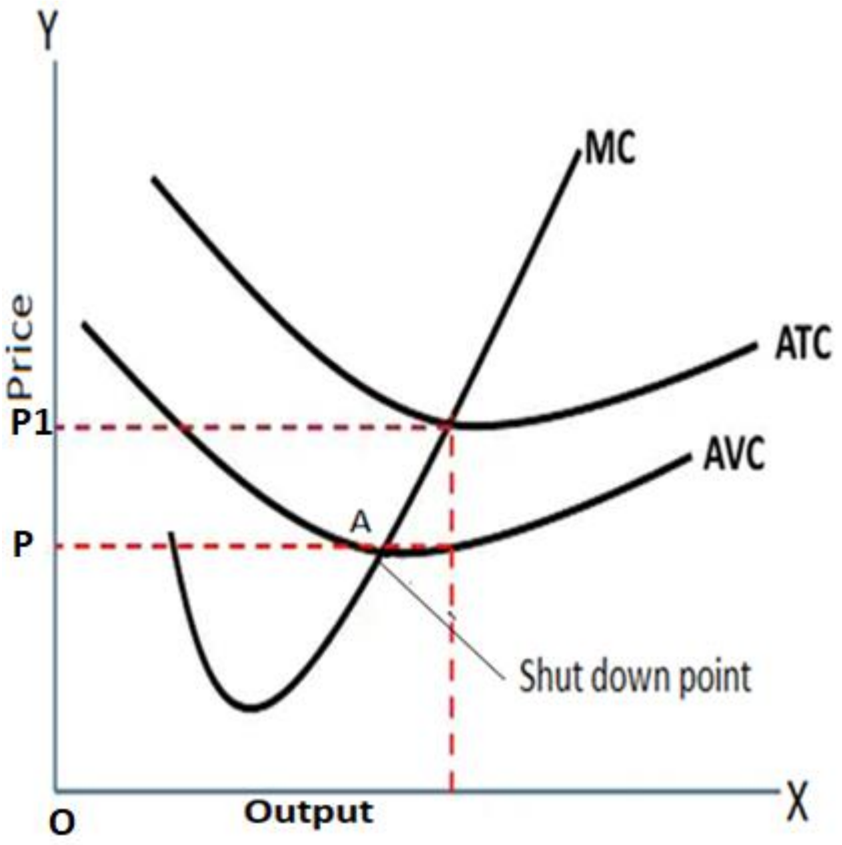
It is the addition to total revenue by selling one more unit of output.

$$MR = \frac{\Delta TR}{\Delta Q}$$

Shut Down Point of a Firm

A **shut down point** is a point of operations where a company experiences no benefit for continuing operations. This happens when the market price for the product is equal to the average variable cost in the short run (P = AVC).

Point 'A' in the figure denotes the shut down point where price 'P' is equal to AVC. Any fall in market price below 'P' will cause this firm shut down.



Break-even Analysis

- **Break-even analysis** is a method that is used to analyse the relationship between total cost, total revenue, and profit of an organization at different levels of output.
- The most important aspect of break-even analysis is identifying the break-even point.
- **Break-even point** is the point at which total revenue of a firm equals total cost. In other words, it is the point at which there is no profit or loss for the firm. It is the point of zero profit.

Break-even chart

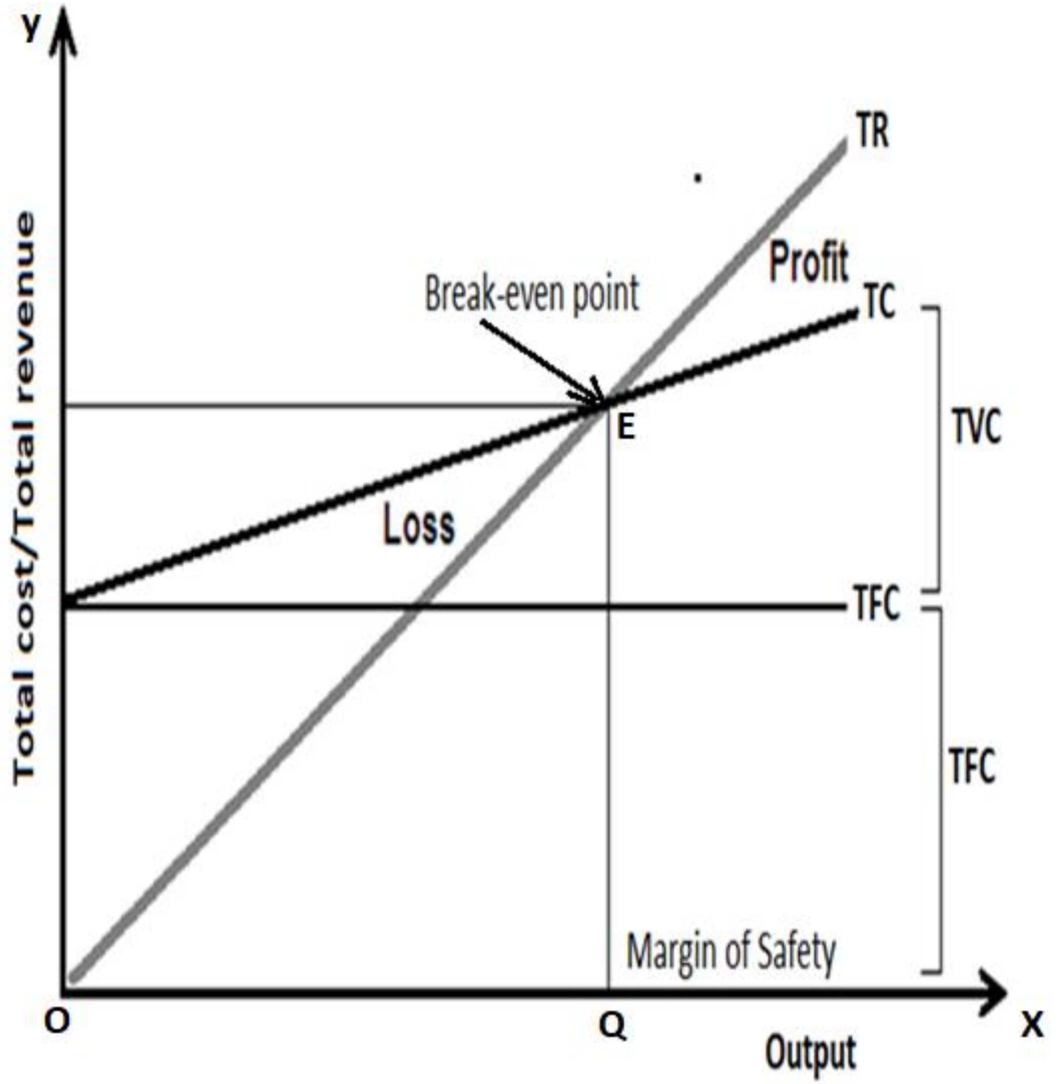
Break-even chart is the graphical representation of break-even point. The point of intersection of the total cost line and the income line is called as the break-even point.

Break-even chart

In our diagram , OX axis represents output and OY axis represents total revenue and cost.

At point ‘E’ the TR curve intersects the TC curve. Hence ‘E’ is the break-even point where the firm produce OQ level of output.

