

## Chapter 6 Cost & Revenue Curves

1. Total Revenue (TR)  $\rightarrow$  TR is the total amt of money received by the firm from the sales of its own product at the given period of time.  $TR = P \times Q$   $P = \text{Price}$   $Q = \text{Quantity Sold}$ .

2. Average Revenue (AR)  $\rightarrow$  Average revenue is the price per unit. It is obtained by dividing total revenue by the no. of units sold.

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

3. Marginal Revenue (MR)  $\rightarrow$  MR is the addition to total revenue from the sales of an additional unit of the commodity.

$$MR = \frac{\Delta TR}{\Delta Q} \quad \text{or, } MR = TR_{n+1} - TR_n$$

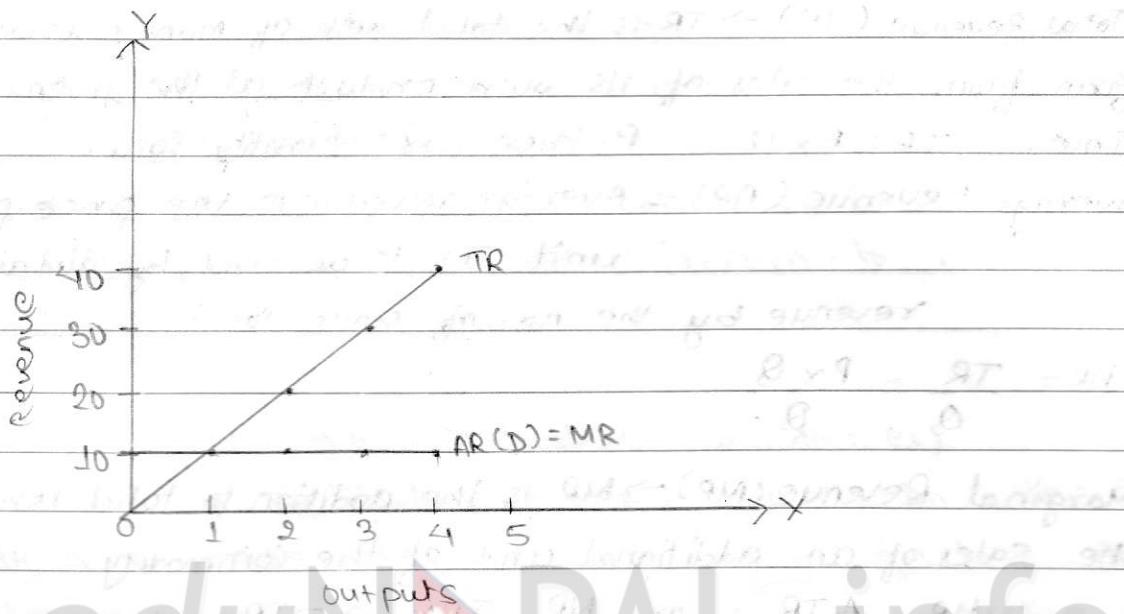
Derivation of Revenue Curve Under Perfect competition.

Perfect competition is the market structure where there are large number of buyers & sellers producing a homogeneous product. In the perfect competition, firm is a 'price-taker'. A firm can sell whatever output it produces at price the given price. Therefore, price remains constant at any level of output. The price is determined by market mechanism.

$$\text{Units Sold} \quad AR/\text{Price (Rs)} = TR/Q \quad TR = P \times Q \quad MR = TR_{n+1} - TR_n$$

0	0	0	-
1	10	10	10
2	10	20	10
3	10	30	10
4	10	40	10

The schedule shows that AR & MR are equal at Rs 10 at every level of output. TR increases at a constant rate i.e. at Rs 10.



When output is 0, TR is also 0. Hence TR curve starts from the origin 0, it slopes upward uniformly. AR curve is a horizontal line. MR curve coincides with AR. AR curve is the demand curve of the firm i.e.  $P = AR = MR$ .

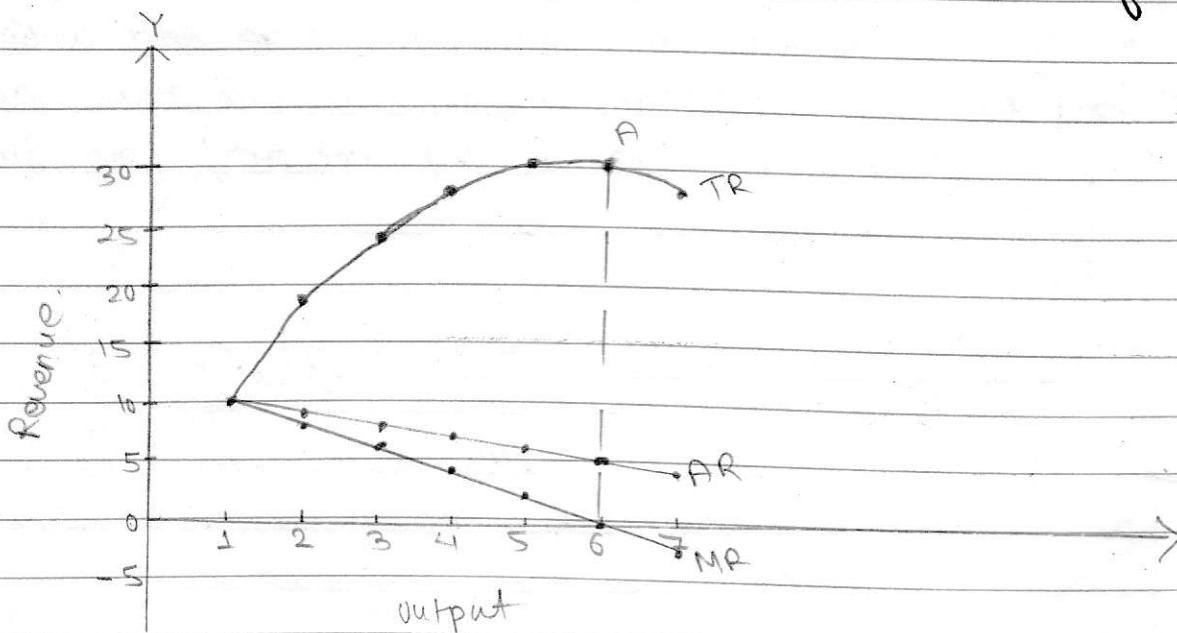
### Derivation of Revenue Curves Under Imperfect Competition or Monopoly.

Imperfect competition is the market structure where there is a single seller or producer, there are no close substitutes for the commodity it produces & there are barriers to entry of new firm in the market. In imperfect competition or monopoly, the firm is itself a 'price maker'. Therefore, it reduces prices in order to increase the sales. Consequently, both the AR & MR curves slope downward from left to right.

It means that if a monopolist desired to sell more units of the output, he will have to reduce the price & vice-versa.

Units sold	AR/P (Rs)	TR	MR
0	0	0	-
1	10	10	10
2	9	18	8
3	8	24	6
4	7	28	4
5	6	30	2
6	5	30	0
7	4	28	-2

The schedule shows that TR increasing at decreasing rate until 5<sup>th</sup> unit of output is sold. When 6<sup>th</sup> unit of output are sold, it becomes maximum & decreases beyond that. AR coincide with price which decline throughout. The price value give the demand curve facing by firm. MR declines, becomes 0 when TR is maxi. at 6<sup>th</sup> unit & then becomes -ve when TR is falling.

