PROJECT WORK
DATE 1

RETURNS TO SCALE

Returns to Scale are defined when all factors of production (i.e. L & K) are variable (i.e. can be changed). This is possible only in the long-run.

Let us assume that all factors are changed in the same proportion or %. Suppose that initially output is $X_0 = f(L, K)$, f production function for given L & K. Now suppose both L & K increases by the same proportion k (eg- k = 2, or 3, or 4 ...). Then, output also increases to $X^* = f(kL, kK)$ Hence, $X^* > X_0$. Now,

① If $X^* > kX_0$, we say that production function f ~~exibits~~ exhibits INCREASING RETURNS TO SCALE. (IRS)

② If $X^* = kX_0$, then f is constant Returns to scale (CRS)

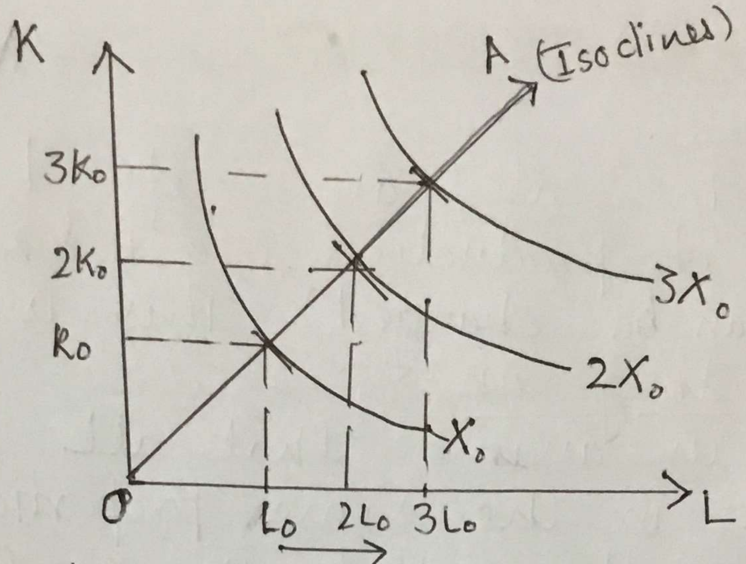
③ If $X^* < kX_0$, " f is Decreasing Returns to scale (DRS)

To show this result let us assume the following

① Production function is homogeneous. Hence, ~~isoclin~~ isoclines are straight lines.

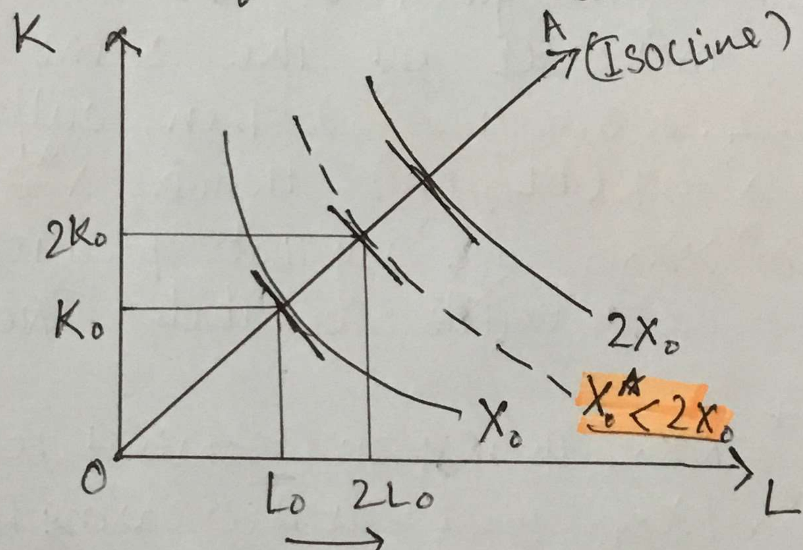
② Production function exhibits CRS or DRS or IRS in the Long Run (LR).