The gap between the TC curve and the TR curve beyond the OQ level of output shows profit and the gap below this level of output shows loss. At the break-even point there is no profit or loss.



Uses of Break-even analysis

i. It helps in the determination of costs, revenue and profits at various levels of output.

ii. It helps in the determination of selling price which will give the desired profits.

iii. It helps in the fixation of sales volume to get a desired level of revenue.

iv. It helps in making inter-firm comparison of profitability.

v. It helps in managerial decision-making.

Limitations of Break-even analysis

i. Break-even analysis is based on the assumption that fixed costs remain constant at all levels of activity. However, fixed costs tend to vary beyond a certain level of activity.

ii. It assumes that variable costs vary proportionately with the volume of output. In practice, it may not be varying in direct proportions.

iii. There is no provision for changes in selling price.

iv. It is based on the assumption that whatever is produced is sold. This may not happen.

Calculation of Break-even point in units

1. When total fixed cost, selling price per unit and variable cost per unit are given,

$$\text{Break-even point (in units)} = \frac{\text{Total Fixed Expenses}}{\text{Selling price per unit - Variable cost per unit}}$$

$$\text{BEP (in units)} = \frac{\text{TFC}}{\text{SP - VC}}$$

Calculation of Break-even point in Value

a) When total fixed cost, selling price per unit and variable cost per unit are given,

$$\text{Break-even point (in Rupees)} = \frac{\text{Total Fixed Expenses}}{\text{Selling price per unit} - \text{Variable cost per unit}} \text{ X Selling price per unit}$$

$$\text{BEP (in Rupees)} = \frac{TFC}{SP-VC} \text{ X } SP$$

b) When total fixed cost, t otal sales and total variable are given,

$$\text{Break-even point (in Rupees)} = \frac{\text{Total Fixed Cost}}{\text{Total Sales} - \text{Total Variable Cost}} \text{ X Total Sales}$$

$$\text{BEP (in Rupees)} = \frac{TFC}{S - V} \text{ X } S$$

PV Ratio (Profit Volume Ratio)

- P/V Ratio is the ratio of contribution to sales which indicates the contribution earned with respect to one rupee of sales.
- If per unit sales price and variable cost are constant then P/V Ratio will be constant at all the levels of output. A change in fixed cost does not affect P/V Ratio.

$$\text{PV Ratio} = \frac{\text{Contribution}}{\text{Sales}}$$

Since **Contribution = Sales (S) – Variable Cost (V)**

$$\text{PV Ratio} = \frac{\text{Sales - Variable Cost}}{\text{Sales}} = \frac{S - V}{S}$$

Using PV Ratio also, break-even point can be estimated.

$$\text{Break-Even Point, BEP} = \frac{\text{TFC}}{\text{PV Ratio}}$$

Margin of Safety

- **Margin of Safety** is the sales beyond break-even point. It is calculated as the difference between total sales and the break-even sales.

Margin of Safety = Sales – Break-even sales

Numerical Examples

1. 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
   a) Estimate the break-even level of output
   b) If the sales is 5000 candles, what will be the profit?
   c) To get a profit of RS. 15000 how many candles are to be produced
   d) If the sales is 5000 candles what is the margin of safety?
   e) Estimate profit volume ratio and break-even sales.
   f) If the firm wants to bring down the break-even output to 1500 units what should be the price charged?

Answer

a) TFC = 3000+3000 = 6000   P = 5   AVC = 2

$$BEP = \frac{TFC}{P-AVC} = \frac{6000}{5-2} = 2000 \text{ units}$$

b) Profit = TR – TC   TR = P*Q = 5*5000 =25000

TC = TFC+TVC =6000+2*5000= 16000

TR-TC = 25000-16000 = 9000

Numerical Examples

c) TR – TC = 15000

15000 = 5*Q – (6000+2*Q) = 5Q-2Q-6000 = 3Q-6000

3Q = 21000   Q = 7000 Therefore 7000 candles are to be produced to get a profit of Rs. 15000

d) Margin of safety = Actual sales – Break-even sales = 5000-2000=3000 units Or Rs. 15000 (5000*5-2000*5)

e) PV ratio = (S-V)/S = (5-2)/5 = .6   or 0.6*100 = 60%

Break-even sales = TFC/PV Ratio = 6000/0.6 =10000

Numerical Examples

This the break-even sales in Rupees. To find BEP in units divide it by price

That is 10000/5 = 2000 units

f) $1500 = \frac{6000}{P-2}$ ie $P - 2 = 6000/1500 = 4$

Therefore $P = 4 + 2 = 6$ The firm should charge a price of Rs.6 per candle to bring down the break-even output to 1500 units

Numerical Examples

2. Suppose the monthly fixed cost of a firm is Rs. 20000 and its monthly total variable cost is Rs. 30000.
a) If the monthly sales is Rs. 60000 estimate contribution and break-even sales. b) If the firm wants to get a monthly profit of Rs.20000, what should be the sales?

a) Contribution = S – V = 60000 – 30000 = 30000

$$\text{Break-even Sales} = \frac{TFC}{PV\ Ratio}$$

TFC = 20000 S = 60000 V =30000

$$\text{PV Ratio} = \frac{S-V}{S} = (60000-30000)/60000 = 0.5$$

$$\text{Break-even Sales} = \frac{TFC}{PV\ Ratio} = 20000/0.5 = 40000$$

$$\text{b) Sales to earn a desired profit} = \frac{TFC+\text{Desired profit}}{PV\ Ratio}$$

$$= (20000+20000)/0.5$$

$$= 80000$$

Numerical Examples

3. The financial details of a company are as below. Variable cost per unit is ₹30, Selling price per unit is ₹40, Fixed expenses are ₹100000. Calculate 1). The 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.

Answer

Given, Variable cost/ unit, v = ₹30, Selling price per unit, s = ₹40 and Fixed expense, F = ₹100000.

1). We have, *Break Even Point* in units $= \dfrac{\text{TFC}}{(\text{S-V})}$

$$= \frac{100000}{(40 - 30)} = 10000 \text{ units}$$

Numerical Examples

2). *Margin of safety* = Actual Sales - Break-even sales

= 15000 - 10000 = 5000 units

3). If BEP is brought down to 8000 units, i.e., $Q = 8000 = \dfrac{100000}{(s - 30)}$

$$\therefore Selling\ price, s = \frac{100000}{8000} + 30 = Rs.42.5$$

Numerical Examples

4. A company sells their product at ₹650 per unit, the fixed cost is ₹82000 and variable cost is ₹240 per unit. (a) What is the *BEP*? (b) What volume is needed to generate a profit of ₹10250?

Solution

Given, $v = ₹240, s = ₹650, F = ₹82000$, expected profit = ₹10250

a) *Break Even Point* in *units*, $Q = \dfrac{F}{(s - v)}$

$$= \frac{82000}{(650 - 240)} = 200 \textit{ units}$$

b) $(\text{No. of units sold} \times s) - [F + (v \times \text{No.of units sold})] = \text{Profit/Loss}$

i.e., $(\text{No. of units sold} \times 650) - [82000 + (240 \times \text{No.of units sold})] = 10250$

$\therefore$ No. of units to be sold to get a profit of *Rs.*10250 is 225 units.