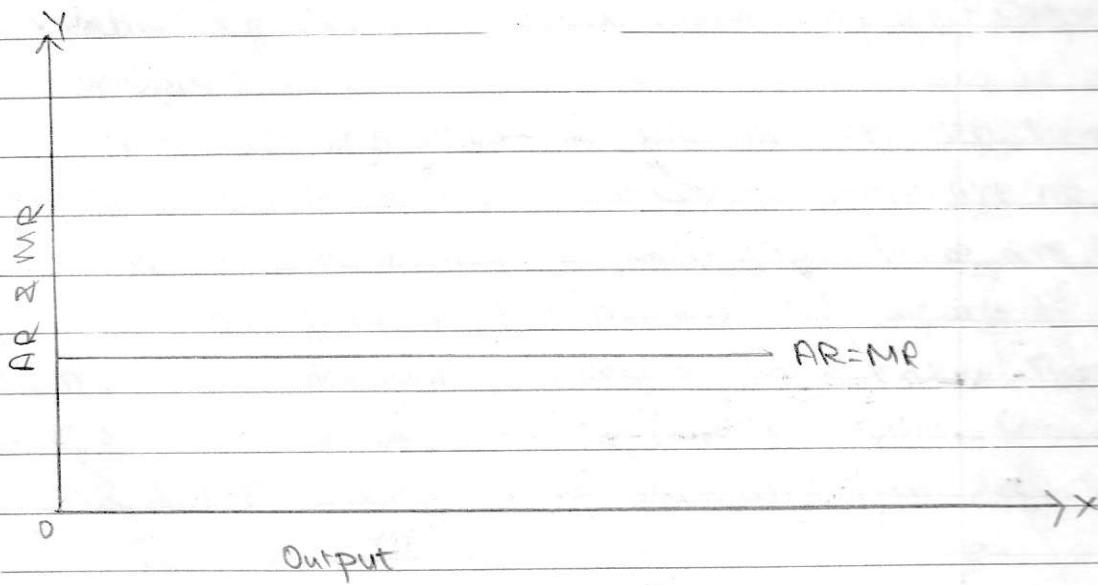


In fig. TR is the total revenue curve. TR increases at a decreasing rate, becomes maximum at point A & then begins to fall. Thus, initially, TR curve slope upward & increases at a decreasing rate, reaches a maximum point A & slopes downward.

MR is the marginal revenue curve & AR is the average revenue curve. AR is sloping downward. It means that to sell more quantity, price should be reduced. MR also slopes downward but lies below AR. It means that MR falls faster than AR. When TR is maxi at point A, MR is zero at point N. When TR declines, MR become -ve but AR never attain negative.

Relationship betw. AR & MR curves under Perfect competition.

Under perfect competition, seller cannot influence price of the product. He has to sell at the price determined by the market. Thus, AR & price is same throughout. MR coincides with the AR coz additional units are sold at the same price as before.

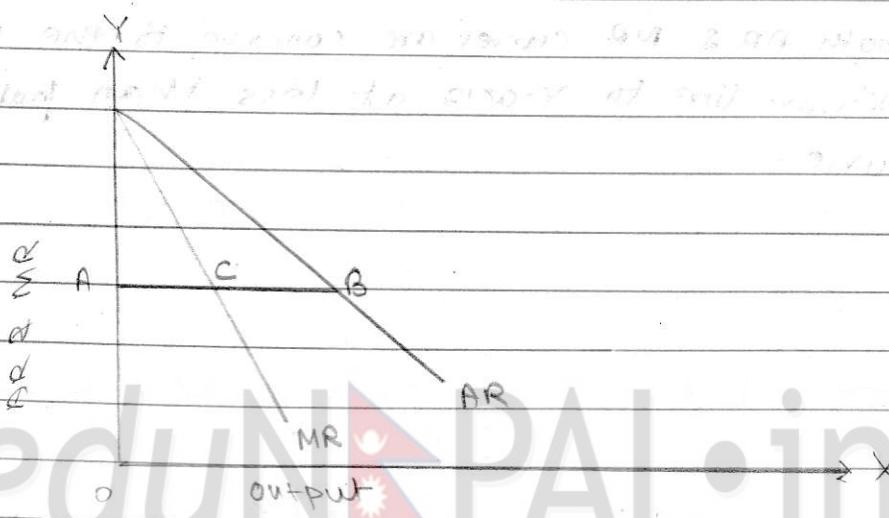


25

Relationship betw. AR & MR under imperfect competition / Monopoly.

- When both AR & MR curves are st. line.

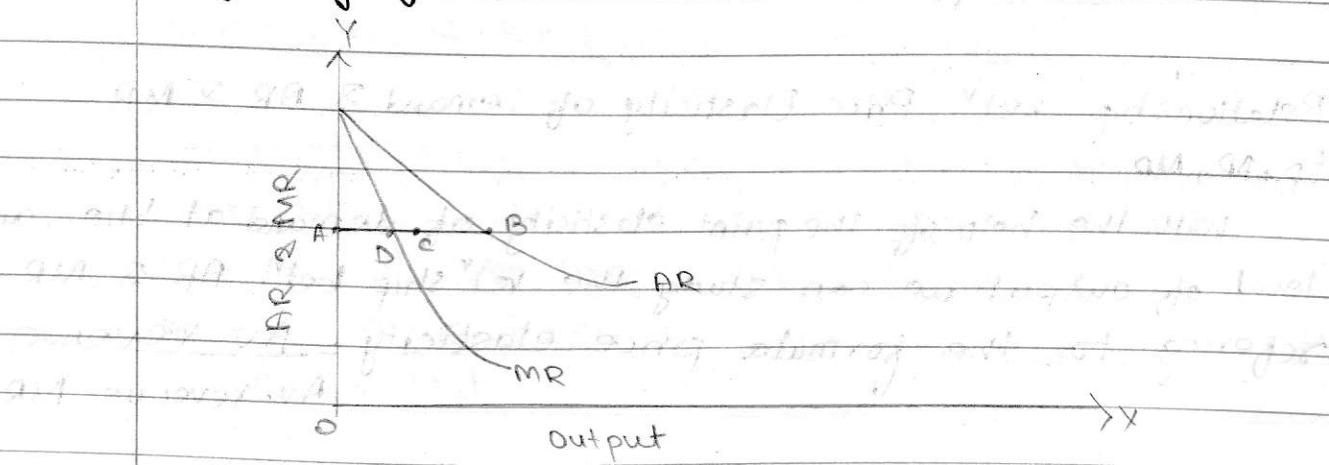
When both AR & MR curves are downward sloping & st line, the MR cuts any perpendicular line to Y-axis at halfway from the AR curve.



In the fig. AR & MR represent average & marginal revenue curves. MR curve cuts a perpendicular AB drawn to the Y-axis at its middle point C, i.e.  $AC = CB$ .

