HS 201 Micro Economics

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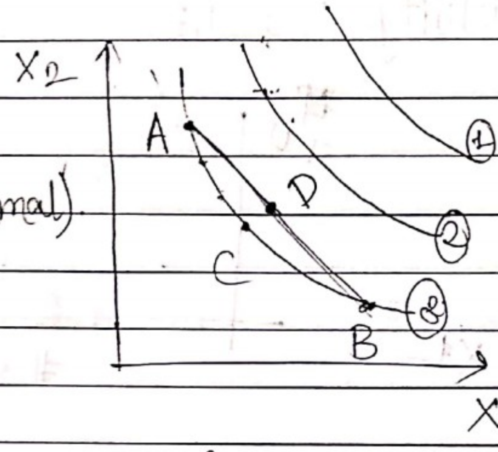
Consumer Behaviour.

Ordinal Theory. ① ~~Non~~-satiety. (Never satisfied).
② Convex Preference.

x_1 & x_2 are some (normal) goods.

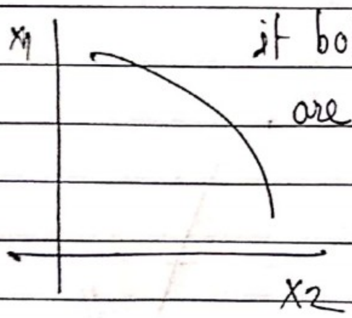


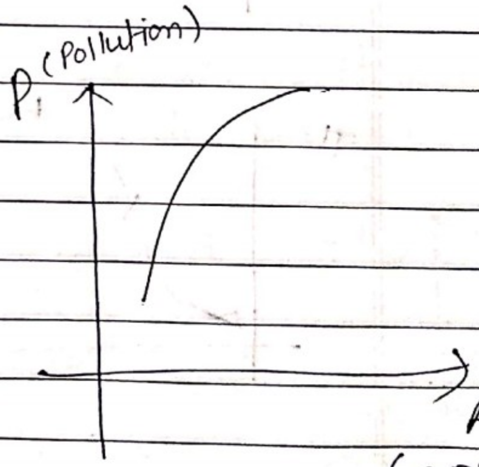
Indifference curves (1, 2, 3)
locus of pts. where level of satisfaction remains same everywhere.

$0 < t < 1$

Moving away from origin increases utility.
(① > ② > ③)

$tA + (1-t)B > A$ or B.
i.e. Average is preferred over extremes.





③ Complete → not being confused about choices.

④ Transitivity →

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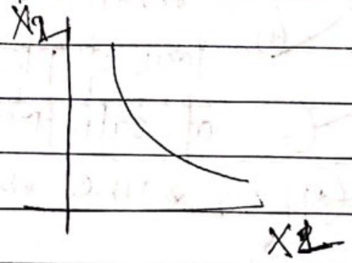
MRS (Marginal Rate of substitution)

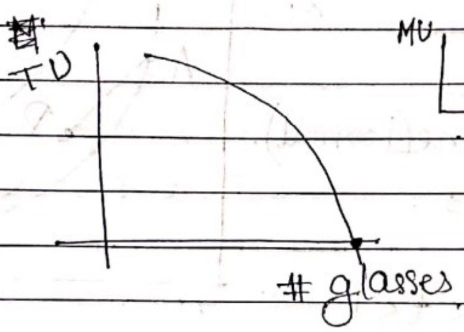
(Utility) → $U = U(x_1, x_2)$

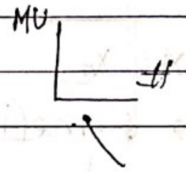
$dU = U_1 . dx_1 + U_2 . dx_2$ $\quad$ U_1, U_2 are partial derivatives

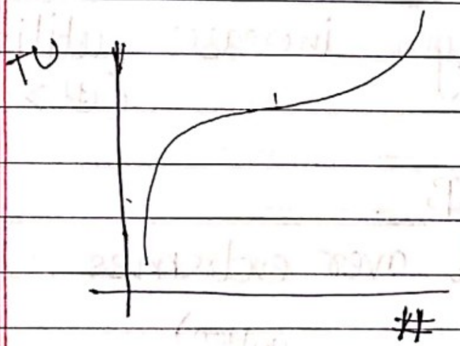
$0 = U_1 dx_1 + U_2 dx_2$ $\Rightarrow \dfrac{dx_2}{dx_1} = \dfrac{-U_1}{U_2} = -\dfrac{MU_1}{MU_2}$

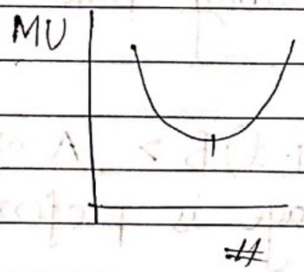
U_i = Marginal utility ; $i = 1, 2$.

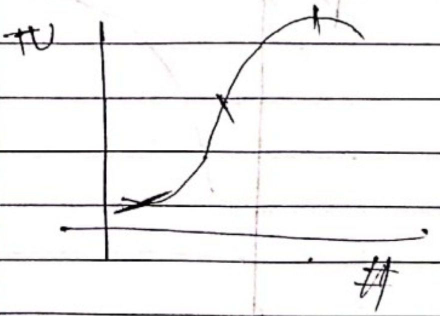


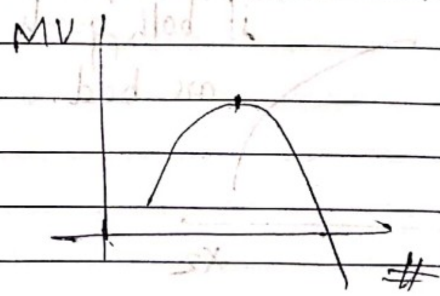




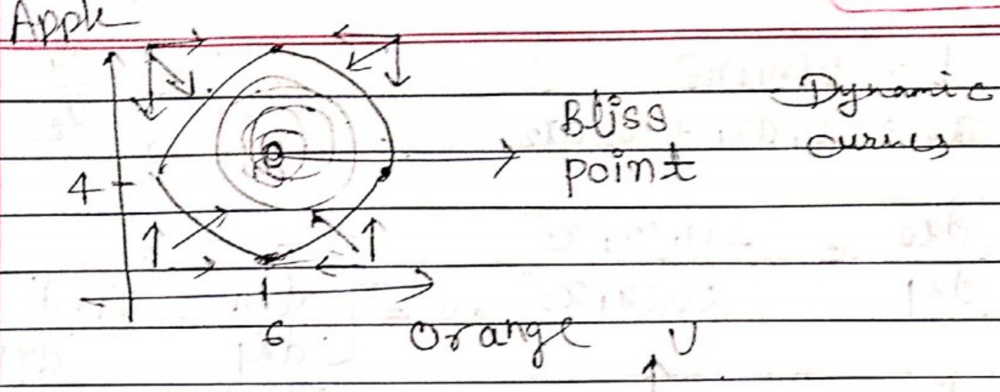




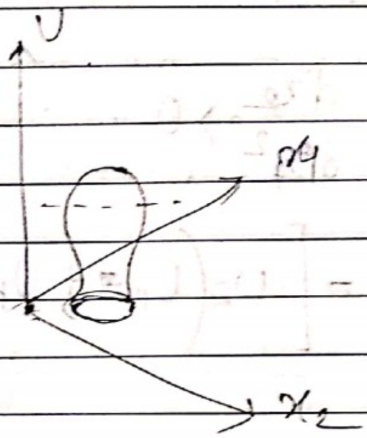




(Latin) Ceteris Paribus ⇒ Keeping everything else constant and seeing affects by changing a particular factor.



quasiconcave.



$$U = U(x_1, x_2)$$
$$= x_1^{\alpha} \cdot x_2^{\beta} ; \quad 0 < \alpha, \beta < 1$$

$$U_1 = \frac{\partial U}{\partial x_1} = \alpha \cdot x_1^{\alpha-1} x_2^{\beta} \qquad U_{11} = \frac{\partial U_1}{\partial x_1} = \alpha(\alpha-1) x_1^{\alpha-2} \cdot x_2^{\beta}$$

$$U_2 = \frac{\partial U}{\partial x_2} = \beta \cdot x_1^{\alpha} \cdot x_2^{\beta-1} \qquad U_{22} = \frac{\partial U_2}{\partial x_2} = \beta(\beta-1) \cdot x_1^{\alpha} \cdot x_2^{\beta-2}.$$

$$U_{12} = \alpha\beta \cdot x_1^{\alpha-1} \cdot x_2^{\beta-1}$$

Bordered Hessian determinant.

Hessian determinant.

$$\begin{vmatrix} U_{11} & U_{12} \\ U_{21} & U_{22} \end{vmatrix}$$

$$B_1 \quad B_2 \quad \begin{vmatrix} 0 & -U_1 & -U_2 \\ -U_1 & U_{11} & U_{12} \\ -U_2 & U_{21} & U_{22} \end{vmatrix}$$

If $B_1 \leq 0$, $B_2 \geq 0$ $\longrightarrow$ Quasiconcave.

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$$\frac{d}{}\left(\frac{u}{v}\right) = \frac{-uv' + vu'}{v^2}$$

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$$U = U(x_1, x_2)$$
$$dU = U_1 dx_1 + U_2 dx_2$$

$$\frac{dx_2}{dx_1} = -\frac{U_1}{U_2}$$

$$\frac{dx_2}{dx_1} = \frac{-U_1(x_1, x_2)}{U_2(x_1, x_2)} = \frac{-\left[U_2 \frac{dU_1}{dx_1} - U_1 \cdot \frac{dU_2}{dx_1}\right]}{U_2^2}$$

$$\frac{d^2 x_2}{dx_1^2} > 0$$

$$\frac{d^2 x_2}{dx_1^2} = \frac{-\left[U_2\left(U_{11} + U_{12} \cdot \frac{dx_2}{dx_1}\right) - U_1\left(U_{22}\frac{dx_2}{dx_1} + U_{21}\right)\right]}{U_2^2}$$

positive monotonic transformation $\Leftrightarrow$ logarithm

$$\frac{-\left[U_2\left(U_{11} + U_{12}\left(\frac{-U_1}{U_2}\right)\right) - U_1\left(U_{22}\cdot\left(\frac{-U_1}{U_2}\right) + U_{21}\right)\right]}{U_2^2}.$$

$$\Rightarrow -\left[U_2 U_{11} - U_1 U_{12} + \frac{U_1^2 U_{22}}{U_2} - U_1 U_{21}\right]$$

$$\frac{|H|}{U_2^2} > 0.$$

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Hal. R. Varian
Introduction theory.