Numerical Examples

5. Suppose a company produces batteries and its fixed cost of ₹50,000/-. If variable expense per battery is ₹3/- and price of battery is ₹8/- estimate i) Break even output ii) Number of batteries to be produced to get a total profit of ₹25000/-. iii) What is the margin of safety if the planned sales is 12000 batteries? (*KTU, Jan, '17)*

Solution :

Given, Variable cost/ unit, v = ₹3, Selling price per unit, s = ₹8 and Fixed expense, F = ₹50000.

i). We have, *Break Even Point* in units, $Q = \frac{F}{(s - v)} = \frac{50000}{(8 - 3)} = 10000$ units

ii) $(\text{No. of units sold} \times s) - [F + (v \times \text{No.of units sold})] = \text{Profit/Loss}$

i.e., $(\text{No. of units sold} \times 8) - [50000 + (3 \times \text{No.of units sold})] = 25000$

$\therefore$ No. of units to be sold to get a profit of *Rs*.25000 is 15000 units.

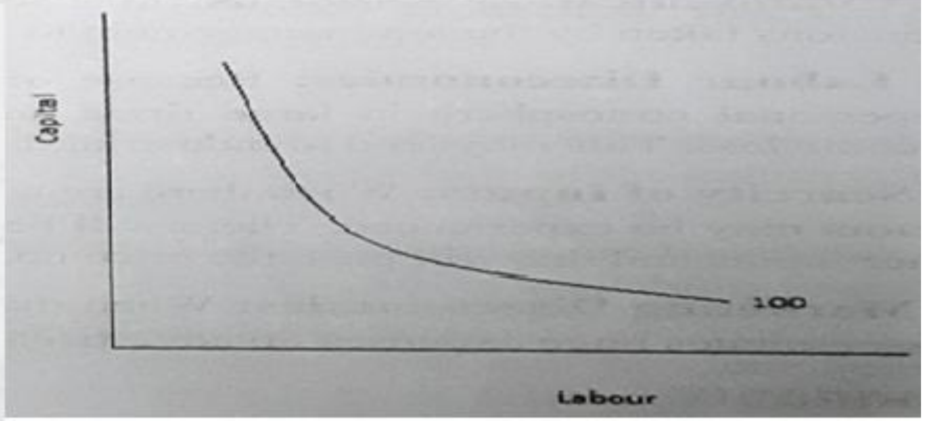
iii). $\textit{Margin of safety} = \textit{Excess sales in units} - \textit{BEP} = 12000 - 10000 = 2000$ units

Isoquants

An isoquant is a curve which shows various combinations of two inputs which give the same level of output. 'Iso' means equal and quant means quantity. That is equal quantity of output. Isoquants are also called isoproduct curves or equal product curves. The construction of an isoquant can be explained with the help of the following schedule.

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

In the above schedule labour and capital are taken as the two inputs. All the given combinations of labour and capital produce the same level of output, that is 100 meters of cloth. The graphical representation of the schedule gives an isoquant. This is given below.



Properties of an Isoquant

The following are the important features or properties of isoquants.

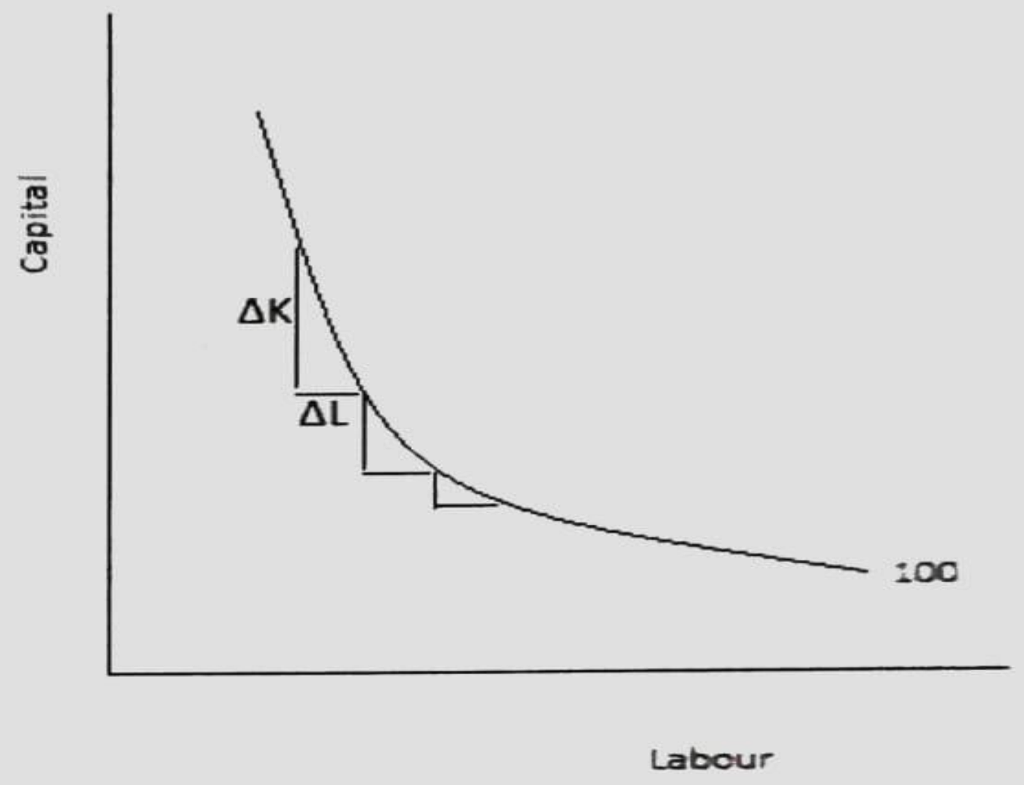
1. Isoquants are negatively sloped. An isoquant represents a particular level of output. Hence, when the quantity of one factor input is increased, the quantity of the other input has to be decreased in order to keep the output constant. Therefore, isoquants are negatively sloped.

2. Isoquants are convex to the origin. This is because along the isoquant $MRTS_{LK}$ (Marginal rate of technical substitution of labour for capital) goes on decreasing. $MRTS_{LK}$ is the rate at which one input is replaced by the employment of additional units of the other factor. In other words, how much of capital is replaced by the employment of an additional unit of labour. This is the slope of the isoquant. Slope of the isoquant is $\Delta K/\Delta L$

Properties of an Isoquants

That is, $MRTS_{LK} = \frac{\Delta K}{\Delta L}$

From the diagram, it can be understood that ΔK, the amount capital replaced by one additional unit of labour is going on decreasing,