- When both AR & MR curves are convex to the origin

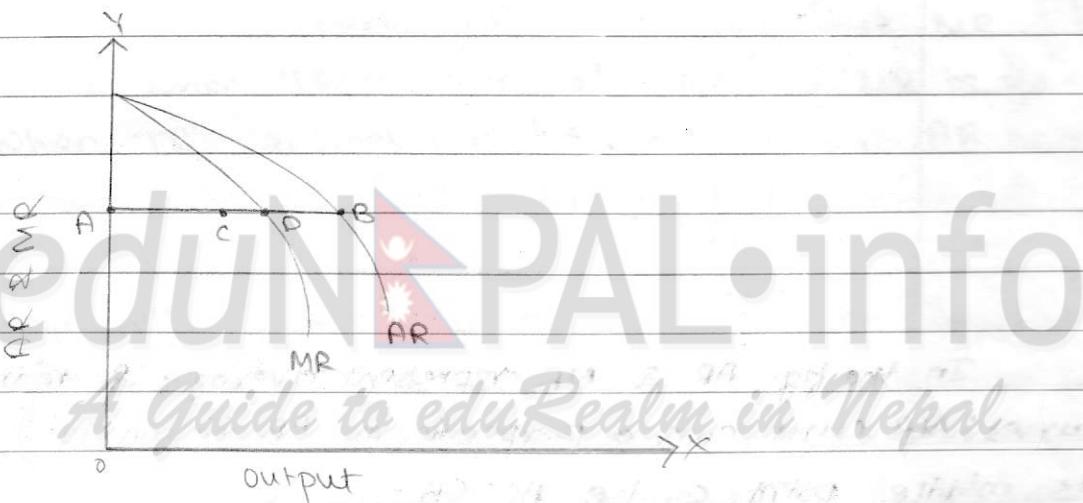
When both AR & MR curves are convex to the origin, the MR curve cuts any perpendicular line to the Y-axis at more than half-way from the AR curve.



In the fig., both MR & AR curves are convex to the origin. AB is the perpendicular drawn from AR to Y-axis & C is the mid-point of the perpendicular. MR curve cuts the perpendicular AB at more than midpoint at D where  $AD < DB$ .

- When both AR & MR curves are concave to the origin.

When both AR & MR curves are concave to the origin, MR cuts any perpendicular line to Y-axis at less than half-way from the AR curve.



In the fig. both MR & AR curves are concave to the origin. AB perpendicular is drawn from AR to Y-axis & C is the mid-point of the perpendicular. MR curve cuts the perpendicular AB at less than mid-point at D where  $AD > DB$ .

Relationship bet<sup>n</sup> Price Elasticity of Demand & AR & MR  
Ep, AR, MR

With the help of the point elasticity of demand at the any level of output we can study the rel<sup>n</sup>ship bet<sup>n</sup>. AR & MR referring to the formula price elasticity =  $\frac{\text{Av. revenue}}{\text{Av. revenue} - \text{MR}}$