Handerson and Quandt.
Mathematical

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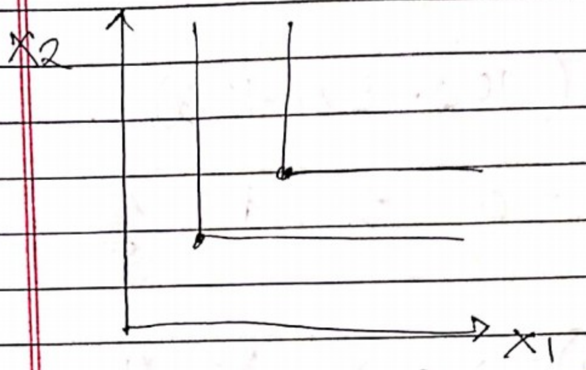
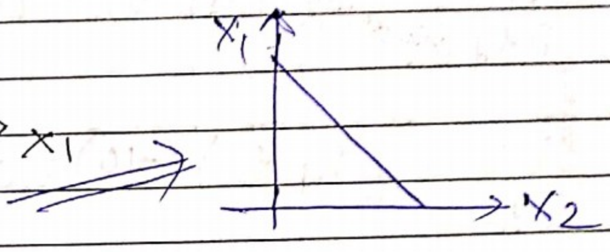
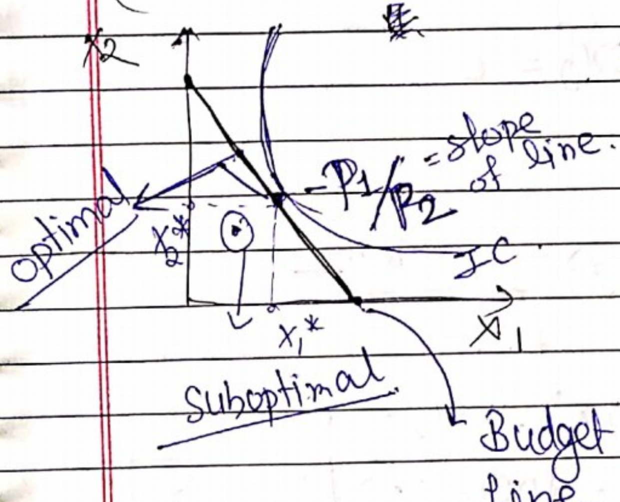
Leontief choice. (Perfect complements)

When both goods to be consumed must have some kind of fixed ratio.





(Perfect substitutes)



$$P_1x_1 + P_2x_2 = M.$$

$$\frac{-P_1}{P_2} = \frac{+dx_2}{dx_1} = \frac{-MU_1}{MU_2} \longleftarrow (1)$$

$$\boxed{Z = \text{obj.} + \lambda\,(\text{constraint})}$$

$$Z = x_1^{\alpha}.x_2^{\beta} + \lambda\,[M - P_1x_1 - P_2x_2].$$

$$\frac{\partial Z}{\partial x_1} = \alpha x_1^{\alpha-1}.x_2^{\beta} - \lambda P_1 = 0.$$

$$\frac{\partial Z}{\partial x_2} = \beta.x_2^{\beta-1}.x_1^{\alpha} - \lambda P_2 = 0.$$

$$\frac{\partial Z}{\partial \lambda} = M - P_1x_1 - P_2x_2 = 0.$$

on solving we get (1)

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Solve for 4.

Q. $U = x_1 x_2$; $P_1 = 5$; $P_2 = 10$; $M = 100$.

$\Rightarrow$ $Z = x_1 x_2 + \lambda(100 - 5x_1 - 10x_2)$.

$\frac{\partial Z}{\partial x_1} = x_2 + \lambda(-5) = 0 \Rightarrow \lambda = \frac{x_2}{5}$

$\frac{\partial Z}{\partial x_2} = x_1 + \lambda(-10) = 0 \Rightarrow \lambda = \frac{x_1}{10}$.

$\frac{\partial Z}{\partial \lambda} = 100 - 5x_1 - 10x_2 = 0$.

$\Rightarrow \frac{x_2}{\cancel{5}} = \frac{x_1}{\cancel{10}\,2} \Rightarrow \underline{x_1 = 2x_2}$

$\Rightarrow 100 - 5(2x_2) - 10x_2 = 0$

$\Rightarrow 20x_2 = 100 \Rightarrow \boxed{x_2 = 5}$

$\Rightarrow \boxed{x_1 = 10}$

$U_1 = x_2$

$U_2 = x_1$.

$\frac{MU_1}{MU_2} = \frac{x_2}{x_1} = \frac{P_1}{P_2} = \frac{5}{10}$

$\boxed{\frac{MU_1}{MU_2} = \frac{1}{2}}$.

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☆ Elasticity :- (E)

$$\frac{\%\text{ change of } x_1}{\%\text{ change of } p_1} = \text{price elasticity of } x_1 \text{ (own price elasticity)}$$

$$\frac{\%\text{ change of } x_2}{\%\text{ change of } p_1} = \text{cross price elasticity of } x_2.$$

complements — crossprice E < 0

substitutes — cross price E > 0.

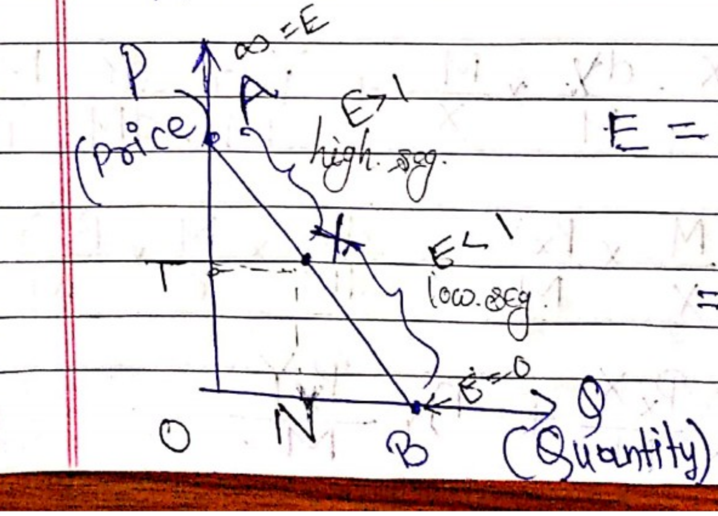
independent / neutral — cross price E → 0.

$$\frac{\%\text{ change in } x_1}{\%\text{ change in } M} = \text{Income Elasticity } (\eta)$$

If Income elasticity > 1 ; Luxury Items.

else if — // — > 0 && < 1 ; Normal Good.

else if — // — < 0 ; Inferior good



$$E = -\frac{dQ}{Q} \times \frac{P}{dP} = \frac{BX}{XA}.$$

$$= \frac{\frac{dQ}{Q} \times 100}{\frac{dP}{P} \times 100} = \frac{\text{low seg}}{\text{high.s}}$$

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$$e = \frac{BQ}{PO} \times \frac{OT}{ON}$$

$$= \frac{(ON + BN)}{(OT + TP)} \times \frac{OT}{ON}$$

* Given, $M = P_X X + P_Y Y$. Prove that both X and Y can not be luxurious at same time.

$\Rightarrow$ $dM = P_X dX + P_Y dY$. $\cancel{\frac{dM}{M} = P_X \frac{dX}{M} + P_Y \frac{dY}{M}}$

$$\eta_X = (I.E.)_X = \frac{dX}{X} \times \frac{M}{dM}$$

$$\eta_Y = (I.E.)_Y = \frac{dY}{Y} \times \frac{M}{dM}$$

$$\cancel{= \frac{dX}{X} \times \frac{P_X X + P_Y Y}{P_X dX + P_Y dY}}$$

$$1 = P_X \cdot \frac{dX}{dM} + P_Y \cdot \frac{dY}{dM}.$$

$$\Rightarrow 1 = \frac{P_X . X}{dM} \cdot \frac{dX}{M} \times \frac{M}{X} + \frac{Y . P_Y}{M} \cdot \frac{dY}{dM} \cdot \frac{M}{Y}$$

$$\Rightarrow 1 = \frac{dX}{dM} \times \frac{M}{X} \times \frac{P_X X}{M} + \frac{dY}{dM} \times \frac{M}{Y} \times \frac{P_Y Y}{M}$$

$$\Rightarrow 1 = \eta_X \frac{P_X X}{M} + \eta_Y \frac{P_Y Y}{M}.$$

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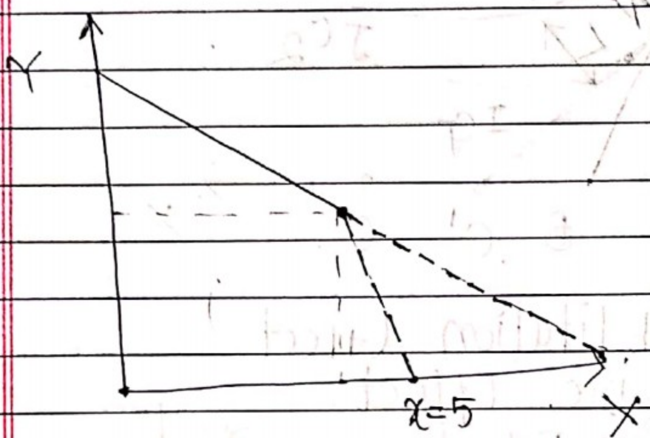
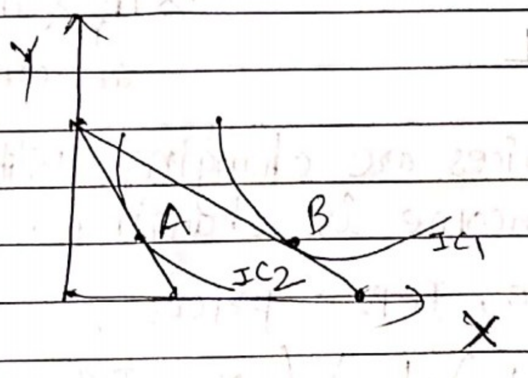
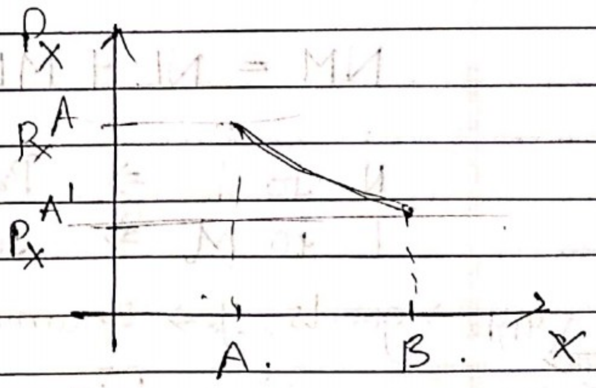
$\Rightarrow 1 = \eta_X \alpha + (1-\alpha)\eta_Y$

$0 \leq \alpha \leq 1$; Therefore η_X & η_Y can not be greater than one at the same time

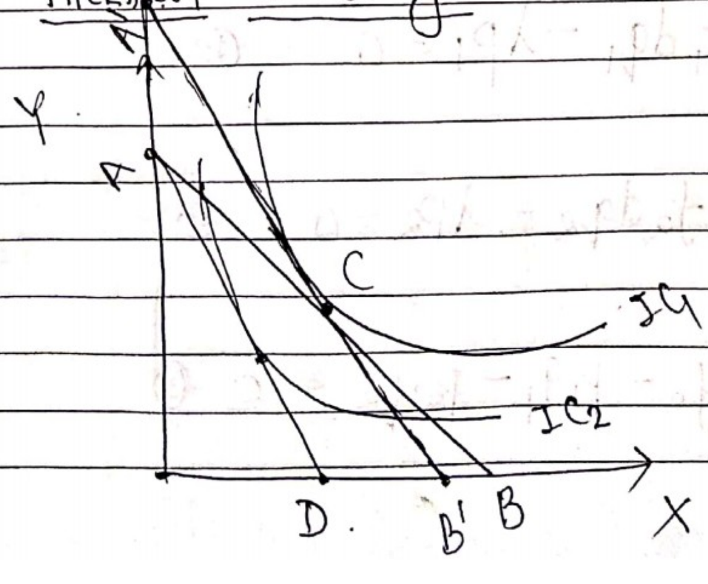
☆







☆ Hicksian Subsidy :-



When price increases (X)

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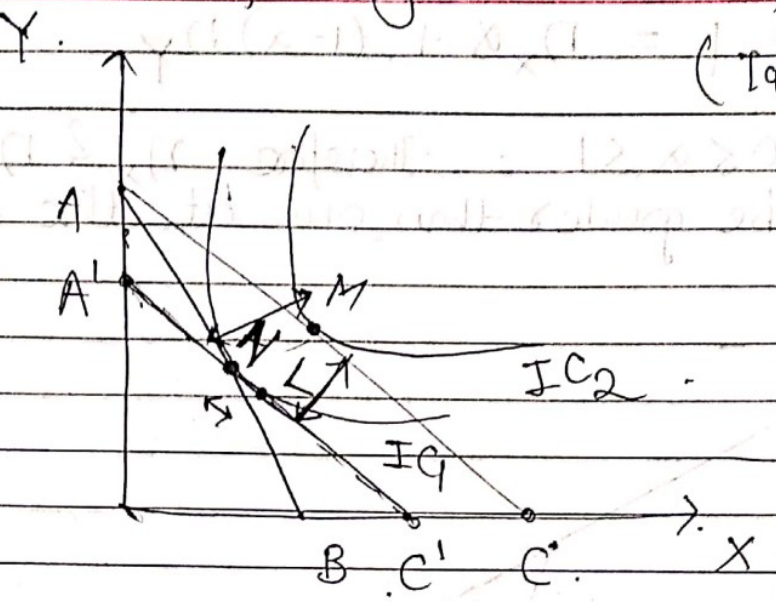
When price gets lowered (X)

('Taxation').