Since output remains constant along the isoquant, the loss in output due to the replacement of capital should be compensated by the additional output produced with the help of the extra amount of labour employed. That is

$$-\Delta K * MPK + \Delta L * MPL = 0$$

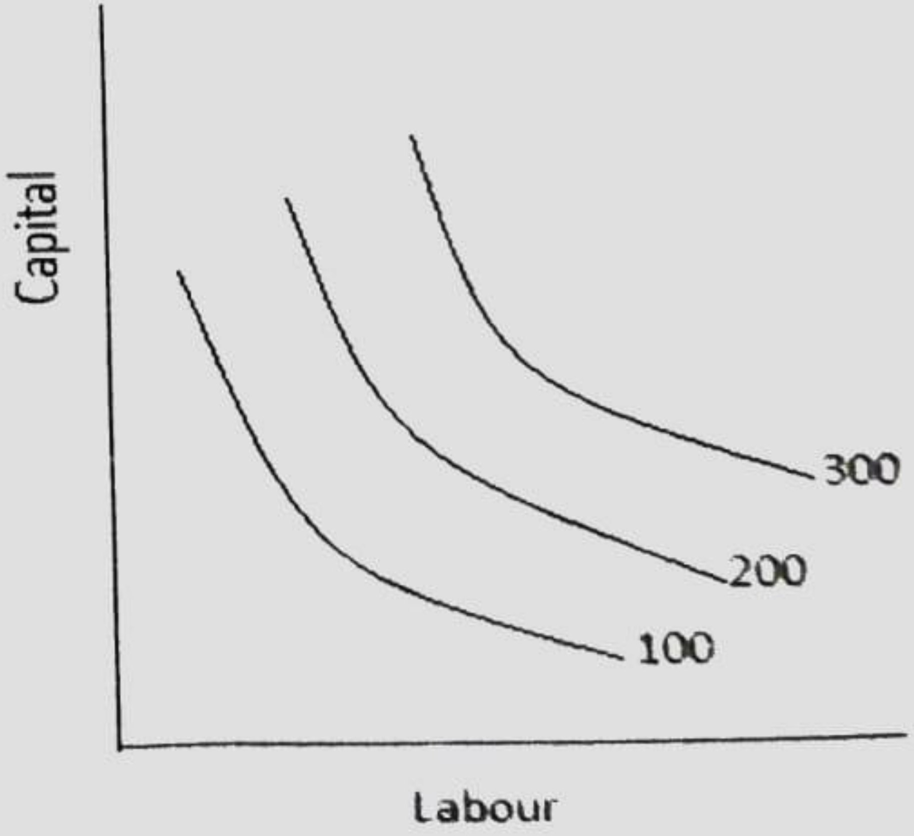
(Where MPK and MPL are the marginal productivity of labour and capital)

$$\text{Therefore} \quad -\frac{\Delta K}{\Delta L} = \frac{MPL}{MPK}$$

Properties of an Isoquants

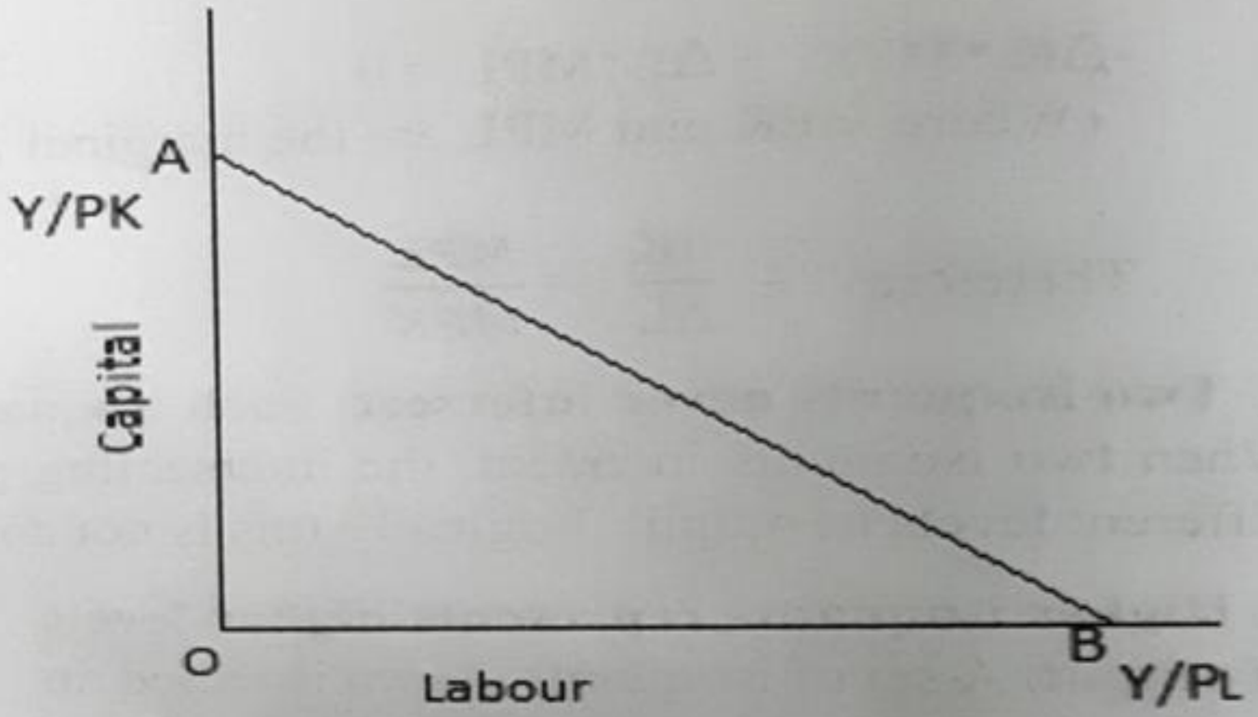
3. **Two isoquants never intersect**. Each isoquant represents a particular level of output. When two isoquants intersect, the intersecting point will be common and it can be two different levels of output. Logically this is not correct.

4. Higher isoquants represents higher levels of output. A set of isoquants drawn is called an isoquants map. In isoquants map higher isoquant represents higher levels of output.