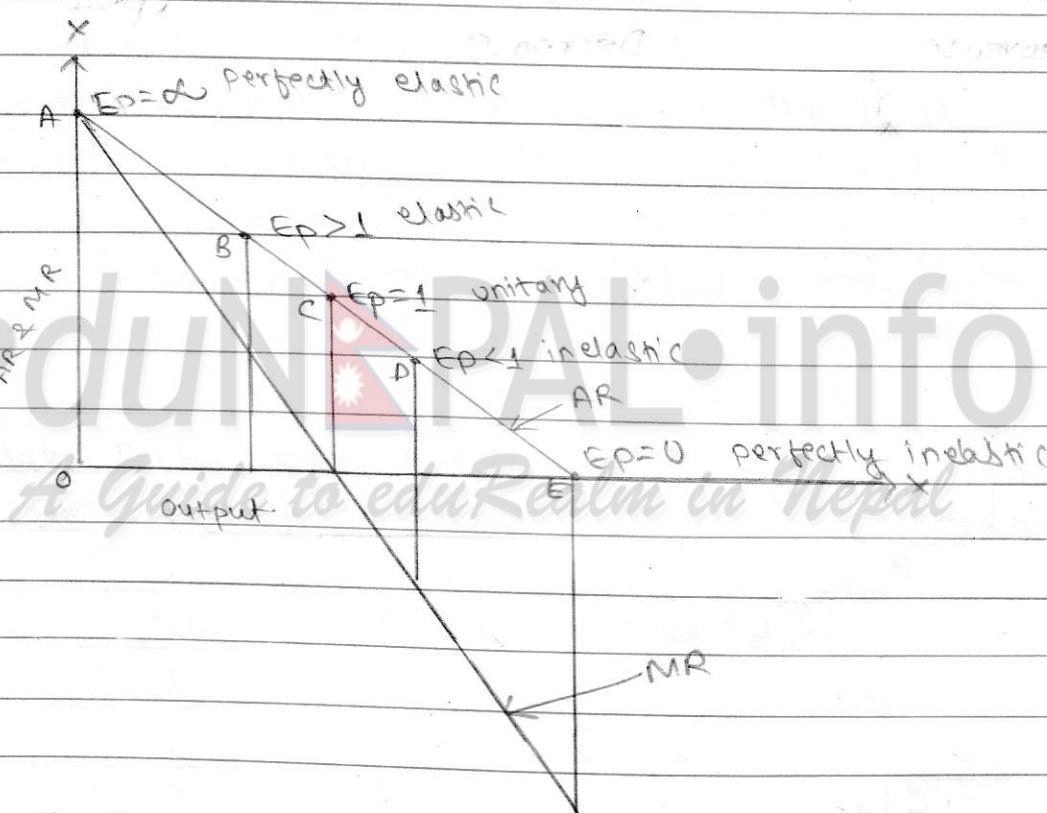
$$E = A$$

$$A = M$$

$$M = A(E - 1)$$

$$E$$

$$A = \frac{M \cdot E}{(E - 1)}$$

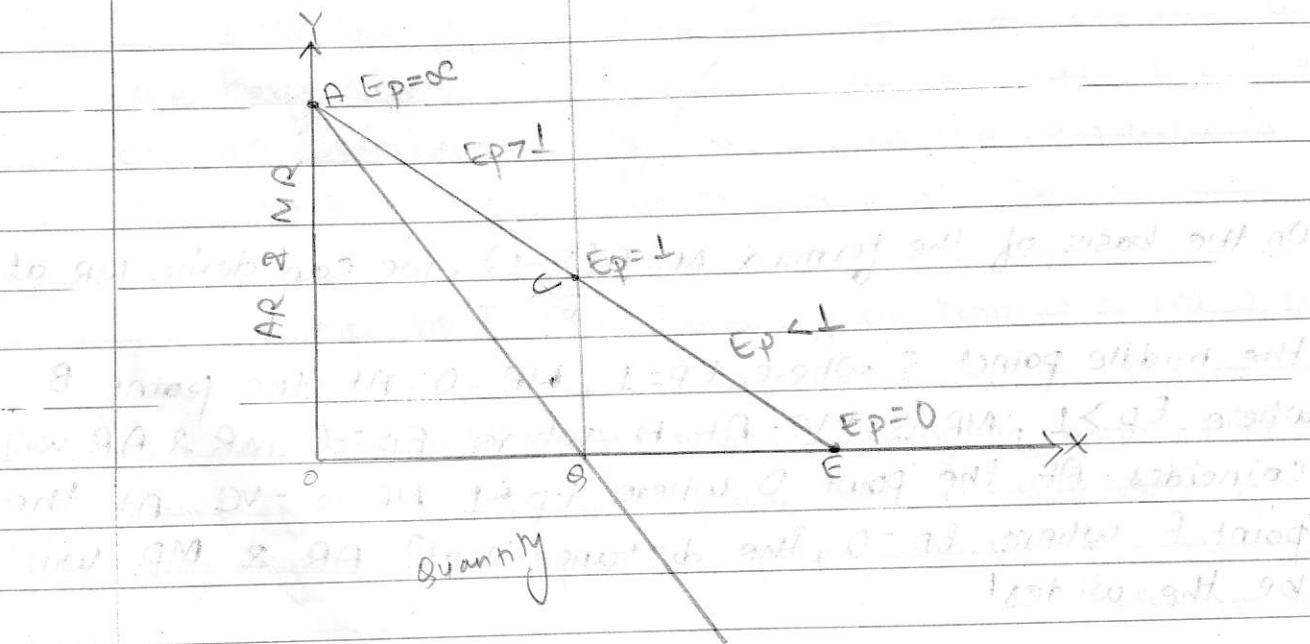
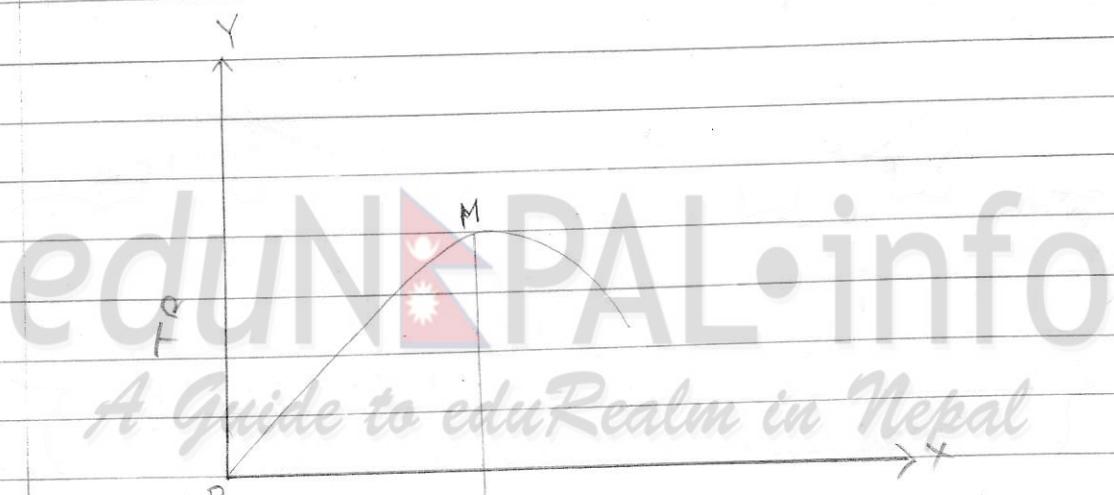


On the basis of the formula  $M = A(E - 1)$ , we can derive MR at E

the middle point C where  $EP = 1$ ,  $MR = 0$ . At the point B where  $EP > 1$ , MR is +ve. At A where  $EP = \infty$ , MR & AR will coincide. At the point D where  $EP < 1$  MR is -ve. At the point E where  $EP = 0$ , the distance bet' AR & MR will be the widest.

## Relation TR & Ep.

	Price	Total Revenue / Total outlay	Degree of FP	M.R.
1.	Increase	Decrease	$F_P > 1$	Positive
	Decrease	Increase		
2.	Increase	Constant	$F_P = 0$	0
	Decrease	Constant		
3.	Increase	Increase	$F_P < 1$	Negative
	Decrease	Decrease		



29

In the fig. X-axis represents quantity of output sold & Y-axis represents total revenue, average revenue & marginal revenue. The inversely U-shaped curve represents TR in the imperfect competition. Before OQ, TR is increasing but at diminishing rate. At the point M, TR is maximum & after that, it is declining.

In the fig AR or demand curve intersects horizontal vertical Y-axis where  $E_p = \infty$ , where  $E_p = 0$  it intersects horizontal X-axis. Up to the level of output Q which corresponds to the mid-point of demand curve C, where MR is 0 TR is maximum & constant at the point M. Below the mid-point C of demand curve  $E_p < 1$ , MR = -ve & TR falls.

- # a. Calculate  $E_p$  by using Arc Method & complete the schedule.  
 b. Explain the reln. of  $E_p$ , TR & MR on the basis of the completed schedule.

Price	$\Delta P$	$\Delta Q$	$\Delta Q$	Price elasticity $E_p = \frac{\Delta Q}{\Delta P} \times \frac{P_1 + P_2}{Q_1 + Q_2}$	$TR = Q \times P$	MR
50	-	1	-	-	50	-
45	-5	2	1	$\frac{1}{-5} \times \frac{50+45}{1+2} = -6.33$	90	40
40	-5	3	1	-3.4	120	30
35	-5	4	1	-2.14	140	20
30	-5	7.5	1	-1.44	150	10
25	-5	6	1	-1	150	0
20	-5	7	1	-0.692	140	-10
15	-5	8	1	-0.466	120	-20
10	-5	9	1	-0.29	90	-30

In the schedule, when price of comm. falls from Rs 50 to Rs 30 per unit,  $E_p > 1$  & TR increase from Rs 50 to Rs 150, when  $P_x$  falls from Rs 30 to 25,  $E_p = 1$  TR is constant at Rs 150. When price falls from Rs 25 per unit downward  $E_p < 1$ . TR decreases from Rs 150 to Rs 90.

As the price falls, over the range of demand when  $E_p > 1$  & TR increase, MR is +ve. Over the range when  $E_p = 1$  & TR constant & maximum,  $MR = 0$ . Over the range when  $E_p < 1$ , TR decrease & MR is negative.

#### cost of production

- 1) Actual cost & opportunity cost
- 2) Implicit & explicit cost
- 3) Accounting & economic cost
- 4) Historical cost & replacement cost
- 5) Separable & common cost
- 6) Fixed & variable cost
- 7) short run & long run cost

#### 1. Actual cost & opportunity cost

Actual cost is the total monetary expenditure on the factors of prod! that is recorded in the book of alc. It enclose actual expenses of the firm such as wages paid to the labours, rent for the use of land & building, payment for the raw material, insurance premium, taxes paid to the govt!, advertisement & transport cost.

Opportunity cost is not the actual cost of prod<sup>n</sup> of the commodity produced. It is the cost or earning of the next best alternative. If no alt. is available opportunity cost will be zero. It is not recorded in the book of alc but for business decision making the knowledge of opportunity cost is necessary because the manager has to face the problem of budget constraint when more resources are allocated by him in one use, they have to be withdrawn from another. Hence, opportunity cost is involved. The opportunity cost of labour is the maxi. wage the labourer would earn as a hired labour in some alt. employment. A person can use his financial capital in his own business. Opportunity cost is the amt of purchase or return on Capital, which he would earn by investing in fixed deposit in bank or purchasing share of company. The O.C of using land for wheat is the value of the alt. crop which goods have been grown in it.

### 2.3 Explicit/Accounting & Implicit cost & Economic cost.

An accountant & an economist have different views regarding the cost of production. Money expenses for purchasing or hiring the factors of prod<sup>n</sup> are known as accounting cost or explicit cost. They are the direct or contractual payment to the factor owners by the entrepreneurs. They are the accounting expenses of the firm. They enters the records of book alc. Monetary payments to the supplier of factors of prod<sup>n</sup> by the firms. They consists of wages paid to the labourers, employees, cost of raw materials & machines, interest payment

on the money borrowed, taxes, insurance premium, transport & advertisement expenses etc. Accounting cost does not include the imputed cost of the factors owned & supplied by the entrepreneurs himself.

**Implicit cost:** Implicit cost of prod! is imputed cost of entrepreneurs self owned & self employed factors. No direct payment is made for such use.

$$\text{Economic cost} = \text{Explicit cost} / \text{Accounting Cost} + \text{Implicit cost}$$

$$EP = TR - EC$$

Short-run total cost.