Case 1 Production function is CRS in the LR

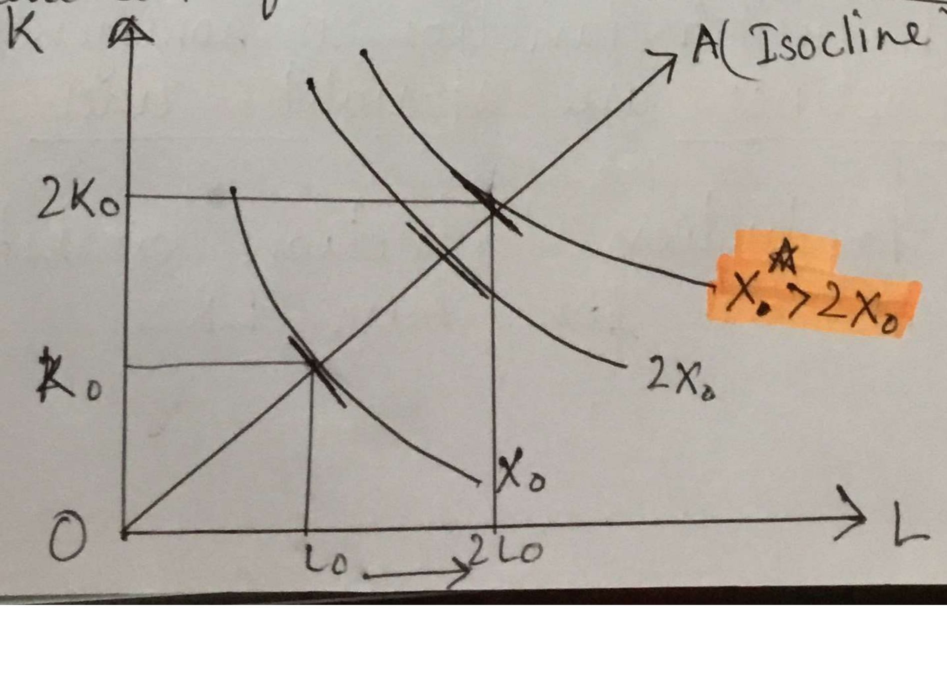


$X^* = X_o$

Case 2 Production function is DRS in the LR



Case-3 Production function is IRS in the LR)



Short Run Cost

① $TC(Q) = VC(Q) + FC$

Function of Q — function of Q — indep. of Q (Fixed)

② $MC(Q) = \dfrac{\partial TC(Q)}{\partial Q}$ = rate at which total cost (TC) changes as we chang output (Q) slightly.

> 0

Also, $MC(Q) = \dfrac{\partial VC(Q)}{\partial Q}$ = rate at which variable cost changes as we change output slightly.

> 0

③ Since $TC(Q) = VC(Q) + FC$

Now dividing by Q on both sides we get:

$$\frac{TC(Q)}{Q} = \frac{VC(Q) + FC}{Q}$$

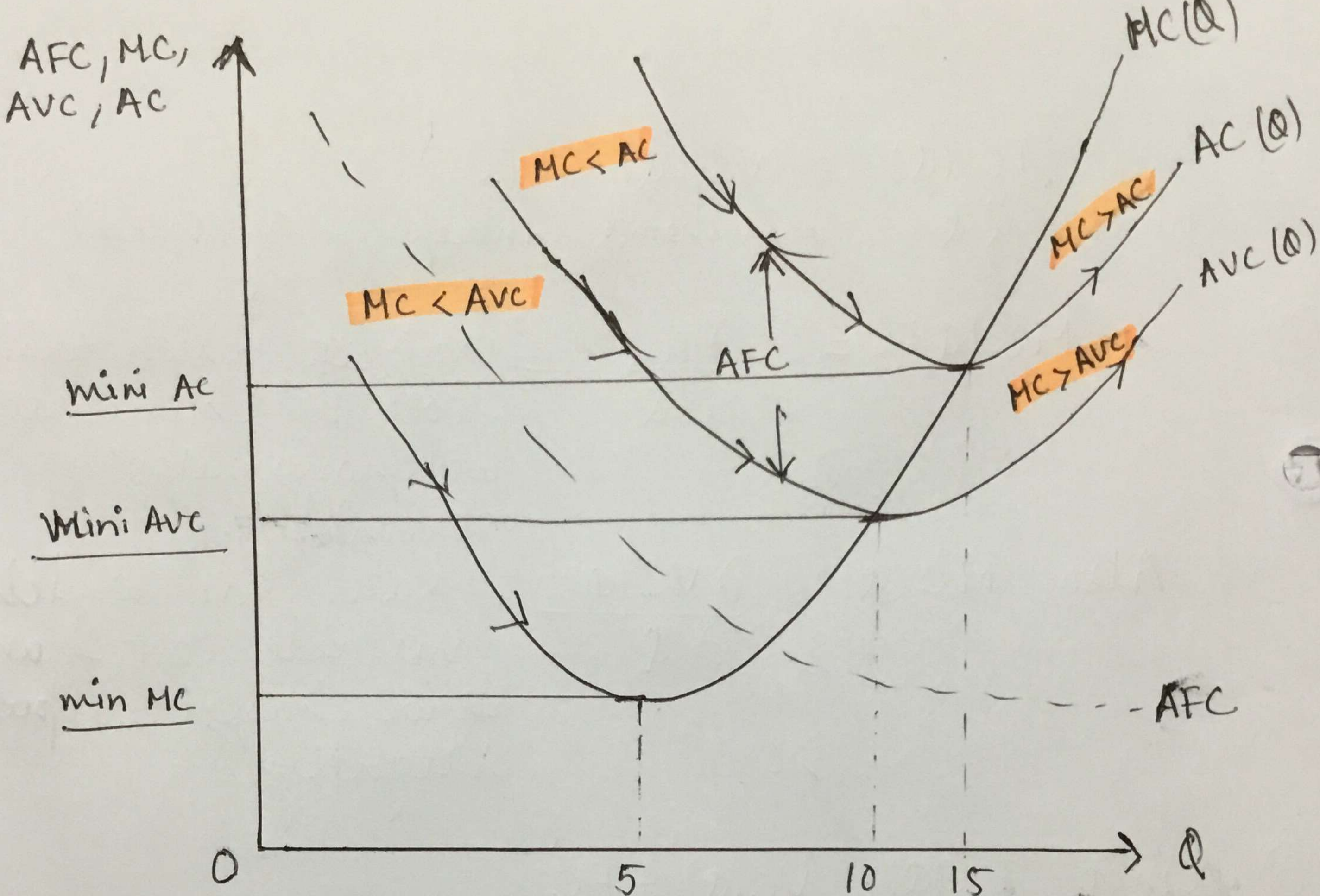
or, $$\left[\frac{TC(Q)}{Q}\right] = \left[\frac{VC(Q)}{Q}\right] + \left[\frac{FC}{Q}\right]$$

$$\underbrace{AC(Q)}_{>0} = \underbrace{AVC(Q)}_{>0} + \underbrace{AFC(Q)}_{>0}$$ depends on Q

④ Note that due to specialization of labour in the SR (capital-fixed) $MC(Q)$ is 'U' shaped ~~in~~ curve. Also, $AVC(Q)$ & $AC(Q)$ are U-shaped curves.

Q	(Rs.-) VC(Q)	FC	TC(Q)	MC(Q)	AVC(Q)	AFC: FC/Q	AC
0	0	100	100	-	-	-	-
1	10	100	110	10	10	100	110
2	18	100	118	8	9	50	59
3	24	100	124	6	8	33.3	41.33
4	32	100	132	8	8	25	33.
5	42	100	142	10	8.4	20	28.4

2



Relationship between MC and AVC in the SR

1. When MC (Q) < AVC(Q), then AVC (Q) ~~dec~~ declines.
2. When MC (Q) > AVC (Q), then AVC (Q) increases.
3. when MC(Q) = AVC(Q), then AVC (Q) minimum.

Relationship between MC and AC in the SR

1) when MC(Q) > AC, then AC increases.
2) when MC (Q) < AC, then AC decreases.
3) when MC = AC, then AC minimum.