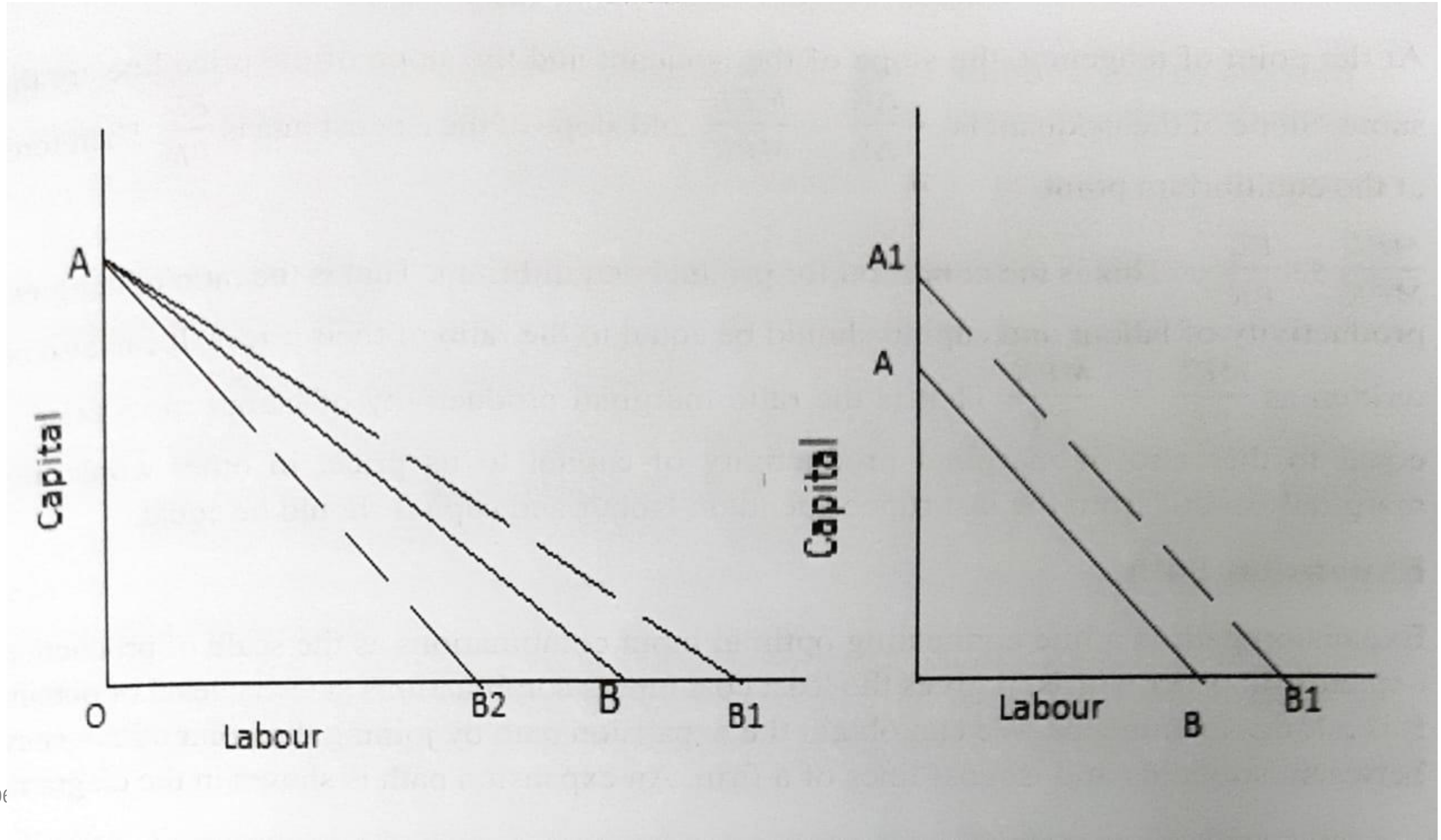
Isocost line

An isocost line shows various combinations of labour and capital (two inputs) that can be purchased for a given expenditure of the firm. In other words, it shows various combinations of labour and capital that is available to the firm at the same cost and at given prices of the inputs. If 'Y' is the total money resources of the firm it can purchase Y/PK amount of capital or Y/PL amount of labour. A price line is shown in the diagram.



The slope of the price line AB is OA/OB or PL/PK. Since price of labour is wage (w) and price of capital is interest (r), the slope can be written as w/r.

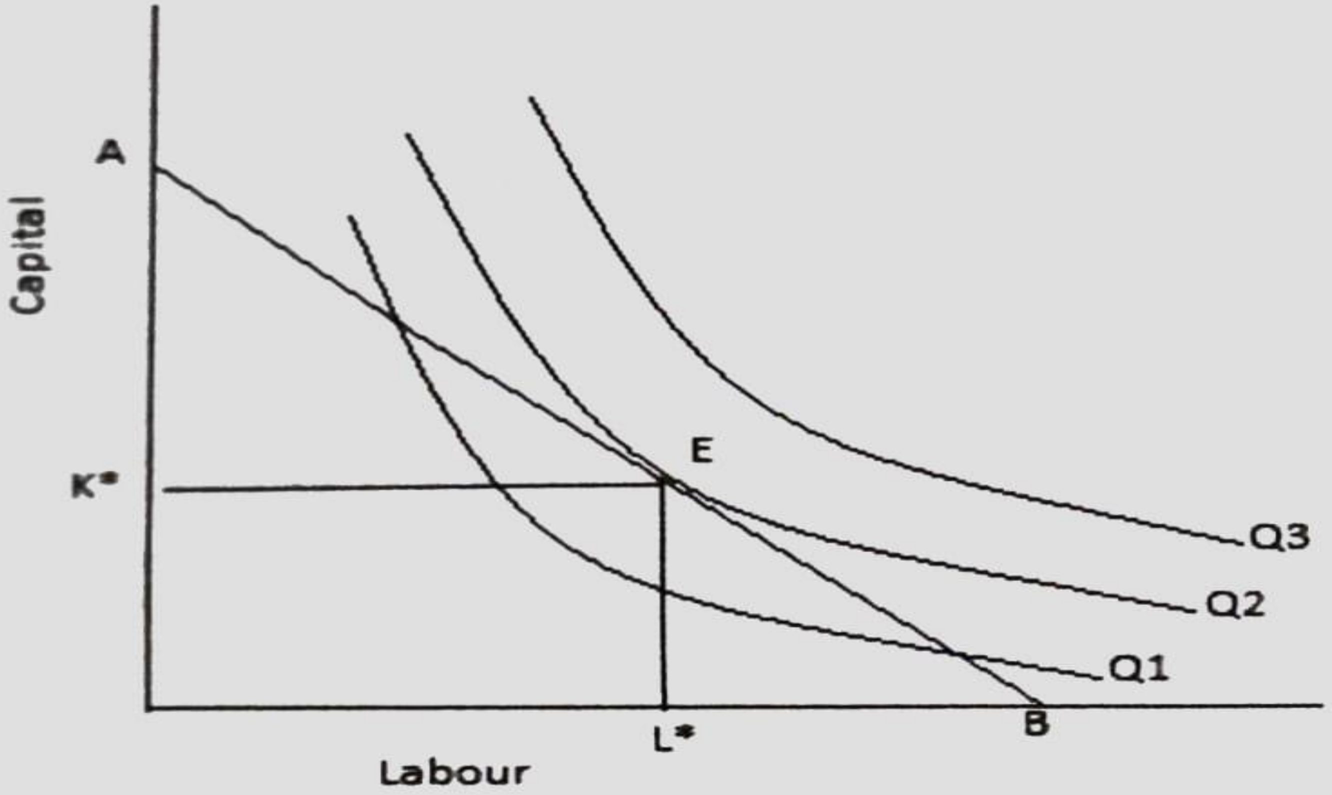
When the money resources of the firm increase, with given prices of inputs, the price line PL shifts upwards parallelly. When price of labour decreases, point B shifts rightwards and vice versa. Similar is the case of capital.


A
Capital
O
B2
B
B1
Labour
A1
A
Capital
Labour
B
B1

Producer's Equilibrium

Least Cost Combination – Producer's Equilibrium

A producer will be in equilibrium when he is able to produce a given quantity of output with least cost or when he produces maximum output with a given amount of inputs. In other words, least cost combination of inputs is that combination which cost least to the firm in producing a certain quantity of output. It is attained at that point where the isoquant is tangent to the isocost line. This is shown in the diagram.



In the diagram, producer is in equilibrium at point E, where the highest possible isoquant is tangent to the isocost line. He is able to produce the maximum output with the available resources. In other words, output Q2 is produced with the least cost.