1. **Variable / Prime / Direct cost:** In the short run there are two types of cost. Short run is a period within which a firm can change its output by changing only the amt of Variable factors such as labour, raw material, fuel, etc. The expenses on such factors are called variable cost. When output is 0, TVC is also 0. With the increase in output it also increases.

2. **Fixed / Supplementary / overhead cost:** In short run fixed factors such as machine, permanent employees, land, building, etc can't be varied. The cost relating to these factors are called fixed factor. They remain ~~consta~~ constant at all level of output.

Thus, there are 3 concept concerning short Run TC.

33

TFC: It is the cost of all fixed factors, it includes rent, interest, insurance premium, depreciation charges, salary of the permanent employee. TFC remains constant at all level of output.

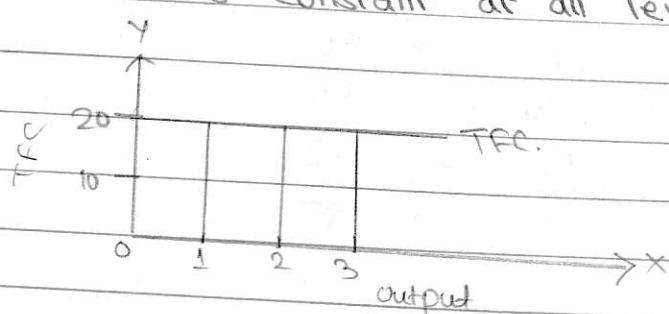
Units      TFC (Rs)

0      20

1      20

2      20

3      20



TVC: It is the cost relating to all variable factors at any given level of output it includes payment for raw materials, water, transport, power & fuel, wages paid to labourers, it is zero when output is zero. It increases with an increase in output. Rate of increase is different at different level of output depending on the law of variable proportion.

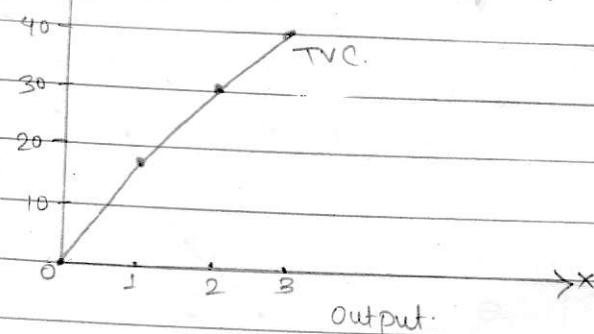
Units      TVC (Rs)

0      0

1      18

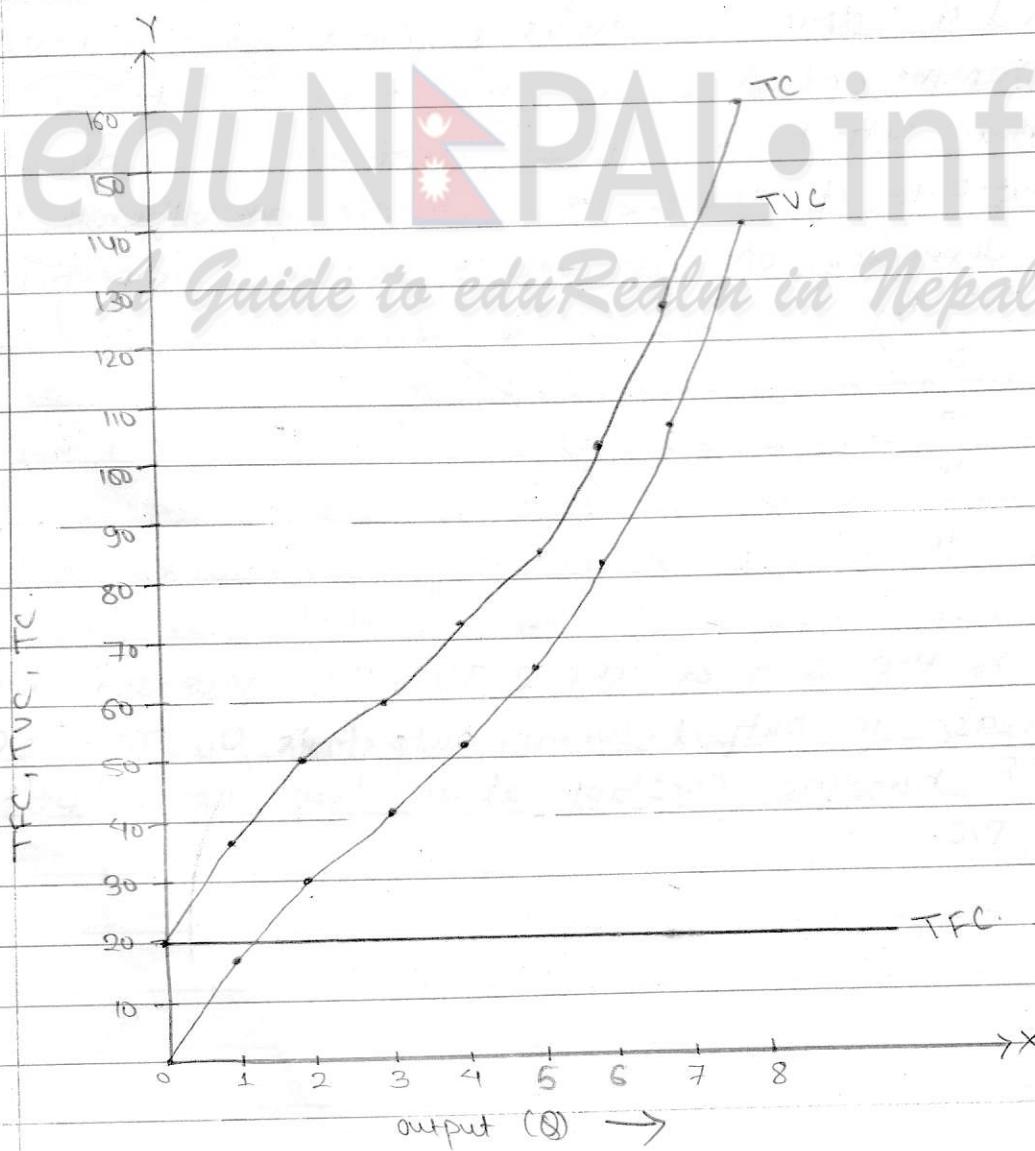
2      30

3      40



TC: It is the sum of TFC & TVC. It increases with the increase in output. When output is 0,  $TC = TFC$ . Since, TFC remains constant at all level of output. TC follows TVC.

Output (Q)	TVC	TFC	TC
0	0	20	20
1	18	20	38
2	36	20	56
3	54	20	74
4	72	20	92
5	90	20	110
6	108	20	128
7	126	20	146
8	144	20	164



35

In the fig. horizontal curve shows constant TFC. If we add a distance equal to TFC to the TVC at different level of output we can obtain TC curve as shown in the figure. TC curve slopes upward as it follows TVC. TC & TVC Curve have the similar sets. The only difference is the TVC curve starts from the origin 0. While TC curve starts above the origin on Y axis, as when output is 0,  $TC = TFC$ .