$AC' \parallel AC$.



NL ⇒ Substitution Effect.

ML ⇒ Income Effect.

NM ⇒ Price Effect. $= \frac{\partial X}{\partial P_X}$ | P_Y & Income are constant

NM = NL + ML

N to L ⇒ Prices are changing (Utility = const)

L to M ⇒ Income is changing.

q_1, q_2 ⇒ goods, y_0 ⇒ Income, p_1, p_2 ⇒ prices

$$V = f(q_1, q_2) + \lambda(y_0 - p_1 q_1 - p_2 q_2)$$

$$\frac{\partial V}{\partial q_1} = V_1 = f_1 dq_1 - \lambda p_1 = 0 \quad \text{—(1)}$$

$$\frac{\partial V}{\partial q_2} = V_2 = f_2 dq_2 - \lambda p_2 = 0 \quad \text{—(2)}$$

$$\frac{\partial V}{\partial \lambda} = V_\lambda = y_0 - p_1 q_1 - p_2 q_2 = 0 \quad \text{—(3)}$$

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$$D = \begin{bmatrix} f_{11} & f_{12} & p_1 \\ f_{21} & f_{22} & p_2 \\ -p_1 & -p_2 & 0 \end{bmatrix}$$

~~from ① ⇒ $f_{11} \cdot dq_1 + f_{21} \cdot dq_2 - \lambda dp_1$~~

from ① ⇒ $f_{11} dq_1 + f_{12} dq_2 - p_1 d\lambda = \lambda dp_1$

from ② ⇒ $f_{21} dq_1 + f_{22} dq_2 - p_2 d\lambda = \lambda dp_2$

from ③ ⇒ $-p_1 dq_1 - p_2 dq_2 + 0 = -dy_0 + q_1 dp_1 + q_2 dp_2$

$$dq_1 = \frac{\begin{bmatrix} \lambda dp_1 & f_{12} & p_1 \\ \lambda dp_2 & f_{22} & p_2 \\ -dy_0 + q_1 dp_1 + q_2 dp_2 & -p_2 & 0 \end{bmatrix}}{D}$$

$$\frac{dq_1}{\cancel{dp_1}} = \frac{\lambda dp_1 D_{11} + \lambda dp_2 D_{12} + (-dy_0 + q_1 dp_1 + q_2 dp_2) D_{13}}{D}$$

$$\boxed{\frac{dq_1}{dy_0} = \frac{-D_{13}}{D}}$$ ⇒ Income effect. $(dp_1 = dp_2 = 0)$

$$\boxed{\left.\frac{\partial q_1}{\partial p_1}\right|_{\substack{dp_2 = 0 \\ U = \text{const.}}} = \frac{\lambda D_{11}}{D}}$$ ⇒ Substitution effect.

Substitution Effect.

$U = f(q_1, q_2)$

$dU = 0 = f_1 dq_1 + f_2 dq_2$

$\Rightarrow \frac{dq_2}{dq_1} = \frac{-f_1}{f_2} = \frac{-p_1}{p_2}$

$$\boxed{p_1 dq_1 + p_2 dq_2 = 0}$$

Total effect

Price$_2$ = const.

Income = const.

$$\boxed{\frac{\partial q_1}{dp_1} = \frac{\lambda D_{11}}{D} + \frac{q_1 D_{13}}{D}}$$

~~$\frac{-dy_0 D_{13}}{D}$~~

$\begin{pmatrix} dp_2 = 0 \\ dy_0 = 0 \end{pmatrix}$

Total effect $= (\text{Sub}^n \text{ effect}) + q_1(-\text{Income Effect})$

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★ $U = X_1^{1/3} . X_2^{2/3}$; $p_1 = 5$, $p_2 = 3$, $y = 100$

Optimal value / Demand function of X_1 and X_2

$\Rightarrow$

$$U = x_1^{1/3} . x_2^{2/3} + \lambda (y - P_1 X_1 - P_2 X_2)$$

$$V_1 = \frac{\partial V}{\partial X_1} = \frac{1}{3} . x_1^{-2/3} . X_2^{2/3} - \lambda p_1 = 0$$

$$V_2 = \frac{\partial V}{\partial X_2} = \frac{2}{3} X_2^{-1/3} . X_1^{1/3} - \lambda p_2 = 0$$

$$V_\lambda = y - p_1 x_1 - p_2 X_2 = 0$$

Marshalian

$$\Rightarrow \left(\frac{x_2}{x_1}\right)^{2/3} = 3 \lambda p_1 \quad \Rightarrow \left(\frac{X_1}{X_2}\right)^{1/3} = \frac{3 \lambda p_2}{2}$$

$$\Rightarrow \cancel{x} = \cancel{27 (\lambda p_1)^3} \quad . \quad y = p_1 X_1 + p_2 X_2 .$$

$$\Rightarrow \left(\frac{X_2}{X_1}\right) = \frac{2 P_1}{P_2}$$

$$\Rightarrow X_2 = \left(\frac{2 P_1}{P_2}\right) X_1$$

$$\Rightarrow y - p_1 X_1 - \cancel{p_2} \left(\frac{2 P_1}{\cancel{P_2}}\right) X_1 = 0$$

$$\Rightarrow X_1 = \frac{y}{3 P_1} \quad \Rightarrow X_2 = \frac{2y}{3 P_2}$$

$$\Rightarrow X_1^* = \frac{100}{15} \quad , \quad X_2^* = \frac{200}{9}$$

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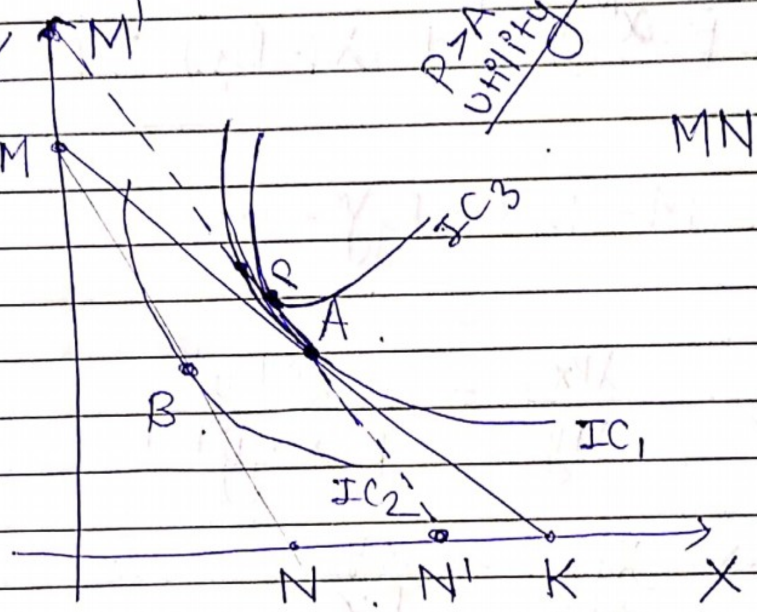
$$3\lambda P_1 = \left(\frac{2\gamma/_3 P_2}{\gamma/_3 P_1}\right)^{2/3} \quad \cancel{\lambda = \frac{y}{2P_1P_2}}$$

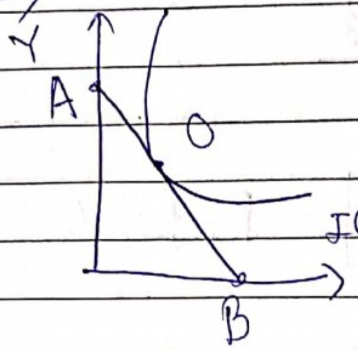
$$\Rightarrow \lambda = \frac{1}{3P_1}\left(\frac{2P_1}{P_2}\right)^{2/3}$$

→ Slutsky



MN ∥ M'N'.

→



$$\alpha = \underbrace{P_x X + P_y Y}_{\text{Minimize}} + \mu \underbrace{\left[U^* - U(x,y)\right]}_{\text{Utility constraint}}$$

$$Z = \underbrace{U(x,y)}_{\text{maximize}} + \lambda \underbrace{\left[M - P_X X - P_Y Y\right]}_{\text{Budget Constraint}}.$$

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$\Rightarrow$ $U = x^{\alpha} y^{\beta}$; $M = P_x X + P_y Y$; $0 < \alpha, \beta < 1$.

$\Rightarrow$ $Z = x^{\alpha} y^{\beta} + \lambda (M - P_x X - P_y Y)$.

$\Rightarrow$ $\frac{\partial Z}{\partial x} = \alpha . x^{\alpha-1} . y^{\beta} + \lambda(-P_x) = 0$

$\frac{\partial Z}{\partial y} = \beta . x^{\alpha} . y^{\beta-1} + \lambda(-P_y) = 0$

$\frac{\partial Z}{\partial \lambda} = M - P_x x - P_y y = 0$

$\Rightarrow$ $\frac{\lambda P_x}{\lambda P_y} = \frac{\alpha . x^{\alpha-1} y^{\beta}}{\beta . x^{\alpha} y^{\beta-1}}$

$\Rightarrow$ $\frac{\cancel{\lambda} P_x}{\cancel{\lambda} P_y} = \frac{\alpha y}{\beta x}$

$\Rightarrow$ $x = \frac{\alpha P_y y}{\beta P_x}$.

$\Rightarrow$ $M - \cancel{P_x} \left[\frac{\alpha P_y y}{\beta \cancel{P_x}} \right] - P_y Y = 0$

$\Rightarrow$ $M = y P_y \left(1 + \frac{\alpha}{\beta} \right)$

$\Rightarrow$ $\boxed{y^* = \frac{M\beta}{(\alpha+\beta) P_y}}$

$\Rightarrow$ $x^* = \frac{\alpha \cancel{P_y}}{\beta P_x} \left(\frac{M \cancel{\beta}}{(\alpha+\beta) \cancel{P_y}} \right) = \frac{M\alpha}{(\alpha+\beta) P_x}$.