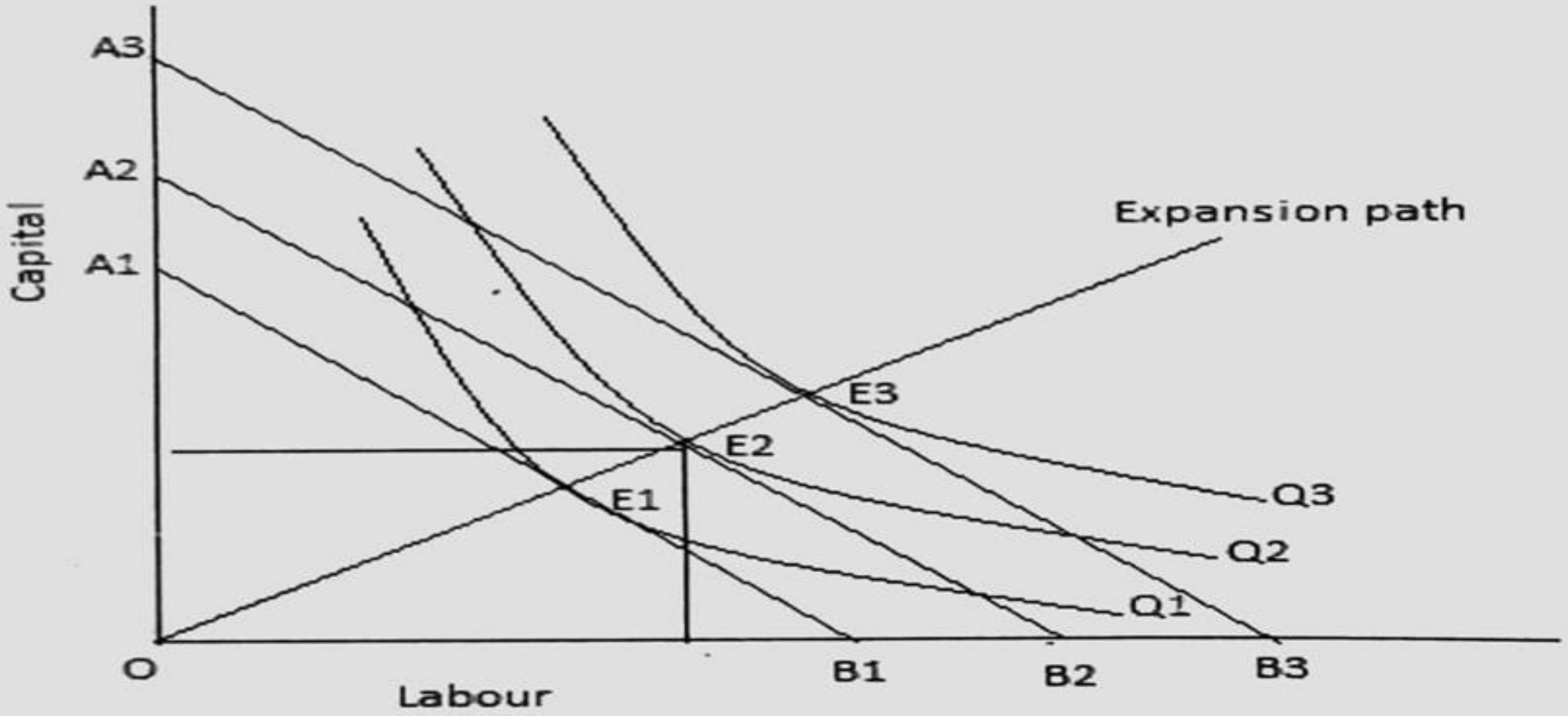
Producer's Equilibrium

At the point of tangency, the slope of the isoquant and the slope of the price line are the same. Slope of the isoquant is $-\frac{\Delta K}{\Delta L} = \frac{MPL}{MPK}$ and slope of the isocost line is $\frac{PL}{PK}$. Therefore, at the equilibrium point

$\frac{MPL}{MPK} = \frac{PL}{PK}$ This is the condition for producer equilibrium. That is the ratio of marginal productivity of labour and capital should be equal to the ratio of their prices.

Expansion Path

Expansion path is a line connecting optimal input combinations as the scale of production expands. In other words, it gives the least cost inputs combinations at every level of output. It is a long run concept. We can obtain the expansion path by joining the point of tangency between isoquants and isocost lines of a firm. An expansion path is shown in the diagram.



Technical Progress and its implications

When there is a change in technical progress, the production function will change. There will be an upward shift in the production function which means that more output is produced with the same level of inputs. In other words, there will be a downward shift of the isoquant which implies that same output is produced with lesser quantities of inputs.

Technical progress may be embodied and disembodied. It is embodied or investment specific when new capital (machinery) is used in the production process. It is disembodied or investment neutral, when output increases without any increase in investment but by an innovation through research.

Types of Technical Progress

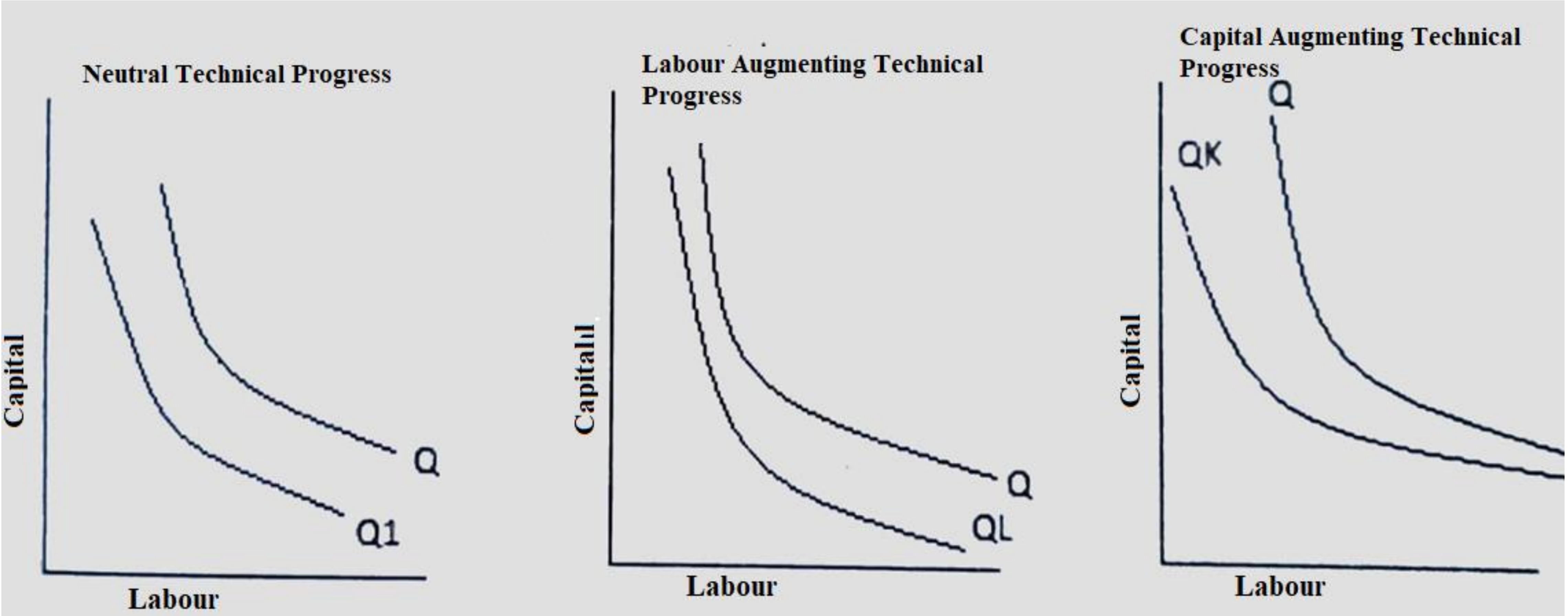
There are three types of technological progress

1. Neutral technical progress: It is neutral when change in the marginal product of labour and capital are same due to the technical progress. In this case there will be a parallel downward shifting of the isoquant. In this case slope of the isoquant or $MRTS_{LK}$ remains the same. In other words, there is an equal reduction in both the inputs in the production of a certain quantity of output.