PROJECT WORK
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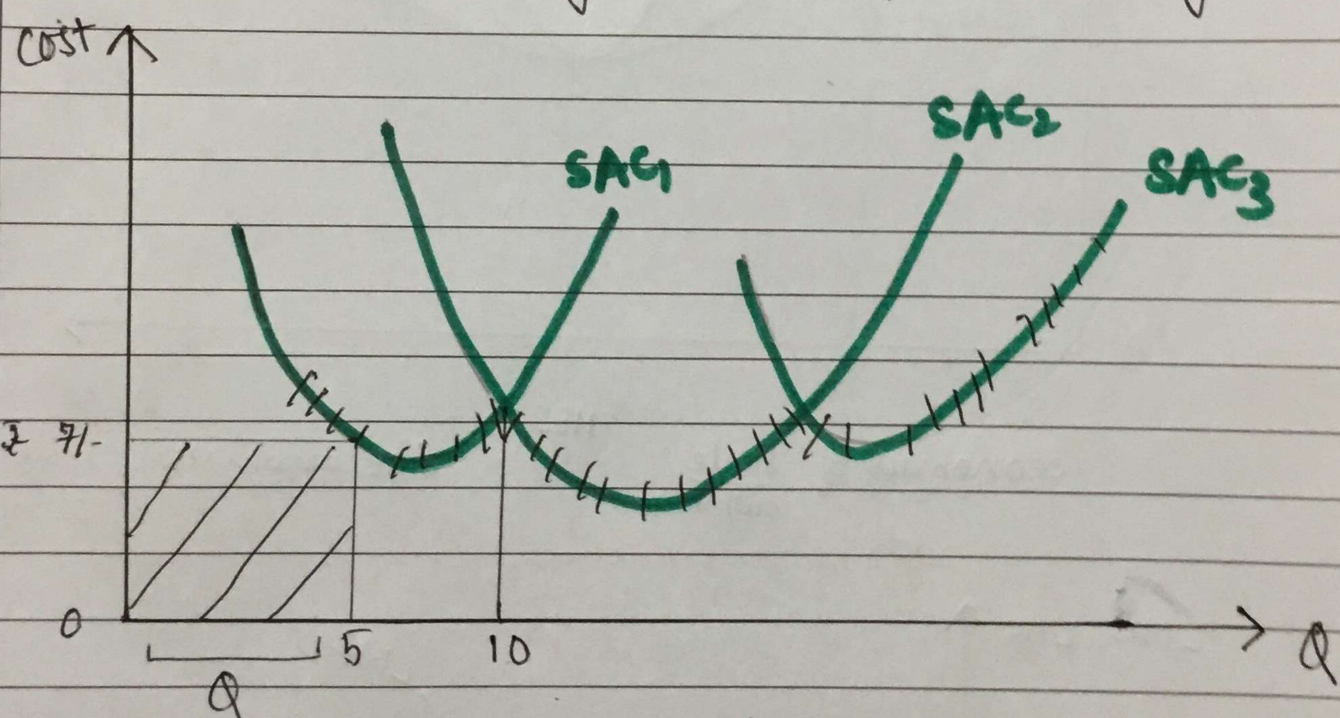
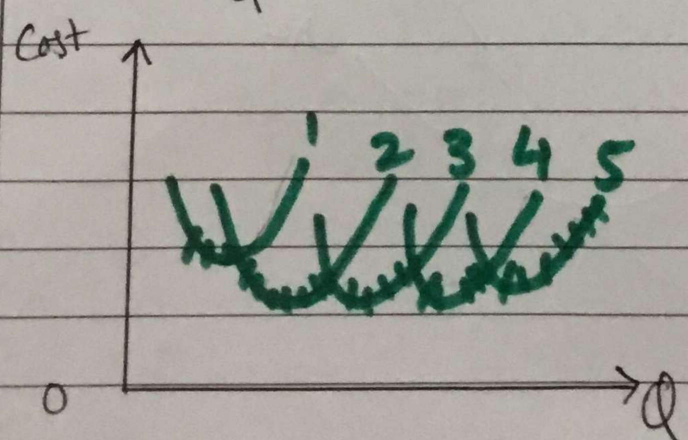
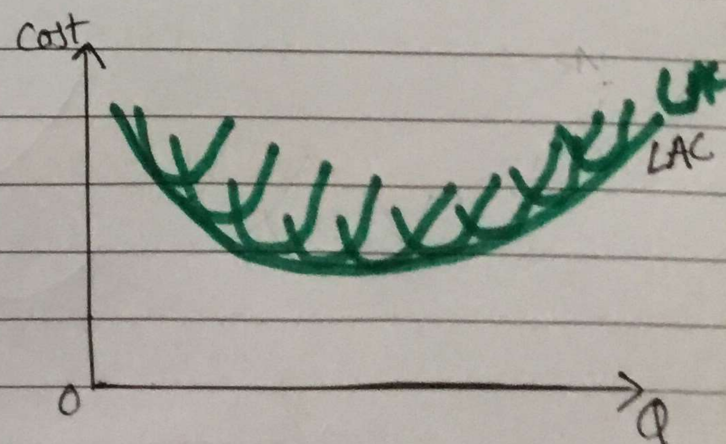
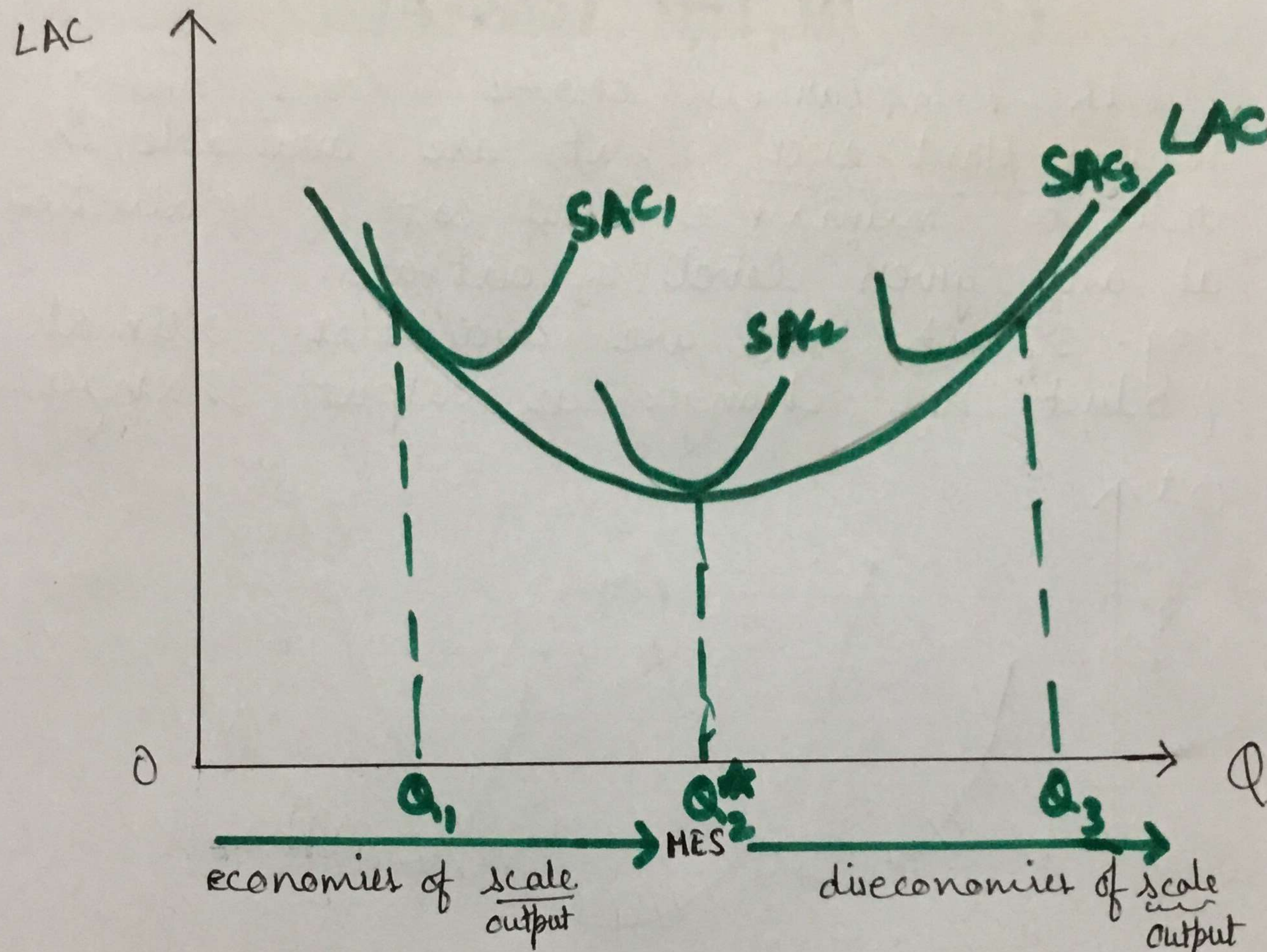
COST IN THE LONG-RUN