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$-\alpha \cdot P_x^{-\alpha-1}$

$$U^* = x^{*\alpha} y^{*\beta}$$

$$= \frac{(M\alpha)^{\alpha}}{(\alpha+\beta)^{\alpha} \cdot P_x^{\alpha}} \cdot \frac{(M\beta)^{\beta}}{(\alpha+\beta)^{\beta} P_y^{\beta}}$$

$$U^* = \left(\frac{M}{\alpha+\beta}\right)^{\alpha+\beta} \cdot \left(\frac{\alpha}{P_x}\right)^{\alpha} \left(\frac{\beta}{P_y}\right)^{\beta}$$

$$\frac{\partial U^*}{\partial P_x} = \left(\frac{M}{\alpha+\beta}\right)^{\alpha+\beta} \left(\frac{\beta}{P_y}\right)^{\beta} \cdot \frac{-\alpha \cdot (\alpha)^{\alpha}}{P_x^{\alpha+1}}$$

$$= \left(\frac{M}{\alpha+\beta}\right)^{\alpha+\beta} \left(\frac{\beta}{P_y}\right)^{\beta} \cdot -\left(\frac{\alpha}{P_x}\right)^{\alpha+1}$$

$$\frac{\partial U^*}{\partial M} = \frac{(\alpha+\beta)\,(M)^{\alpha+\beta-1}}{(\alpha+\beta)^{\alpha+\beta}} \left(\frac{\alpha}{P_x}\right)^{\alpha} \left(\frac{\beta}{P_y}\right)^{\beta}$$

$$= \left(\frac{M}{\alpha+\beta}\right)^{\alpha+\beta-1} \left(\frac{\beta}{P_y}\right)^{\beta} \left(\frac{\alpha}{P_x}\right)^{\alpha}$$

$$\frac{\left(\frac{\partial U^*}{\partial P_x}\right)}{\left(\frac{\partial U^*}{\partial M}\right)} = \frac{-\left(\frac{M}{\alpha+\beta}\right)^{\alpha+\beta} \cancel{\left(\frac{\beta}{P_y}\right)^{\beta}} \left(\frac{\alpha}{P_x}\right)^{\alpha+1}}{\left(\frac{M}{\alpha+\beta}\right)^{\alpha+\beta-1} \cancel{\left(\frac{\beta}{P_y}\right)^{\beta}} \left(\frac{\alpha}{P_x}\right)^{\alpha}}$$

Roys' Identity $= \dfrac{-M\alpha}{(\alpha+\beta) P_x} = \underline{\underline{-x^*}}$

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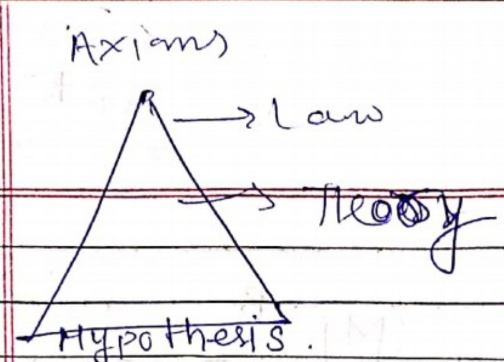

* <u>Shephard's</u> <u>Lemma</u> :-

Q. Minimize $p_1x_1 + p_2x_2$ subject to $U^* = x_1x_2$

$$\alpha = p_1x_1 + p_2x_2 + \mu(U^* - x_1x_2)$$

$$\left.\begin{aligned} \frac{\partial \alpha}{\partial x_1} &= p_1 - \mu x_2 = 0. \\ \frac{\partial \alpha}{\partial x_2} &= p_2 - \mu x_1 = 0. \\ \frac{\partial \alpha}{\partial \mu} &= U^* - x_1x_2 = 0. \end{aligned}\right\} \quad \frac{p_1}{x_2} = \frac{p_2}{x_1}$$

$$x_1 = \frac{p_2 x_2}{p_1}.$$

$$x_1^* = \sqrt{\frac{p_2}{p_1}U^*} \; ; \; x_2^* = \sqrt{\frac{p_1}{p_2}U^*}.$$

$$E^* = p_1x_1^* + p_2x_2^* = 2\sqrt{p_1p_2U^*}$$

$$\boxed{\frac{\partial E^*}{\partial p_1} = x_1^* = \sqrt{\frac{p_2}{p_1}U^*}} \Rightarrow \text{Shephard's Lemma.}$$

$$\boxed{\frac{\partial U^*/\partial p_1}{\partial U^*/\partial M} = -x_1^*} \Rightarrow \text{Roys' Identity.}$$

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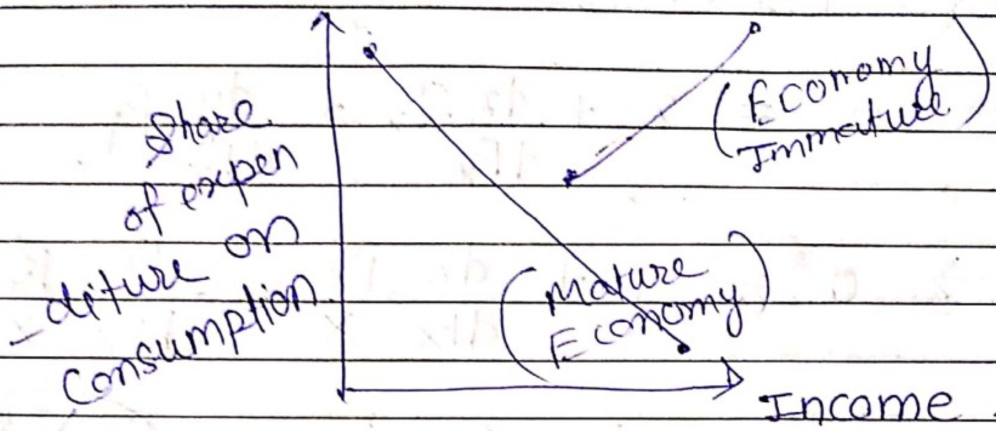
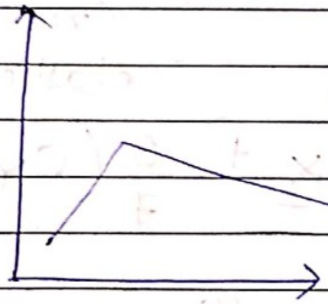
☆ Engel curve :-



(for Aggregate Economy).



(for Individual)

Q. Own Price elasticity of X = 0.3.
Share of expenditure of X = 70%.
Cross price elasticity b/w X ~~and~~ Y = ?
Y w.r.t. X = ?

Ans:-

$\frac{dX/X}{dP_X/P_X} = 0.3.$ $\frac{P_X X}{M} \times 100 = 70$

$\frac{dX/X}{dP_Y/P_Y}$ $\left(\frac{dX}{X}\right)\left(\frac{P_X}{dP_X}\right) = 0.3$ $\frac{P_X X}{M} = 0.7.$

$\frac{P_X}{Y} = \frac{7}{3} \cdot \frac{P_Y}{X}$ $\frac{P_X X}{P_Y Y} = \frac{7}{3}$ $\frac{P_Y Y}{M} = 0.3$

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$$M = P_x X + P_Y Y.$$

$$\frac{dM}{dP_x} = X + \frac{dX}{dP_x}P_x + \frac{dY}{dP_x}P_Y Y + 0$$

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(P_Y & M are not changed).

$$\Rightarrow 0 = x + \frac{dx}{dP_x}.P_x + \frac{dy}{dP_x}.P_Y.$$

$$\Rightarrow 0 = 1 + \frac{dX}{dP_x}.\frac{P_x}{X} + \frac{dY}{dP_x}.\frac{P_Y}{X}.$$

$$\Rightarrow 0 = 1 + \frac{dX}{dP_x}.\frac{P_x}{X} + \frac{3}{7}.\frac{dY}{dP_x}.\frac{P_X}{Y}$$

Cross price elasticity of Y.

$$\Rightarrow 0 = 1 + \underline{e_X} + \frac{3}{7}(e_{YX})$$

$$\Rightarrow \frac{-1.3}{3} \times 7 = (e_{YX})$$

$$\Rightarrow (e_{YX}) = \frac{-9.1}{3} = -3.033.$$

$$\Rightarrow \boxed{e_{YX} = -3.033}$$

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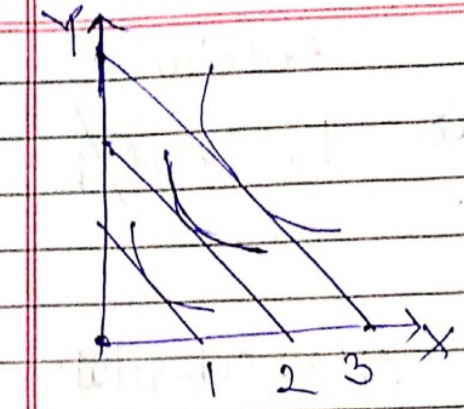
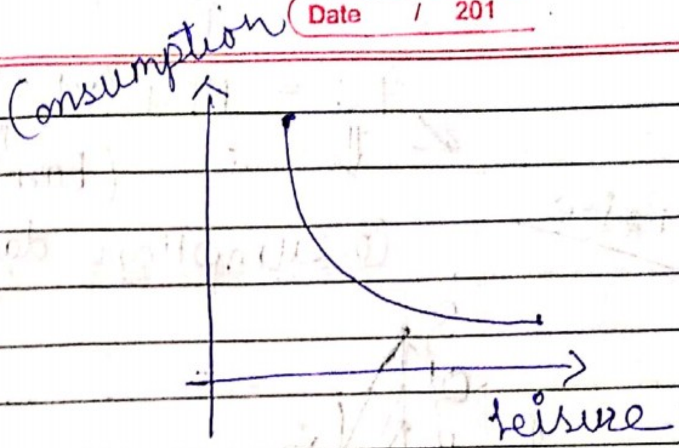
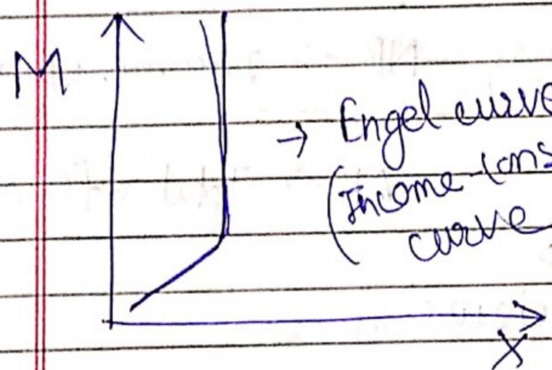
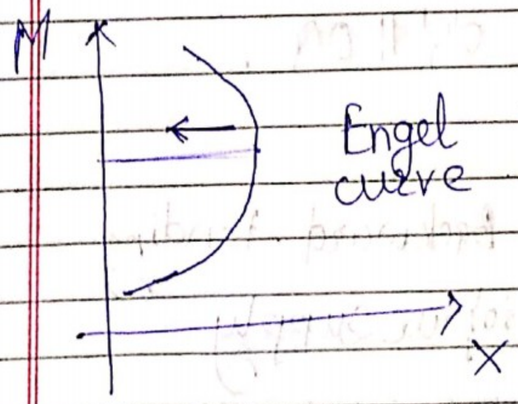




H → working
~~24~~ - H → Leisure



→ Engel curve (~~Income~~-consumption curve)



Engel curve

Q. Plot demand curve ~~Income~~ elasticity is everywhere constant

$$\frac{dX}{dP_X} \cdot \frac{P_X}{X} = -c$$

$$\Rightarrow \frac{dX}{X} = -c \cdot \frac{dP_X}{P_X}$$

$$\Rightarrow \ln X = \cancel{-c}\,.\ln(P_X^{-c}) + \ln k$$

$$\Rightarrow X = kP_X^{-c}$$

$$\Rightarrow \boxed{X = \frac{k}{P_X^{c}}}$$

5% each × 2 quiz = 10% ⇒
10% Assignment
30% Midsem
50% Endsem

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(Inherited Income)

$$PC = M + (24-L)W$$

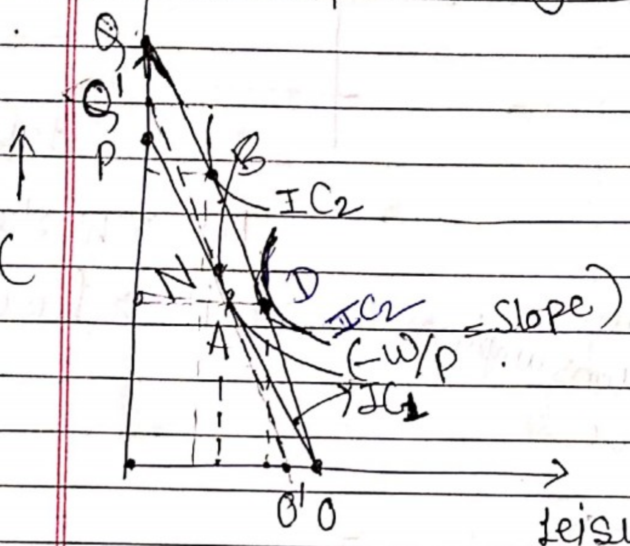
L = Leisure

(Earning per day)

W = Wage/hr.