2. Labour Augmenting Technical Progress: It means the marginal product of labour increases faster than the marginal product of capital. Here, the new isoquant becomes more steeper.

3. Capital Augmenting Technical Progress: It means the marginal product of capital increases faster than the marginal product of labour. In this case, the new isoquant becomes more flatter.

Types of Technical Progress



Law of Returns to scale (Long Run Production Function)

- Returns to scale is a long-run production function. In the long-run there is no distinction between fixed factors and variable factors. In other words all factors are variable in the long run.
- Returns to scale refer to changes in returns (output) caused by proportionate change in all inputs.
- There are three types of returns to scale. They are;

  a) Increasing Returns to scale b) Constant Returns to scale and

  c) Diminishing Returns to scale

Law of Returns to scale (Long Run Production Function)

a) *Increasing Returns to scale :* This is the situation in which proportionate increase in all factors of production leads to more than proportionate increase in output. For example, a 20% increase in all factors leads to a more than 20% increase in output. In the initial stage of expansion of production, increasing returns to scale operate.

b) *Constant Returns to Scale:* Constant Returns to Scale is the situation in which a given proportionate increase in factors causes an equally proportionate increase in output. For example, a 20% increase in inputs causes a 20% increase in output.

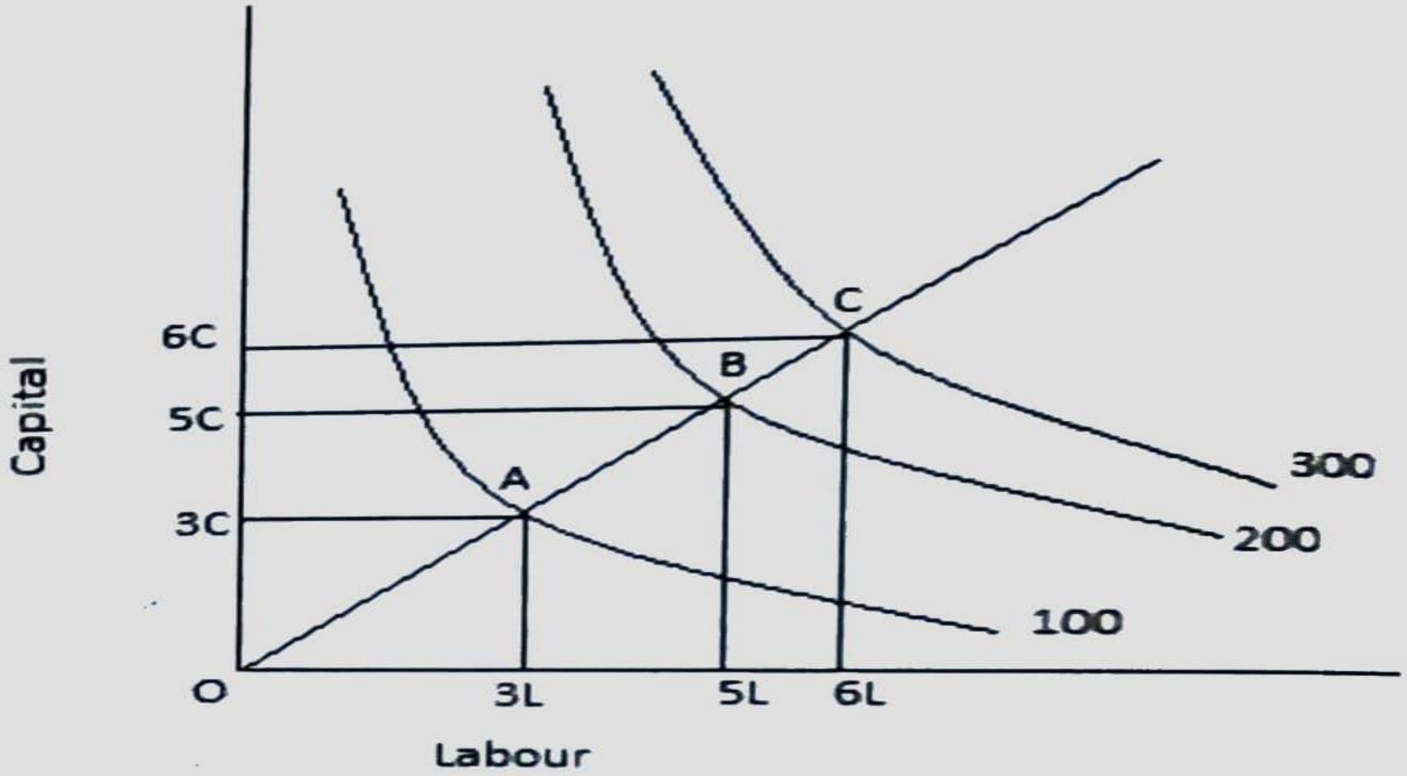
c) *Diminishing Returns to scale:* Diminishing returns to scale is a situation in which proportionate increase in inputs causes a less than proportionate increase in output. For example, a 20% increase in inputs causes a less than 20% increase in output.