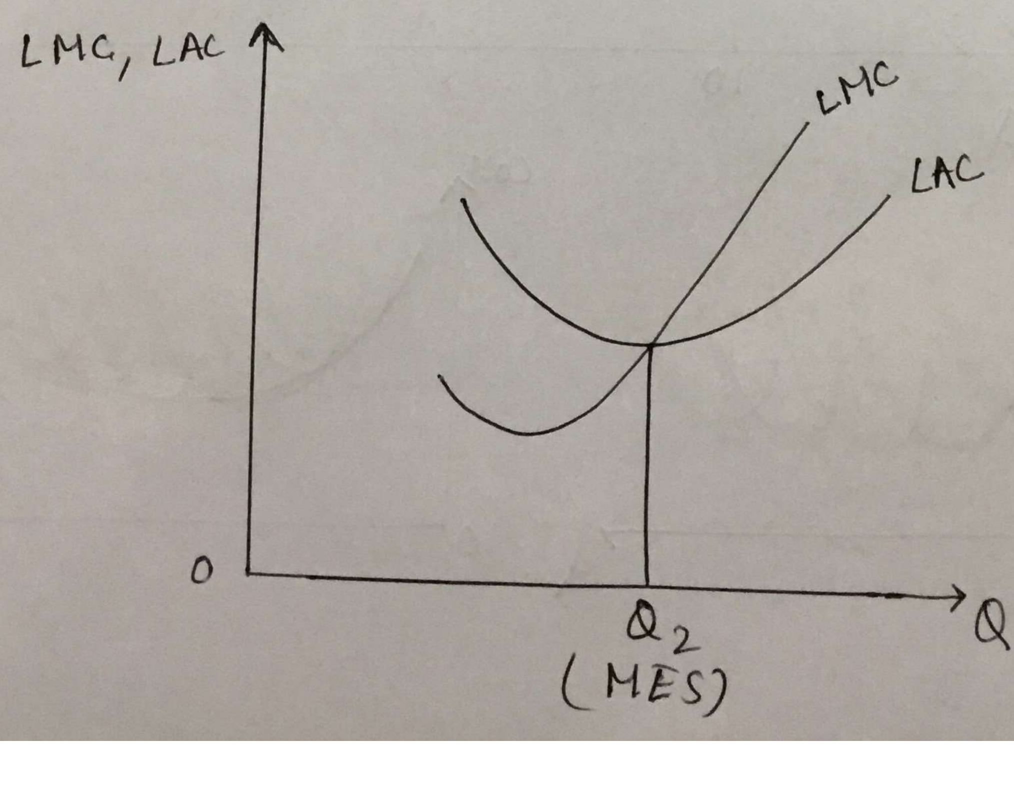
In LR, firm / business ~~chooses~~ choocs among various plant sizes that are available, in order to minimizes total cost of production, at any given level of output.
eg- 3 plant sizes are availables. optimal product size changes as output changes.