Price

Consumption



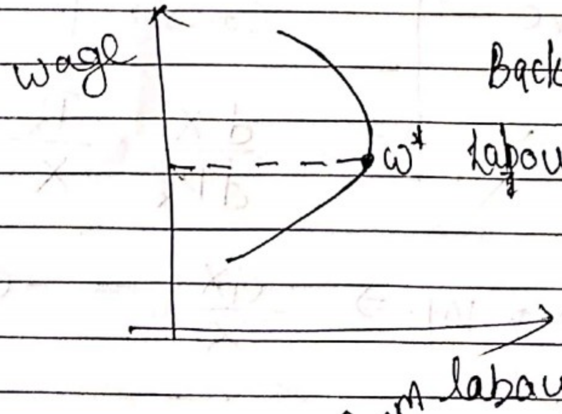
AN → Substitution effect.

NB → Income effect.

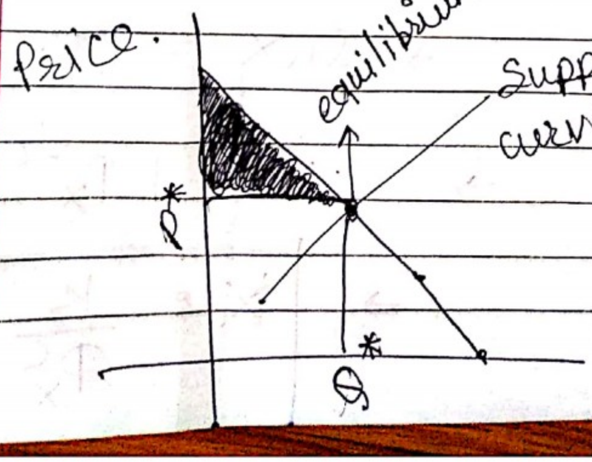
AB → Total effect.

O'Q' ∥ OQ.

OP → OQ → O'Q'.



Backward Bending Labour Supply.



Consumer Surplus

$$= \int_0^{q^*} p\,dq - p^* q^*.$$

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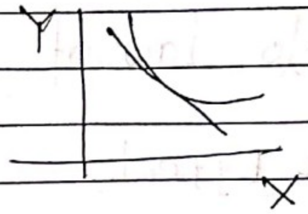
Revision Chapter I : Consumer Behaviour.

① Indifference Curve :-



; $\frac{-P_x}{P_Y}$; $P_X X + P_Y Y = M$

② Lagrange → Optimization under linear budget constraint.

③ Demand curve → X and Y.

④ Elasticity. (Price & Income)

Price → Own, Cross.

Income → Luxury IE>1, Normal IE (0,1), Inferior IE < 0.

Cross >0 Substitute

<0 Compliment

⑤ Income Consumption Curve. (Engel Curve).

⑥ T.E. = S.E. + I.E. (Slutsky equation).
Total Subs. Income

⑦. Backward Bending labour Supply curve.
(Labour - Leisure).

⑧ Consume Surplus.

⑨ Mathematical Derivation (Refer to Henderson-Quandt 6th topic) of ⑥ point

⑩ Problems related to all above topics (mathematical).

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☆ Exceptions to law of Demand.

(not related to price) ① Bandwagon Effect. (Herd Behaviour)

Everybody is doing. so I am doing

↑ ② Snob effect.

difference

Everybody is doing so I am not doing.

↓ ③ Conspicuous effect (Veblen effect).

(mostly related to price) Expensive items, others are purchasing so ~~othe~~ I will buy.

④ Giffen good.

Though the price is increasing, you buy the good.

☆ $f(P_1, P_2, M, T)$

10^{th} september 2019 ← Quiz-I (5% weight)

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Chapter 2 : Production

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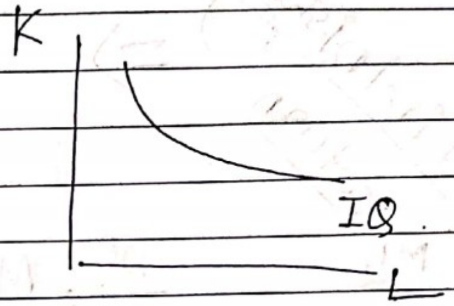
★ Isoquant K (Capital) ; L (Labour) ; Q (Output)

Physical   Intellectual .

~~Locus of combinations~~ of capital & labour ~~for which we get~~ same output.

$Q = f(K, L)$



(Short run)   (Long run)

Shortage of one of K & L, i.e. you can vary only one of inputs

you can vary both of inputs

Notation :
$Q = f(K, L)$

Notation
$Q = f(\bar{K}, L)$ or $f(K, \bar{L})$

$\boxed{Q = f(K, L)}$ → Production function.

$dQ = f_K \cdot dK + f_L \cdot dL$.

$\rightarrow \dfrac{dK}{dL} = \dfrac{-f_L}{f_K} \quad (dQ = 0)$.

MRTS
Marginal rate of technical Substitution .

$f_L = \dfrac{\partial f}{\partial L}$; $f_K = \dfrac{\partial f}{\partial K}$.

$\Downarrow$ $\Downarrow$

MP_L MP_K .

Marginal product of labour   Marginal product of capital .

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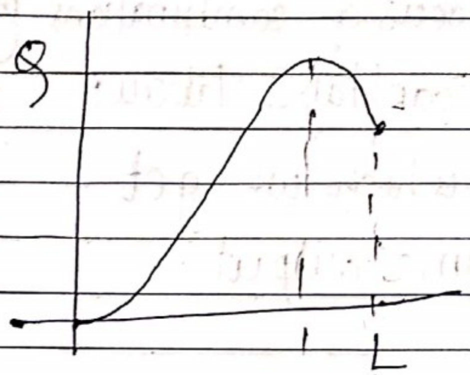
Technique to change input to output. (Production).

eg. $Q = K^{\alpha} L^{\beta}$ (Isoquant is a long run concept)

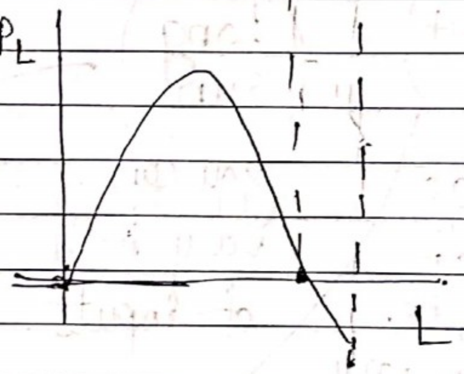
Short Run $\Rightarrow$ $Q = f(\bar{K}, L)$



Law of Diminishing return

$\cancel{MP_L}$ $\frac{\partial Q}{\partial L} = MP_L$

(LOVP)
(law of variable proportion)



Average product of labour $= AP_L = \frac{Q}{L}$.

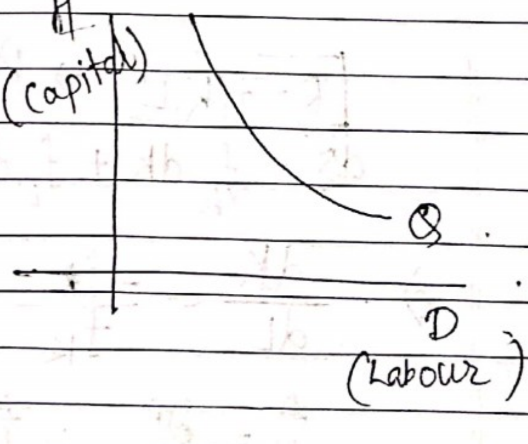
eg $\boxed{\text{Oil}}$.

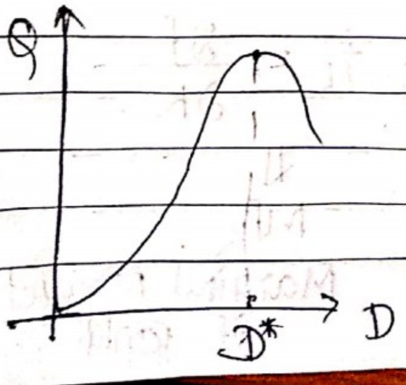
$\boxed{\text{OPEC}}$

Q = Quantity : $Q^{1.04} = \frac{H \cdot D^{2.74}}{1.004}$

H ⇒ Horse power

D ⇒ Diameter.





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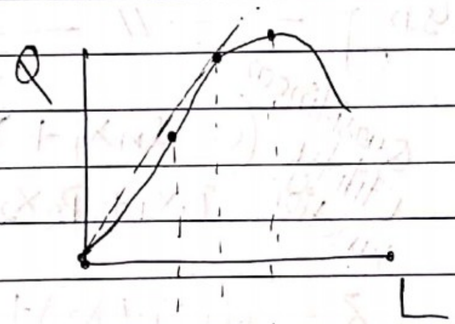
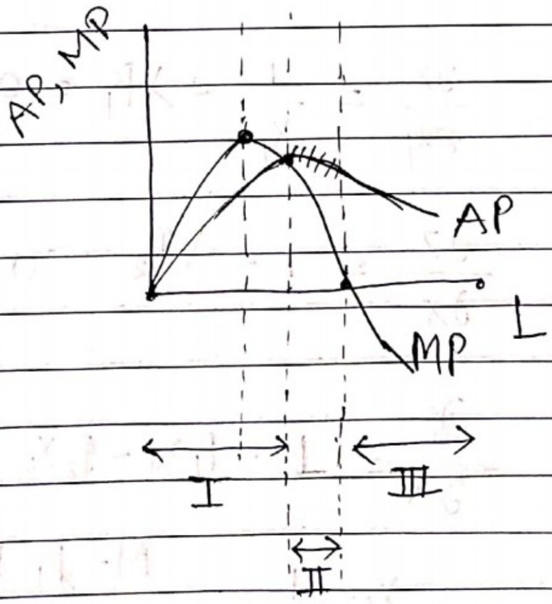
$$AP = \frac{Q}{L}$$

$$\Rightarrow \frac{d(AP)}{dL} = \frac{d(Q/L)}{dL} = \frac{L \cdot \frac{\partial Q}{\partial L} - Q \cdot \frac{\partial L}{\partial L}}{L^2}$$

$$= \frac{1}{L}\left(\frac{\partial Q}{\partial L} - \frac{Q}{L}\right)$$

$$\frac{d(AP_L)}{dL} = \frac{1}{L}\left(MP_L - AP_L\right)$$





zone III $\rightarrow MP_L < 0$

Zone II $\rightarrow \frac{dAP}{dL} < 0$

Zone-I $\Rightarrow \frac{dAP}{dL} > 0$.

III $\Rightarrow$ with increasing L, Q decreasing (Discard)

I $\Rightarrow$ —— " ——, (Q, AP) increasing.

II $\Rightarrow$ Zone of Production to utilize max of condition in zone I.

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Long Run ⇒

Return to Scale.