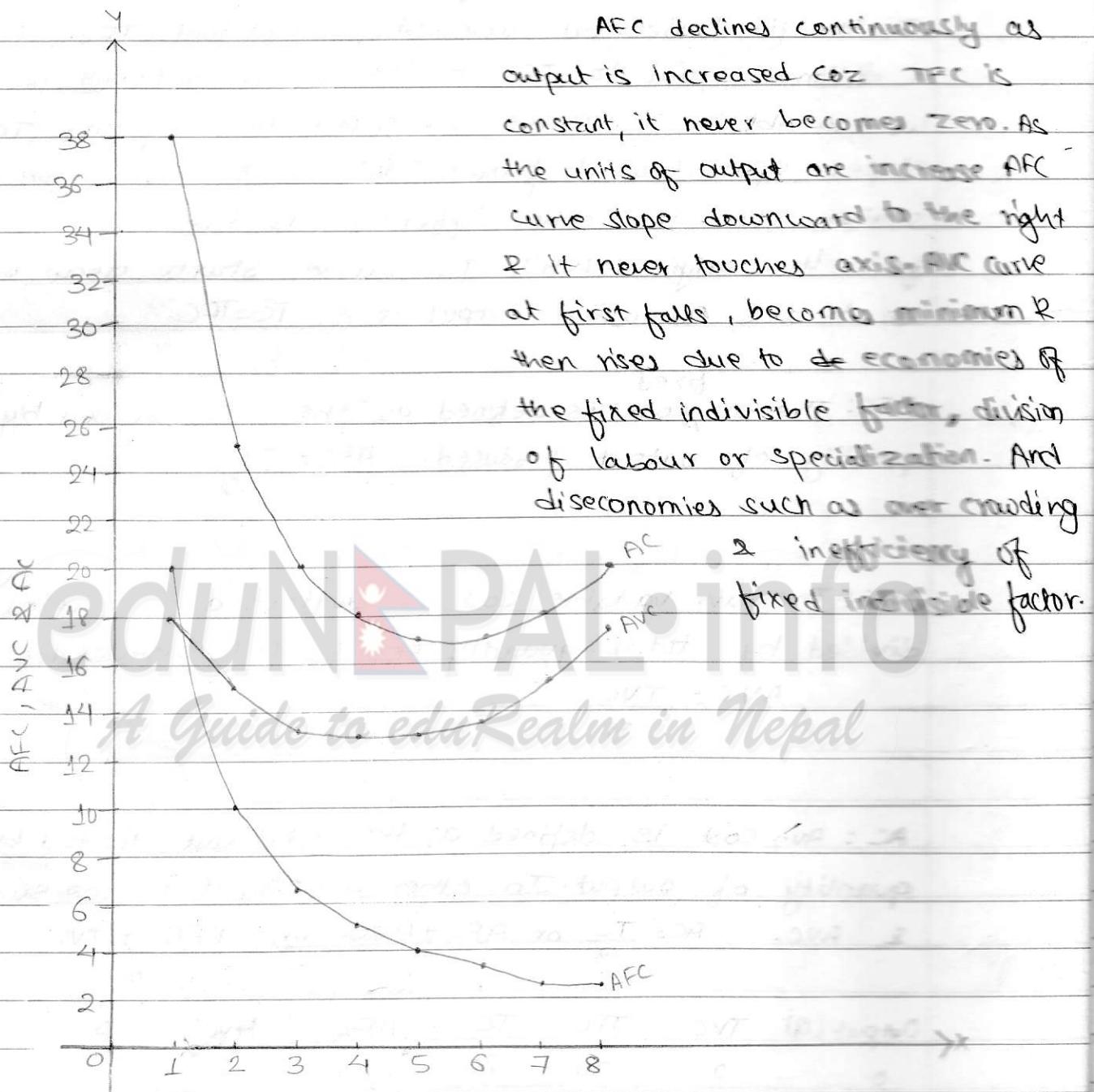
<sup>fixed</sup>  
AFC: The av. cost is defined as the TFC divided by the total quantity of output produced.  $AFC = \frac{TFC}{Q}$

AVC: The av. variable cost is defined as the total <sup>variable</sup> cost divided by total quantity of output produced.

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

AC: Av. cost is defined as the total cost divided by total quantity of output. In other words, it is the sum of AFC & AVC.  $AC = \frac{TC}{Q} \text{ or } AFC + AVC \text{ or } \frac{TFC + TVC}{Q}$

Output (Q)	TVC	TFC	TC	AFC	AVC	AC
0	0	20	20	0	0	0
1	18	20	38	20	18	38
2	30	20	50	10	15	25
3	40	20	60	6.6	13.3	20
4	52	20	72	5	13	18
5	65	20	85	4	13	17
6	82	20	102	3.3	13.6	17
7	106	20	126	2.8	15.14	18
8	140	20	160	2.5	17.5	20



Causes of V-shaped SAC

1) Behaviour of the ~~AFC & AVC~~ By adding the two cost curve AFC & AVC, AC is drawn. In the fig. AC curve lies above the AVC curve, equal to the corresponding height of AFC from x-axis. AC is V shaped

the AV. cost is high at low level of output as the level of output is increase AC decreases because AFC & AVC both goes on decreasing. Hence at the beginning both AFC & AVC slopes downward, AC curve also falls. After the lowest point on AVC it increases; AFC curve continuously falls, as the fall in AFC is more than the increase in the AVC, AC curve continuously falls. The minimum point of AC lies to the right of the minimum point of AVC. But after the mini. point of AC, the case will be reversed & AC increases. Thus, AC first falls & after reaching the mini. point, it is U shaped. The mini. point of AC shows optimum capacity of output.

## 2). Operation of law of variable proportions.

In the beginning with the use of increased variable factors, law of increase in returns or diminishing cost operate. Average product of variable factor increases, cost per unit decreases then it become minimum at the optimum capacity output. After this point, increase output has to face diseconomies, law of decrease in return or increase in cost operate. Average product of variable factors starts to fall & cost per units increase & it will be U shape. Law of variable proportion operates coz of the following reasons & SAC will be U shape.

## 3) Indivisibility of fixed factors:

As more & more variable factors are added to the fixed indivisible factors, there will be the efficient use of these factors AC decreases in the short run after having the optimum use of it, the economies are over weighted by the diseconomies which result the SAC curve to rise. Thus, SAC curve gets U-shape.

### Marginal Cost

MC is the increase in TC resulting from a unit increase in output.  $MC = TC(n+1) - TC_n$

$TC(n+1) \rightarrow$  After producing an additional unit of output.