Isoquants and different returns to scales

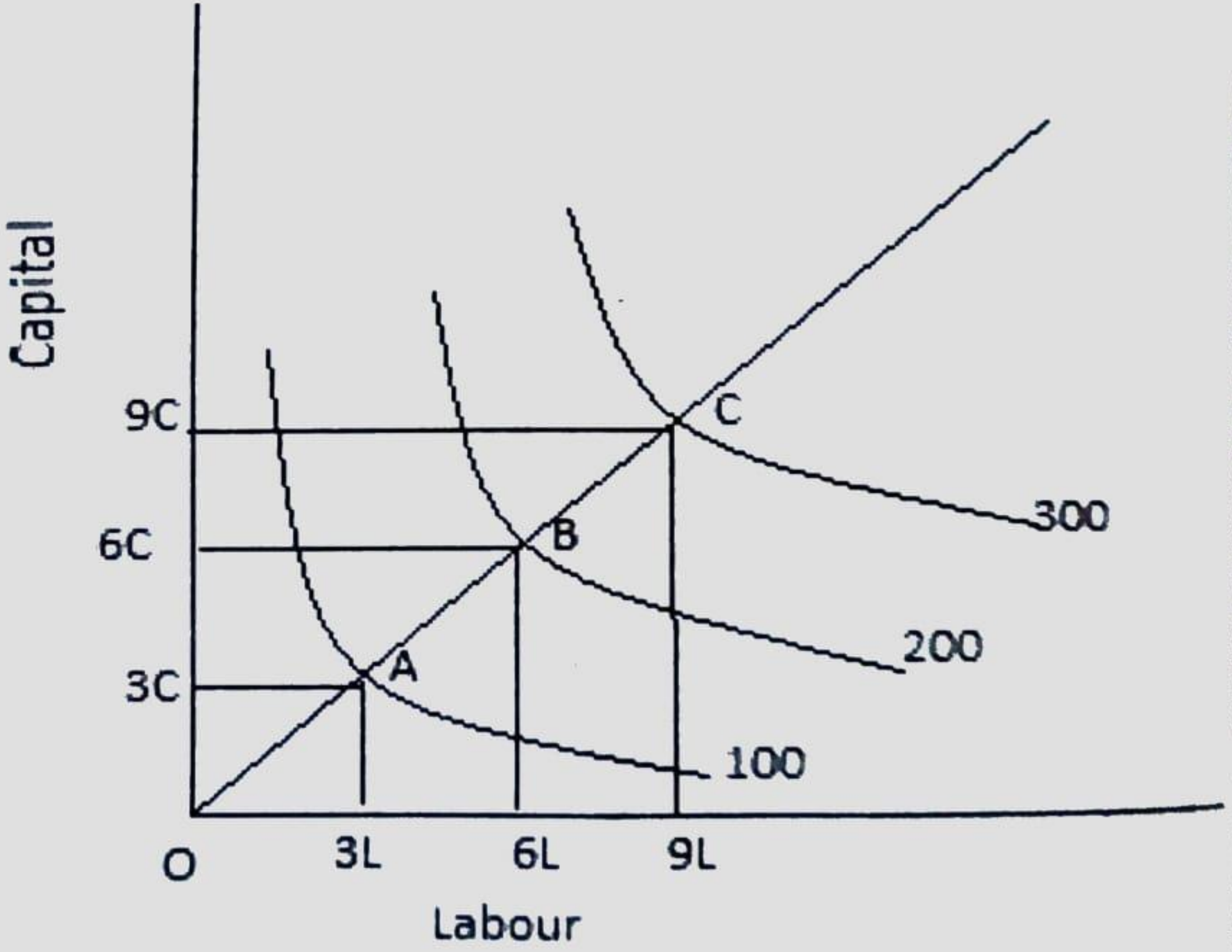
The laws of returns to scale can also be explained in terms of the isoquants.

Increasing returns to scale – Increasing returns to scale means that output increases at a greater proportion than the increase in inputs. The following diagram depicts increasing returns to scale.

In the diagram the first 100 units of output is produced with 3 units of capital and labour. The next 100 units need only 2 additional units of labour and capital. The third 100 units of output is produced with an additional one unit of labour and capital. In the expansion path OA>AB>BC. This kind of production function shows increasing returns to scale.



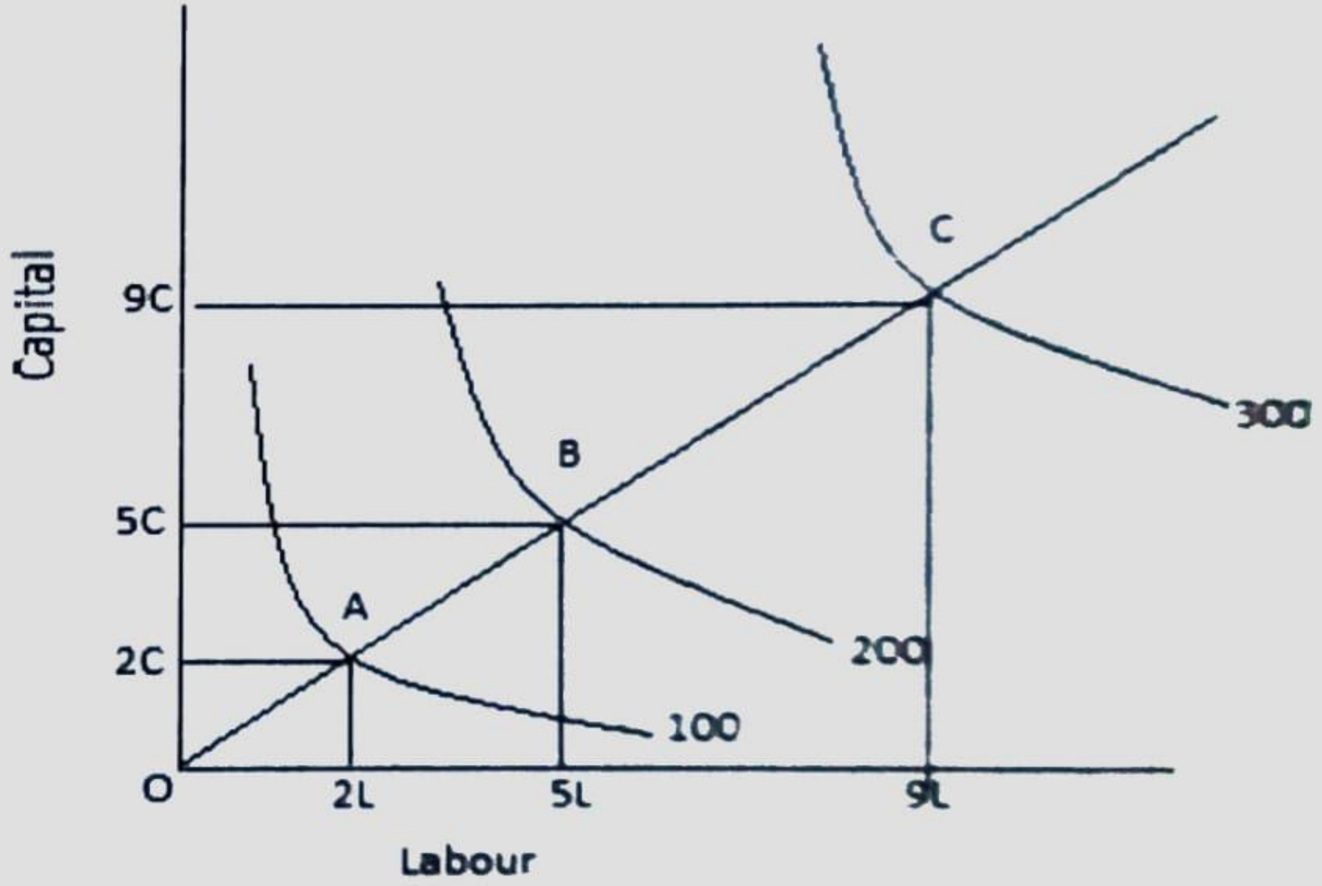
Constant returns to scale- Constant returns to scale means the inputs and the output increases at the same proportion. Increasing returns to scale can be explained with the help of the following diagram.



The diagram shows that the first 100 units of output is produced with 3units of capital and 3 units of labour. The second hundred as well as the third hundred is also produced with an additional 3 units of labour and capital respectively. In the expansion path OA=AB=BC. Thus, there is an equal proportionate increase in inputs and output.

Decreasing returns to scale- Decreasing returns to scale means output increases at a lesser proportion than the increase in inputs. A production function with decreasing returns to scale is depicted in the following diagram.

In the diagram the first 100 units of output is produced with 2 units of labour and capital. But the next 100 units is produced by employing an additional 3 units of labour and capital. The third 100 units of output is produced by using 4 units of labour and capital. In the expansion path OA<AB<BC. Thus, a larger amount of inputs are needed to produce additional units of output. Hence, the production function shows decreasing returns to scale.



Thank You