$Q = f(K, L)$

$\lambda^k . Q = f(\lambda K, \lambda L) \Rightarrow k > 1$ (IRS)
$k = 1$ (CRS)
$k < 1$ (DRS)

proportional increase in Q

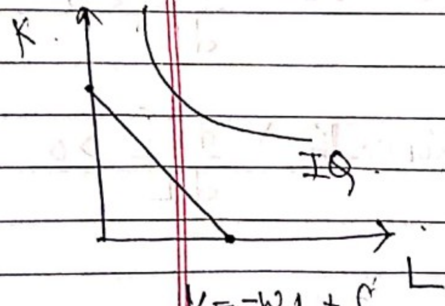
$Q = K^{1/3} . L^{2/3}$. $=$
$= K^{2/3} . L^{2/3}$ $>$
$= K^{1/4} . L^{2/3}$. $<$

IRS ⇒ Increasing return to scale
CRS ⇒ Constat —— // ——
DRS ⇒ Decreasing —— // ——

e.g. $Q = K + L^2$.

K	L
rent	wage
r.	ω.

$\text{Cost}(C) = \omega L + rK$.



$K = \frac{-\omega}{r} L + \frac{C}{r}$

quasi-linear utility function $(U = \ln X_1 + X_2)$;
$P_1X_1 + P_2X_2 = M$.

$Z = (\ln x_1 + x_2) + \lambda(M - P_1X_1 - P_2X_2)$

$\frac{\partial z}{\partial x_1} = \frac{1}{x_1} - \lambda P_1 = 0$

$\frac{\partial z}{\partial x_2} = 1 - \lambda P_2 = 0$

$\frac{\partial z}{\partial \lambda} = M - P_1X_1 - P_2X_2 = 0$.

$X_1 = \frac{1}{\lambda P_1}$

$M - P_1 . \frac{P_2}{P_1} - P_2X_2 = 0$

$X_1^* = \frac{P_2}{P_1}$

$P_2X_2 = M - P_2$

$X_2^* = \frac{M}{P_2} - 1$

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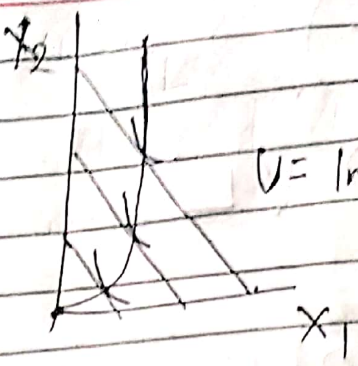
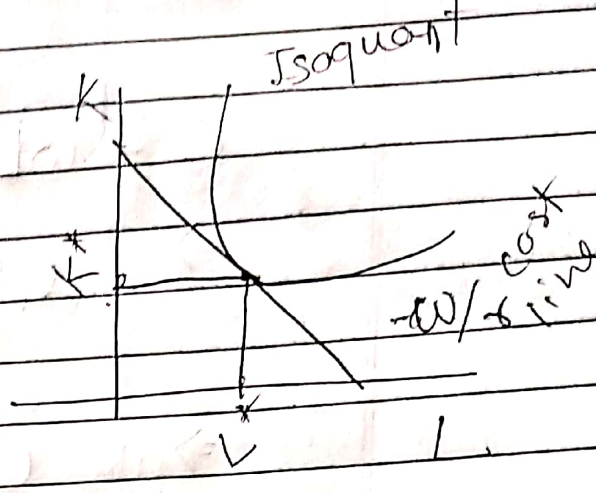
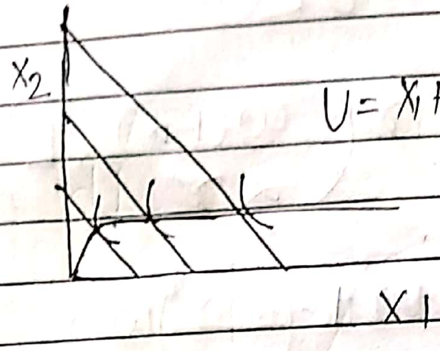
Income Consumption Curve (ICC).



$U = \ln X_1 + X_2$





$U = X_1 + \ln X_2$

* Opportunity Cost :-

A B

Cost of missed opportunity.

* Maximize $Q = L^{\alpha} . K^{1-\alpha}$. s.t. $C = \omega L + rK$.

$$\Rightarrow \mathcal{L} = L^{\alpha} K^{1-\alpha} + \lambda (C - \omega L - rK)$$

$$\Rightarrow \frac{\partial \mathcal{L}}{\partial L} = \alpha . L^{\alpha-1} . K^{1-\alpha} - \omega\lambda = 0$$

$$\frac{\partial \mathcal{L}}{\partial K} = (1-\alpha) . L^{\alpha} . K^{-\alpha} - \lambda r = 0 .$$

$$\frac{\partial \mathcal{L}}{\partial \lambda} = C - \omega L - rK = 0 .$$

$$\frac{\omega \cancel{\lambda}}{\cancel{\lambda} r} = \frac{\alpha . \cancel{L^{\alpha-1}} . K^{\cancel{1-\alpha}}}{(1-\alpha) L^{\alpha} . \cancel{K^{-\alpha}}} .$$

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$$\frac{w}{r} = \frac{\alpha}{(1-\alpha)} \cdot \left(\frac{K}{L}\right)$$

$$\Rightarrow K = \frac{w(1-\alpha)}{\alpha r} \cdot L$$

$$C - wL - rK = 0$$

$$\Rightarrow C - wL - \cancel{r}\left(\frac{w(1-\alpha)}{\alpha \cancel{r}} \cdot L\right) = 0$$

$$\Rightarrow C = L\left(w + \left(\frac{1-\alpha}{\alpha}\right)w\right)$$

$$\Rightarrow C = \frac{L}{\alpha}\left(\cancel{\alpha w} + w - \cancel{\alpha w}\right)$$

$$\Rightarrow \boxed{L^* = \frac{C\alpha}{w}}$$

$$\Rightarrow K = \frac{\cancel{w}(1-\alpha)}{\cancel{\alpha} r} \cdot \frac{C\cancel{\alpha}}{\cancel{w}}$$

$$\Rightarrow \boxed{K^* = \frac{C(1-\alpha)}{r}}$$

$$Q^* = L^{*\alpha} \cdot K^{*1-\alpha}$$

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Q) $Q = L + 2K$ s.t. $C = wL + rK$.

$\Rightarrow \quad Z = Q + \lambda(C - wL - rK)$

$Z = (L + 2K) + \lambda(C - wL - rK)$

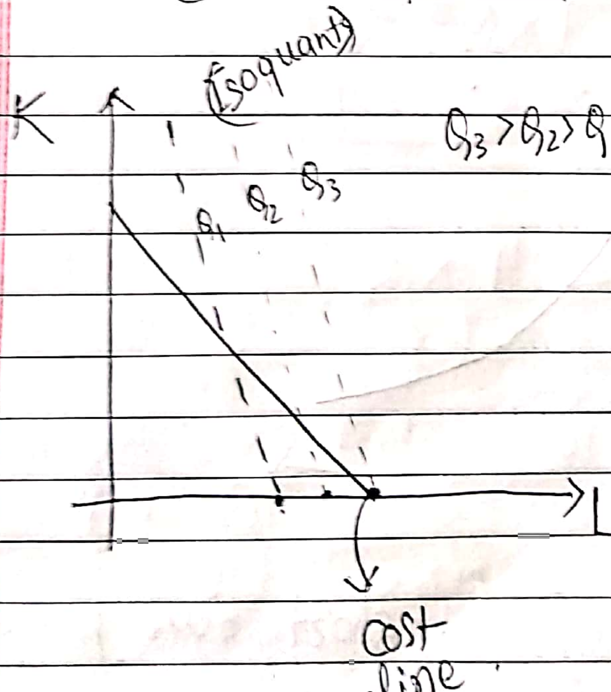
$\Rightarrow \quad \dfrac{\partial Z}{\partial L} = 1 + \lambda(-w) = 0 \Rightarrow \lambda = 1/w$

$\Rightarrow \quad \dfrac{\partial Z}{\partial K} = 2 + \lambda(-r) = 0 \Rightarrow \lambda = 2/r$

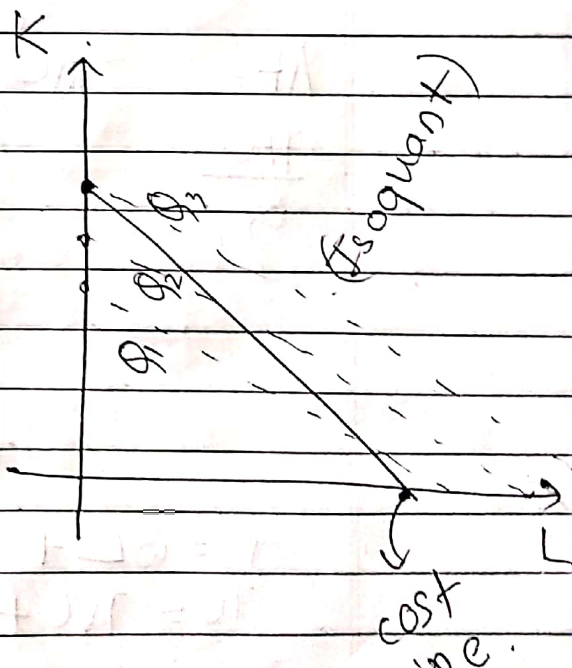
$\Rightarrow \quad \dfrac{\partial Z}{\partial \lambda} = C - wL - rK = 0$

$\Rightarrow \quad \dfrac{1}{w} = \dfrac{2}{r} \Rightarrow \boxed{r = 2w}$

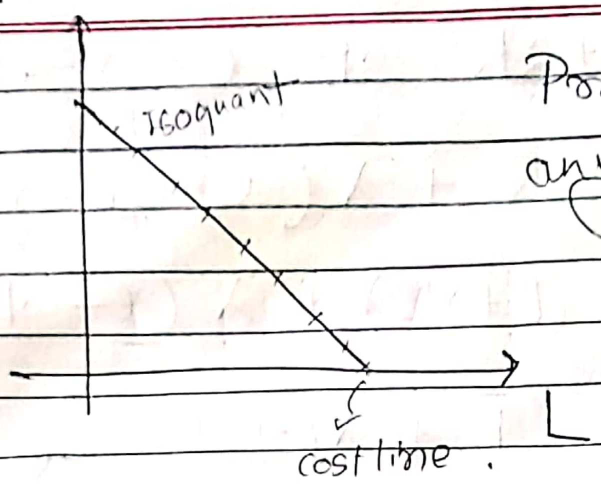
$\Rightarrow \quad C = wL + rK$



Production at (L,0)



Production at (0,K)



Production at any point on $C = L\omega + rK$

* Production Cost :

TOTAL COST = FIXED COST + VARIABLE COST.

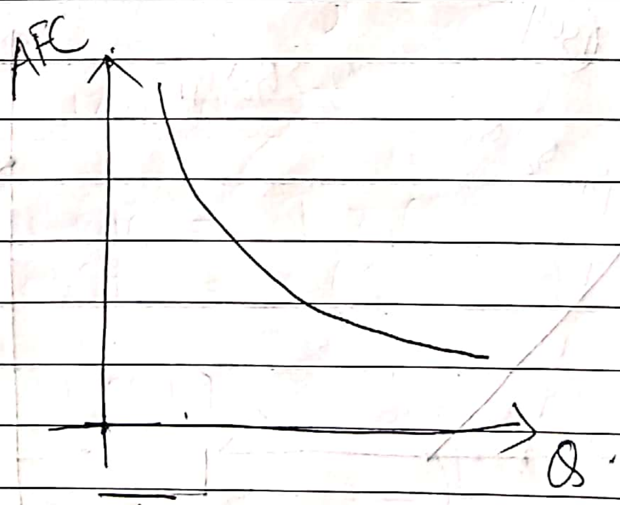
$TC = FC + \underbrace{VC(Q)}_{\text{function of } Q}$; Q = output product.

$$\frac{TC}{Q} = \frac{FC}{Q} + \frac{VC}{Q}.$$

A ⇒ Average

$$ATC = AFC + AVC.$$

$AFC = \frac{TFC}{Q}$.