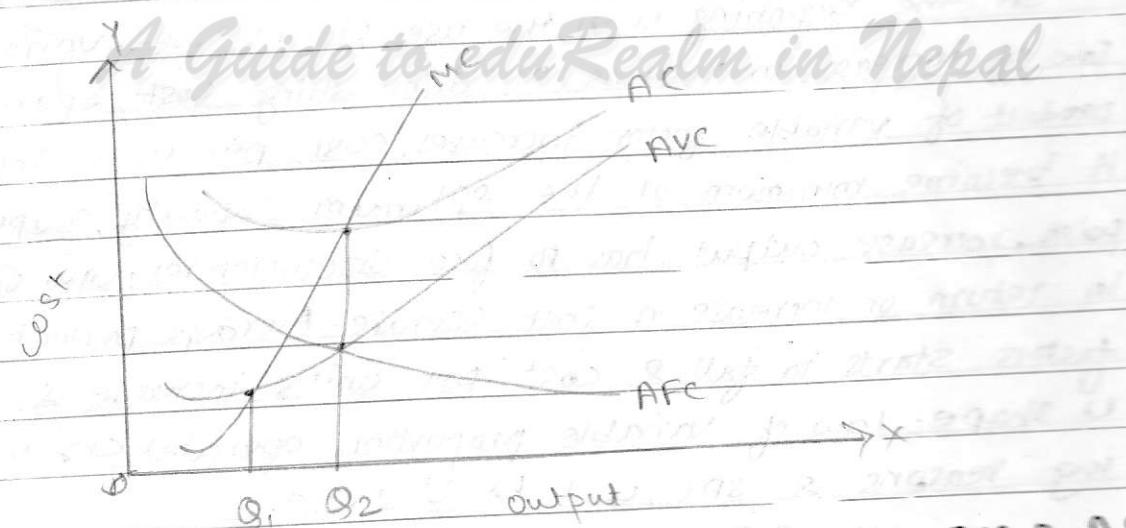
MC falls initially as output is increase hence MC curve slopes downward. With the further addition to total output MC increases & MC slopes upward after reaching its mini. point it become U shaped.

since, TFC is constant in the short run. MC has nothing with TFC.

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

$$\therefore (TFC_{(n+1)} + TVC_{(n+1)}) - (TFC_n + TVC_n)$$

since,  $TFC_{(n+1)} = TFC_n$   
 $TVC_{(n+1)} = TVC_n$

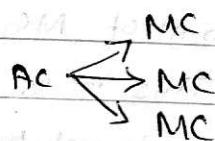


MC cost bears a close rel<sup>n</sup> to the AVC & AC curves.

It cuts the mini. point of AVC & then of AC. Before intersecting them MC is less than AVC & AC. After intersecting them MC is more than AVC & AC.

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Relationship between AC & MC in short-run.

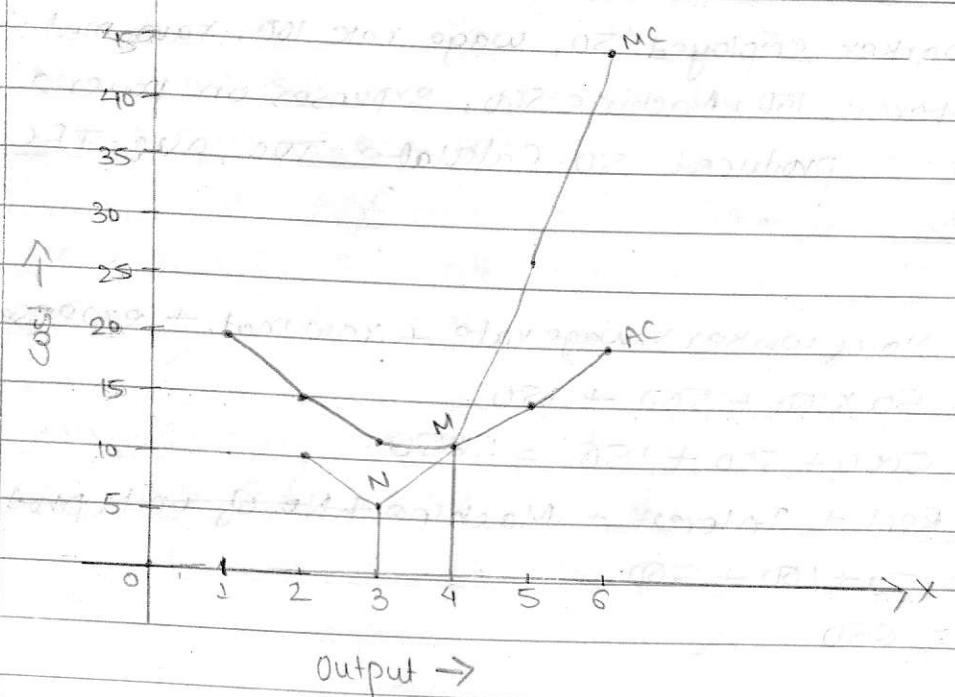


Both AC & MC are derived from TC.  $AC = \frac{TC}{Q}$

MC is the additional to TC resulting from a unit increase in output. AC & MC have the same behaviour as the output increases. They both fall initially & rise ultimately. Both AC & MC are U shaped.

Units of Output (Q)

	AC	MC	TC
1	20	-	20
2	15	10	30
3	12	6	36
4	12	12	48
5	15	27	75
6	20	45	120



In the fig. MC represent Marginal cost curve & AC represents average cost curve. The mini. point of AC is M & the mini. point of MC is N. When the MC curve lies below the AC, AC is falling. This is so coz AC includes both AVC & AFC. But MC is addition made only to Variable Cost when one more unit of output is produced. That is why, the fall in AC is less & the MC is more. When  $\frac{MC}{AC}$  is above AC, AC is rising. At the point of intersection M, MC & AC are equal.

The rel!ship bet! AC & MC can be summarized as below:

- i Both AC & MC are calculated from TC.
- ii Both AC & MC are V shaped.
- iii When AC is falling, the MC is always below the AC & the MC falls faster than AC.
- iv When AC is rising, the MC is <sup>above</sup> the AC & the MC rises faster than AC.
- v When AC is constant & minimum the MC equals to AC.
- vi ~~AC~~ intersects at the minimum point of AC.

Q. The no. of worker employed 50, wage rate 100, raw mat. 500, Rent 50, Interest 100, Machine 500, expenses on power & fuel 150, No. of units produced 50. Calculate TVC, AVC, TFC, AFC, TC & AC.

Sol!,

$$\begin{aligned}
 TVC &= \text{No.of workers} \times \text{wage rate} + \text{raw mat.} + \text{expenses on power \& fuel} \\
 &= 50 \times 100 + 500 + 150 \\
 &= 5000 + 500 + 150 = 5650
 \end{aligned}$$

$$\begin{aligned}
 TFC &= \text{Rent} + \text{Interest} + \text{Machine} + \cancel{\text{No.of units prod}} \\
 &= 50 + 100 + 500 \\
 &= 650
 \end{aligned}$$

41

$$TC = TVC + TFC = 5650 + 650 \doteq 6300$$

$$AVC = \frac{TVC}{Q} = \frac{5650}{50} = 113$$

$$AFC = \frac{TFC}{Q} = \frac{650}{50} = 13$$

$$AC = AVC + AFC = 113 + 13 = 126 //$$

Q. Short run total cost function is given below:

$$TC = 100 + 50Q - 12Q^2 + Q^3$$

Determine  $\rightarrow$  (a)  $TFC$ , (b)  $TVC$ , (c)  $AVC$ , (d)  $MC$  function.