LAC
SAC1
SAC2
SAC3
LAC
0
Q
Q1
Q2*
Q3
MES
economies of scale output
diseconomies of scale output


LMC, LAC
LMC
LAC
0
Q
Q2
(MES)

"BREAK-EVEN" ANALYSIS

(No profit No loss)

When a business starts, it may not be able to cover its fixed cost in the short-run. ~~(b/c sales may not~~ This is so because the firm's volume of sales / output → Q may be low initially, due to low demand. Hence, the firm's revenue (sales) may not be high enough to cover all its costs, in particular, its fixed cost.

The level of output / volume of sales at which the firm's revenue $= (P \cdot Q)$ is large enough to cover its fixed cost, besides its variable cost, is called the "BREAK-EVEN level of output / vol. of sales" of the firm.

BREAK-EVEN implies that the firm does not make either a profit or a loss (i.e. 'normal' profit only is obtained by the firm) in short run

Total Revenue = PQ

BREAK-EVEN: $TR = FC + VC = TC$

so, $TR = TC$, or Profit $= TR - TC = 0$ (normal profit)

To calculate the break-even level of output / vol. of sales of the firm, two important assumptions are made in the analysis. These are:

1. Price of the product does not depend on the vol. of sales of the firm. (like in 'Perfect competition')
2. AVC (Avg. Var. cost) of the firm does not depend on vol. of sales (Q) of the firm. $\frac{VC}{Q} = \frac{VC(Q)}{Q}$

assumption 3 - $\boxed{P > AVC}$

Given the above assumptions, we can write:

BREAK-EVEN: $TR = TC = FC + VC(Q)$

↓ (use Graph to explain)

or $TR = PQ = FC + \underbrace{\left(\frac{VC}{Q}\right)}_{AVC} \cdot Q$ (Q = vol. of sales of the firm) dividing by Q and multiplying by Q.

or $PQ - AVC\,Q = FC$

or $(P - AVC)\,Q = FC$ → indep. of Q (by definition of FC)

indep. of Q (b/c of Assumption 1 & 2 above)

or $Q_{BE} = \frac{FC}{(P - AVC)}$ → indep. of Q

FC → indep. of Q; $(P - AVC) > 0$; $Q_{BE} > 0$

We also assume: $\boxed{P > AVC}$

$\therefore (P - AVC) > 0$

$FC > 0$

$\therefore \boxed{Q_{BE} > 0}$

"BREAK-EVEN POINT" OF THE FIRM in VSL (2)

(B.E.P.)