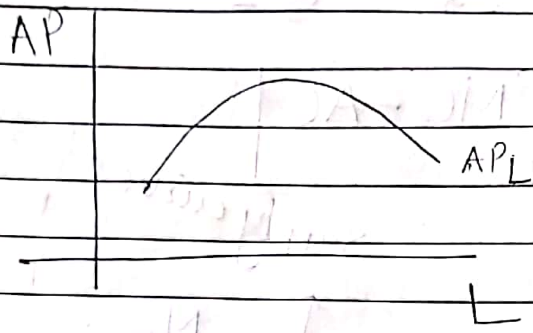


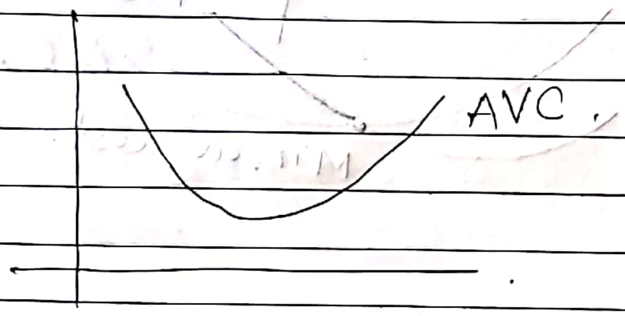
$TC = \omega L + \overline{rK}$

$TC = TVC + TFC$. (In short run K = const.)

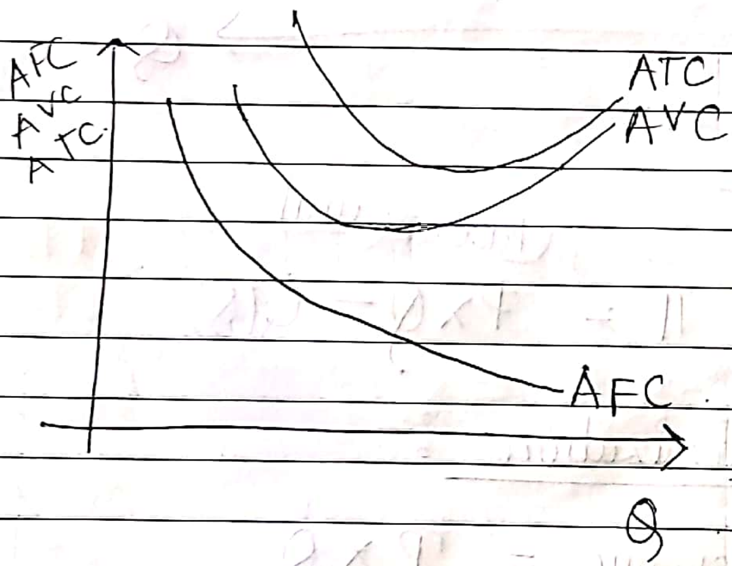
$\Rightarrow \frac{TVC}{Q} = \frac{\omega L}{Q} \Rightarrow AVC = \frac{\omega L}{Q}$

$$\Rightarrow AVC = \frac{w}{(Q/L)} = \frac{w}{AP_L}.$$





$$AVC = \frac{w}{AP_L}$$



$$\Rightarrow MC = \frac{\partial C}{\partial Q} \Rightarrow AC = \frac{C}{Q}$$

(Marginal cost) (Average cost). $C \Rightarrow$ Total cost.

$$\frac{d(AC)}{dQ} = \frac{d(C/Q)}{dQ} = \frac{Q.\frac{\partial C}{\partial Q} - C.\frac{\partial Q}{\partial Q}}{Q^2}.$$

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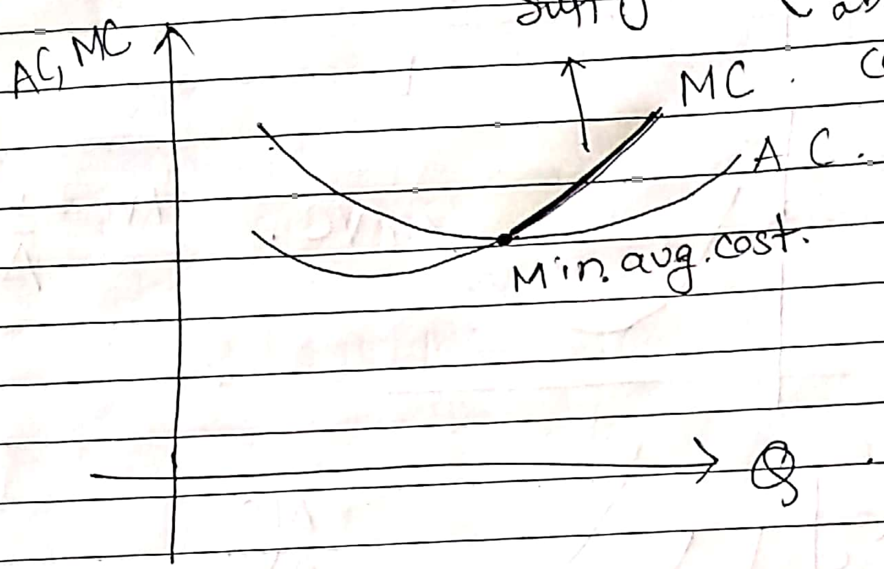
Notⁿ :- (M(N) M is a function of N)

$$= \frac{1}{Q}\left[\frac{\partial C}{\partial Q} - \frac{C}{Q}\right]$$

$$\frac{d(AC)}{dQ} = \frac{1}{Q}\left[MC - AC\right].$$



☆ **Profit :-**

$$\text{Profit} = \pi = P \times Q - C(Q)$$ (Price per unit)

Profit maximization :-

Total revenue $= P \times Q$

Total cost $= C(Q) = wL + rK$.

$C(Q) = 10Q^2 + 2Q + 10$ (Short Run due to constant term) fixed cost.

Long Run $10Q^2 + 2Q$

$$\pi = \text{Profit} = P \times Q - C(Q)$$

MR ⇒ Marginal Revenue = $\frac{\partial(\text{Total Revenue})}{\partial Q}$.

MC ⇒ Marginal Cost.

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$P = a - bQ$

$$\pi(Q) = P(Q)\,Q - C(Q)$$

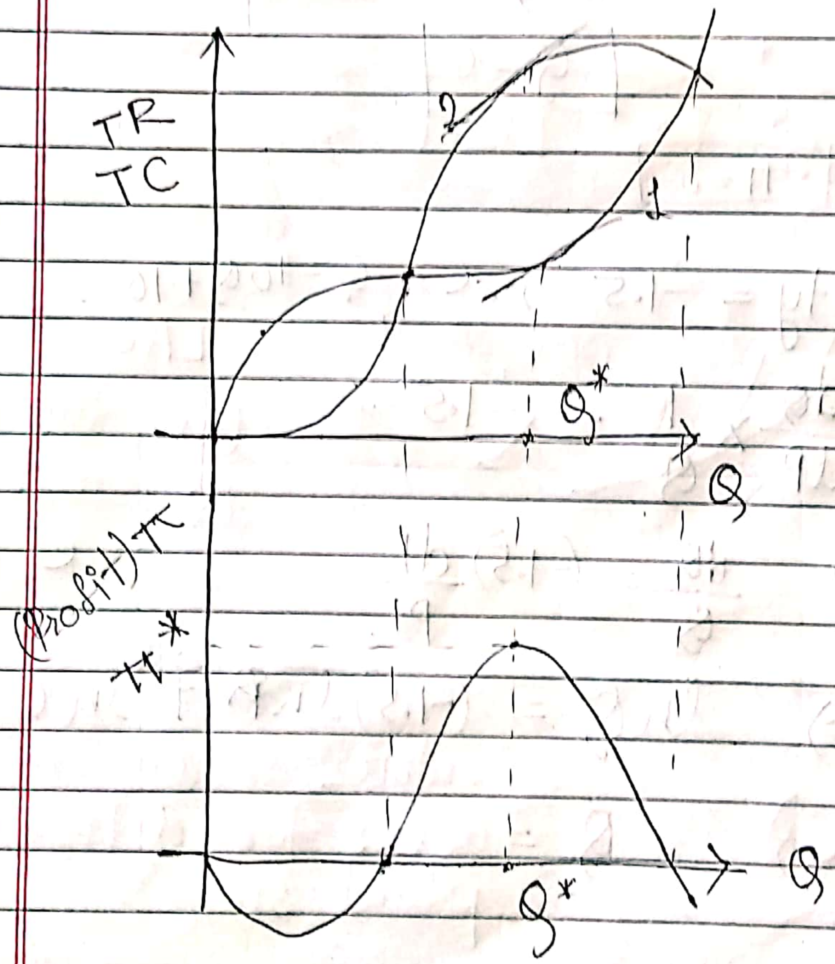
$$\frac{\partial \pi}{\partial Q} = Q\,P'(Q) + P(Q) - C'(Q),$$

where $P'(Q) = \frac{dP}{dQ}$; $C'(Q) = \frac{\partial C}{\partial Q} = MC$

$$= MR - MC.$$

for max. Profit $\frac{\partial \pi}{\partial Q} = 0$.

$$\Rightarrow \boxed{MR = MC}$$



1 ⇒ TC

2 ⇒ TR

At Q^*,

$$\boxed{MR = MC}.$$

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Q. $P = 10 - 5Q$; $C = 10Q + 2Q^2$
Maximize π. (Profit)

Ans $\pi = PQ - C$

$$\pi = (10-5Q)(Q) - (10Q+2Q^2)$$

$$\frac{\partial \pi}{\partial Q} = (10 - 5Q \times 2) - (10 + 4Q).$$

$$(10-10Q) - (10+4Q) = 0$$

$$\Rightarrow \cancel{10} - 10Q = \cancel{10} + 4Q$$

$$\Rightarrow \boxed{Q = 0}.$$

$$\boxed{\pi = 0}$$

Q. Elasticity $= -1.5$; $C = Q^2 - 10Q + 10$.

$$\Rightarrow \frac{dQ}{dP} \times \frac{P}{Q} = -1.5$$

$$\Rightarrow \frac{dQ}{Q} = (-1.5)\frac{dP}{P}.$$

$$\Rightarrow \ln Q = (-1.5)\ln P + \ln C.$$

$$\Rightarrow Q =$$

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SAC ⇒ Shortrun avg. cost function