(e) Calculate  $TC$ ,  $AC$ ,  $AVC$  &  $MC$  when the firm produce 10 units.

a) As fixed cost of the firm doesn't vary with output, the firm in output function which has no output  $Q$  term will be the fixed cost. The given cost function is  $TFC = 100$ .

$$\begin{aligned} b) TVC \text{ function} &= 100 + 50Q - 12Q^2 + Q^3 - 100 \\ &= 50Q - 12Q^2 + Q^3 // \end{aligned}$$

$$c) AVC = \frac{TVC}{Q} = \frac{50Q - 12Q^2 + Q^3}{Q} = 50 - 12Q + Q^2 //$$

d)  $MC = NC$  is the 1<sup>st</sup> derivative of  $TC$  function or  $TVC$ .

$$\begin{aligned} MC &= 50Q - 12Q^2 + Q^3 \\ &= 50 - 12 \times 2Q + 3Q^2 = 50 - 24Q + 6Q^2 // \end{aligned}$$

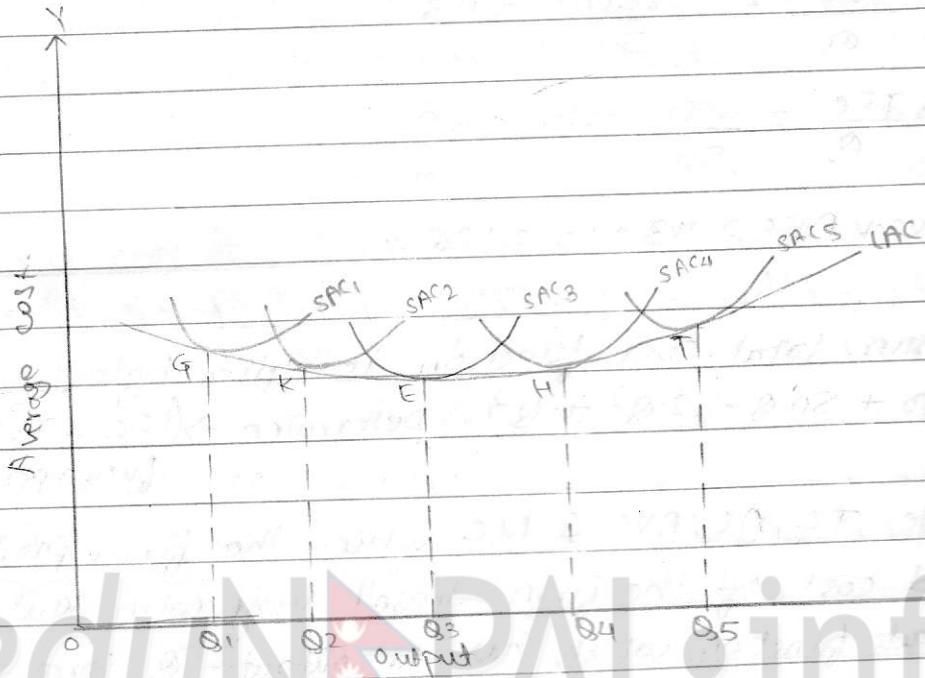
$$e) TC = 100 + 50 \times 10 - 12 \times 10^2 + 10^3 = 400 //$$

$$AC = \frac{TC}{Q} = \frac{400}{10} = 40 //$$

$$AVC = 50 - 12 \times 10 + 10^2 = 30 //$$

$$MC = 50 - 24 \times 10 + 6 \times 10^2 = 410 //$$

### Derivation of LAC



In the fig.  $SAC_1, SAC_2, SAC_3, SAC_4$  &  $SAC_5$  are 5 short-run average cost curves. A long-run average cost curve is so drawn as to be tangent to each of the short-run average cost curves. In other words, LAC envelope  $SAC_5$  from below. Therefore, it is also called envelop curve. When LAC declines, it is tangent to the falling portion of  $SAC_1$  & vice versa.

The falling portion of the LAC curve is tangent to the falling portion of the  $SAC_1$  &  $SAC_2$  at points G & K. The rising portion of the LAC curve is tangent to the rising portion of  $SAC_4$  &  $SAC_5$  curve at points H & T. The lowest point of the LAC curve is tangent to the lowest point of the  $SAC_3$  curve at E. Hence,  $SAC_3$  is the optimum size of the plant. The firm will choose plant size  $SAC_3$  in the long run.

Thus, the LAC first falls & then beyond a certain point it rises. ∴ the LAC is 'U' shaped, but less flatter than short-run average cost curves. In other words, SAC is less pronounced; it is coz of operation of law of returns to scale in the long run.

# Why is LAC flatter (less pronounced)?

- It is flatter than the SAC coz in the long run almost all the factors of prod! are variable. Plant size & scale of prod! can be changed, each output can be produced at the lowest cost possible.

# Why LAC is U-shaped?

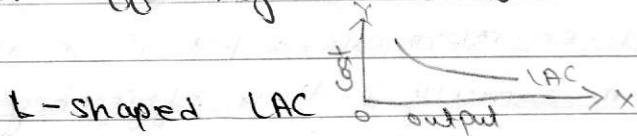
- LAC exhibits increasing returns to scale or decrease cost due to economies. The constant returns to scale or constant cost at the constant LAC point. Ultimately decreasing returns to scale or increasing cost due to diseconomies.

i. Economies of scale: Various reasons have been advance for the occurrence of economies of scale:

- a. Specialization: Plants designed for large scale output can provide more opportunity for the employment of labourers with special skills & for the introduction of specialized capital equipment or machine as a result, LAC decline.
- b. Indivisibility of factors: When scale of output is increase, the invisible factors such as entrepreneur, expensive heavy machine are employed to maximum capacity & their efficiency increases hence, LAC decline.
- c. Massed resources: Law of large no many result economies of scale of massed resources for eg: a firm using several identical machines will have to stop a few spare parts than a firm with only one coz the firm with several machine can assume that its machines are unlikely to develop the same faults at the same time.
- d. Other economies: As the firm increases, the scale of prod! it can sell its product more easily it can borrow money cheaply & purchase raw mat. at cheaper price, it can employ the efficient manager, per unit transport cost will be low. Thus, LAC initially decline.

After the minimum point of LAC, at the minimum point of LAC, it becomes constant over a certain range of output. Here, economies & diseconomies balance each other.

2. Diseconomies of scale : with the expansion of scale of prod! diseconomies occurs coz of following reasons :
  - a. Managerial inefficiency : when the scale of prod! become too large it become very difficult to supervise & coordinate. The manager become very busy & face difficulties in making right decision. As a result LAC increases.
  - b. Indivisibility of factor : when indivisible factor become inefficient due to the over expansion of the scale of prod! LAC rises.
  - c. Problem of morale & motivation : The morale & motivation among the manager & labourer to increase the productivity decrease as the scale of prod! increases after the mini. LAC. They lose the collective sentiment & the incentive to increase the prod! their efficiency decreases LAC rises.



Initially the LAC remains quite high at a lower range of output. Then, it takes a down corach & remains almost constant. The LAC curve is almost flat at the right. Making the LAC curve L-shape.

Empirical evidence shows that LAC curve of modern theory doesn't show the tendency to turn up even at a very large scale of prod! as the traditional LAC does.

15

The reasons for L-shaped LAC.

- 1) Technical progress: As a result of continuous technical progress LAC falls initially & then becomes almost constant, it will be L-shaped.
- 2) Learning by doing: Because of learning by doing the efficiency of labourers goes on increasing & the cost decreases with the increase in the scale of output in the long run therefore LAC becomes L-shaped.
- 3) Managerial cost behaviour: For producing diff scale of output diff appropriate technique of management is applied. The managerial cost decreases, as a result LAC decreases & then remains almost constant.
- 4) Economies: The LAC curve slopes downward coz with the expansion of output the firm experiences various economies of scale such as larger scope for specialization of labour & machines Availability of cheaper raw materials & equipments improvement in skill, lower requirement & transport etc. As a result product cost decreases & LAC turns down & then over a large range of output it remains constant. Hence, LAC become constant.

### Chapter 7 - Theory of Product Pricing

Equilibrium of the firm in the long-run under perfect competition  
 TR - TC approach → According to this approach the firm will be in equilibrium when it gets maximum profit. It occurs at the maximum difference betw TR & TC.