OF SALES : B.E.P $= \boxed{Q_{BE}} = \boxed{\frac{FC}{(P-AVC)}}$

By Assumption 3 → $(P > AVC)$

P = Revenue per unit of the firm

AVC = Variable cost per unit of the firm

$(P > AVC)$: $(P - AVC)$ is the amount (Profit) per unit that the firm can spend to cover its fixed cost. Therefore, like Profit

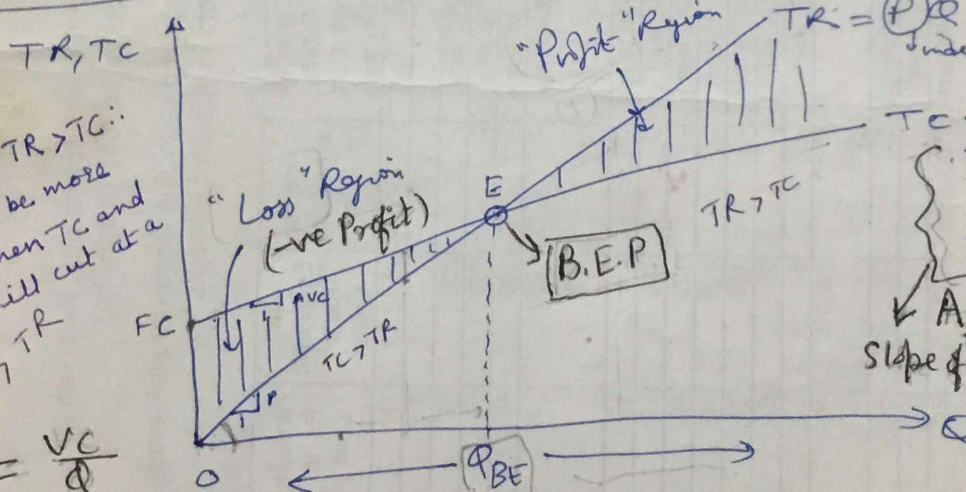
$(P-AVC)$ is called PROFIT CONTRIBUTION PER UNIT / CONTRIBUTION PER UNIT → towards payment of FC

$$\therefore \quad \underline{B.E.P.} = \boxed{Q_{BE} = \left(\frac{\text{Fixed Cost}}{\text{Contribution Per Unit}}\right)}$$

↓ formula to calculate B.E.P.

or Break-even level of output of the company.

Graphical Illustration / Depiction of B.E.P. of a firm



Slope of TR $= \frac{\partial TR}{\partial Q} = P > 0$ (indep. of Q - Constant)

$TC = FC + VC$

$= FC + \left(\frac{VC}{Q}\right) \cdot Q$ (AVC)

$= FC + AVC \cdot Q$

A-3 ($P > AVC$)

Slope of TC $= \frac{\partial TC}{\partial Q} = AVC$ = Constant

slope of TR > TC ∴ TR will be more steeper than TC and TR, TC will cut at a point E. TR

TC > TR

(use above formula to calculate Q_{BE})

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

$(AVC)\,Q = \left(\frac{VC}{\cancel{Q}}\right) \cdot \cancel{Q}$

$\therefore TC = FC + VC(Q)$

indep. indep. AVC (Q)

(1) slope of TR is P which is > slope of TC (it is = AVC)

(2) (slope of TC is AVC)

eg- FC = Rs 1000/- p. mth, P = Rs 2/- per unit, AVC = Rs 1.5/- per unit. Calculate BEP of the firm.

$Q_{BE} = \frac{FC}{(P-AVC)} = \frac{1000}{(2-1.5)} = \frac{1000}{.5} =$ 2000 Units per mth

or $.5 = \frac{1}{2}$

Q_{BE} = 2000 units per mth