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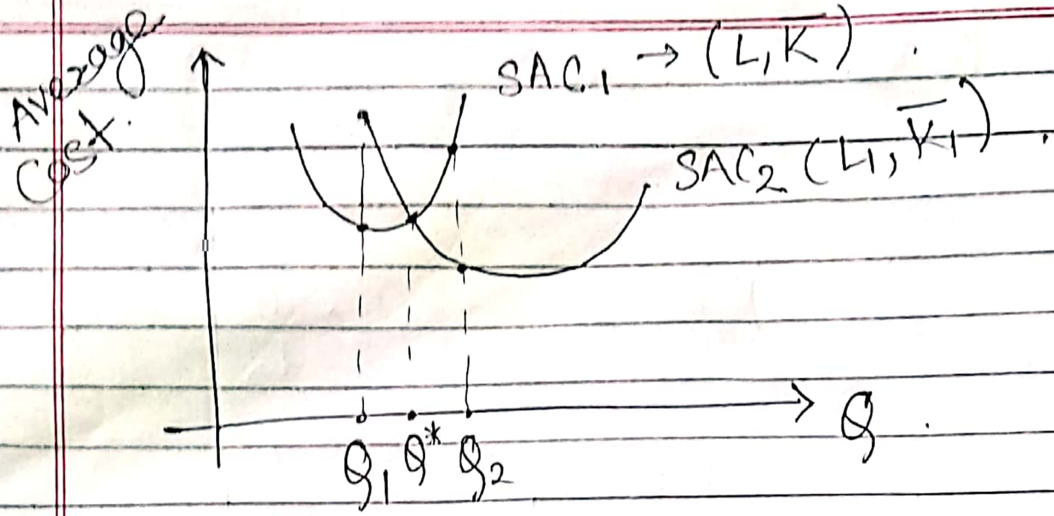
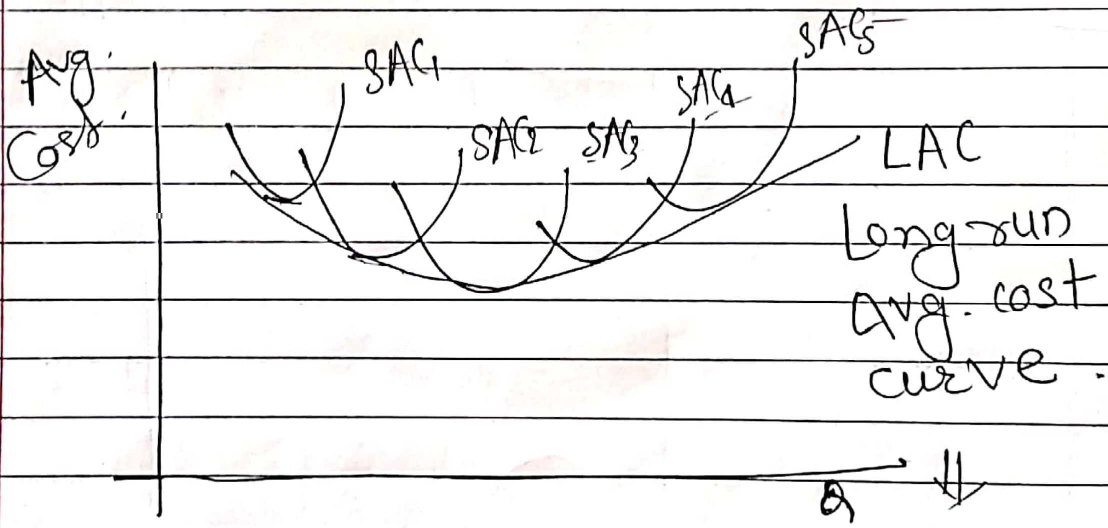


$Q_1 \Rightarrow SAC_1 < SAC_2$.

$Q_2 \Rightarrow SAC_2 < SAC_1$.

Optimal choices: Below $Q^* \Rightarrow$ Plant 1.
Above $Q^* \Rightarrow$ Plant 2.



(Envelope). Contour of all SAC curves for different plant sizes.

Fig. Relationship betn SAC and LAC.

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* Economies of scope (merge).

for same item.

Place	A	B
quantity	Q_1	Q_2
cost f^n.	$C(Q_1)$	$C(Q_2)$

$C(Q_1) + C(Q_2)$

$> C(Q_1+Q_2)$

if same location cost is less.

(If other cost-effective options are available).

* diseconomies of scope $C(Q_1)+C(Q_2) < C(Q_1+Q_2)$

* Economies of Scale :- $\Rightarrow$ (Producing extra $\Leftrightarrow$ avg. cost falls)

Increment cost for production of Q_2

$$IC_{Q_2} = C(Q_1,Q_2) - C(Q_1,0).$$

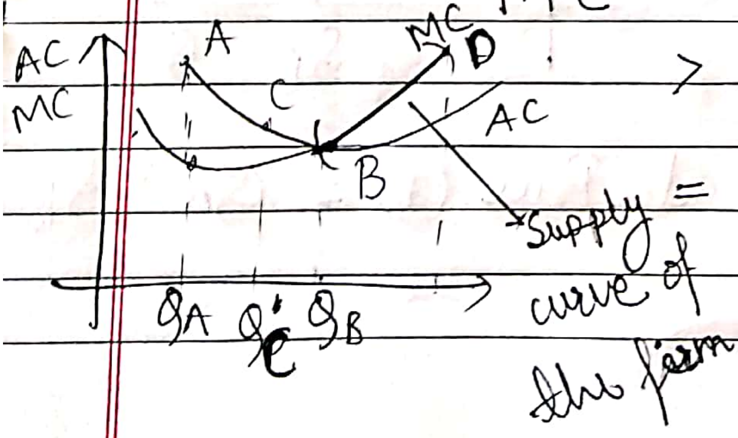
$$AIC_{Q_2} = \frac{C(Q_1,Q_2) - C(Q_1,0)}{Q_2}.$$

$$MC = \frac{\partial C}{\partial Q_2} \quad \text{(Marginal)}$$

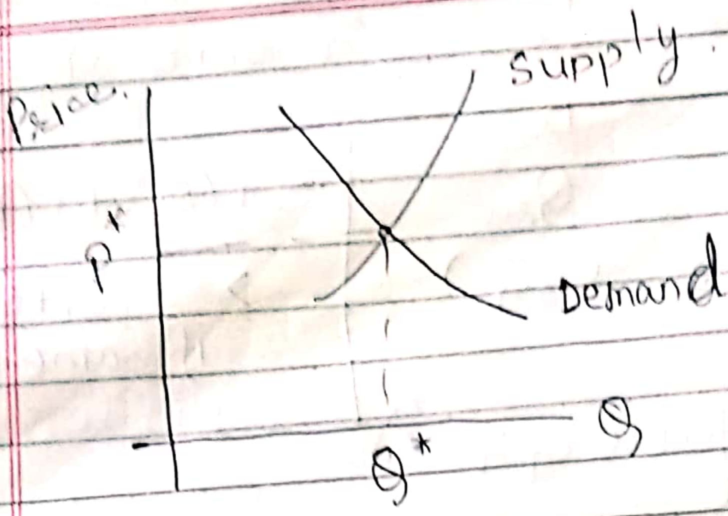
$$\text{Scale} = \frac{ATC}{MC} < 1 \Rightarrow \text{Diseconomies of Scale}$$

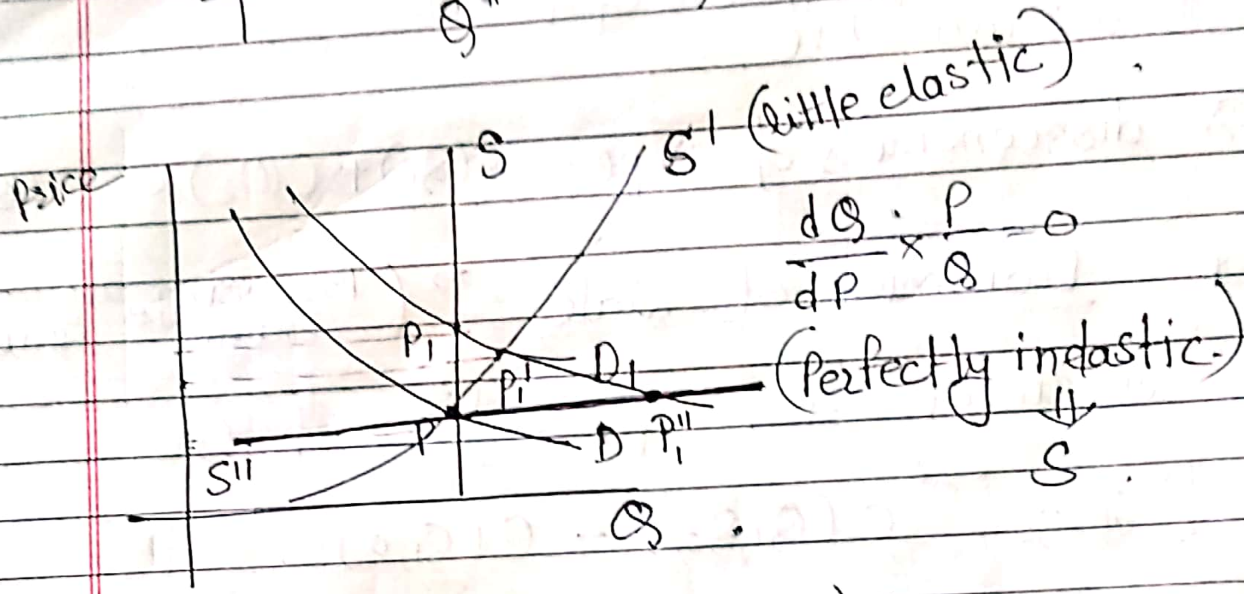
$> 1 \Rightarrow$ Economies of Scale (EOS)

$= 1 \Rightarrow$.



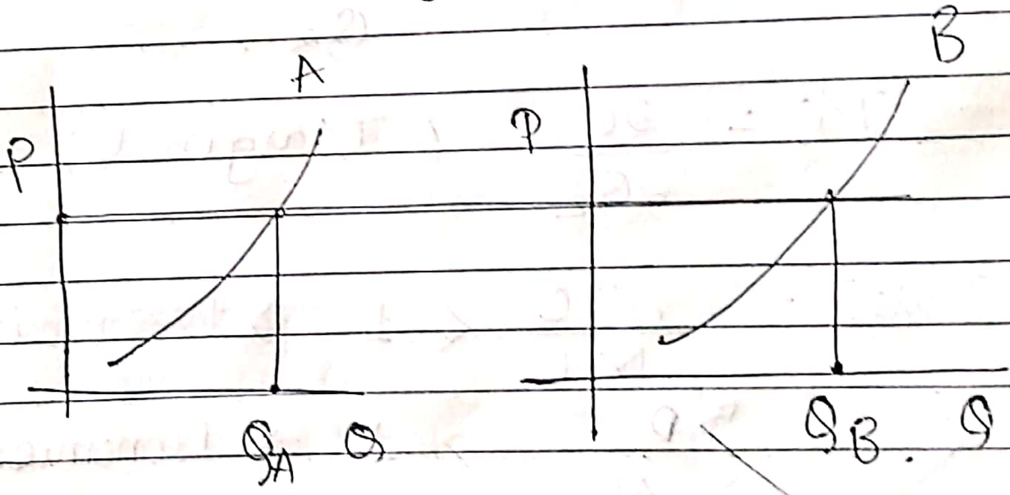
In BD portion, producer will produce.





$S'' \Rightarrow$ (Perfectly elastic)

A, B
Two different suppliers.



Market supply at Price (P) = $Q_A + Q_B$

Cobweb Model

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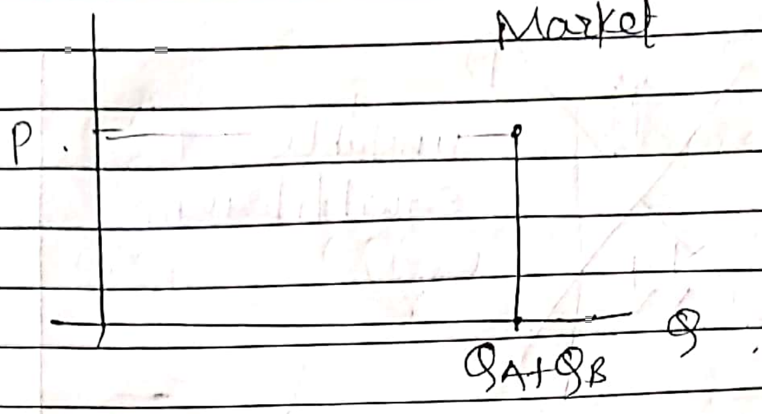
Market

Horizontal Summation.



Q. $Q_D = a - bp$; $Q_S = c + dP$.
(Demand) (Supply).

⟹ for equillibrium, $Q_D = Q_S$
Price.

$$\Rightarrow a - bP = c + dP$$

$$\Rightarrow a - c = (b+d)P$$

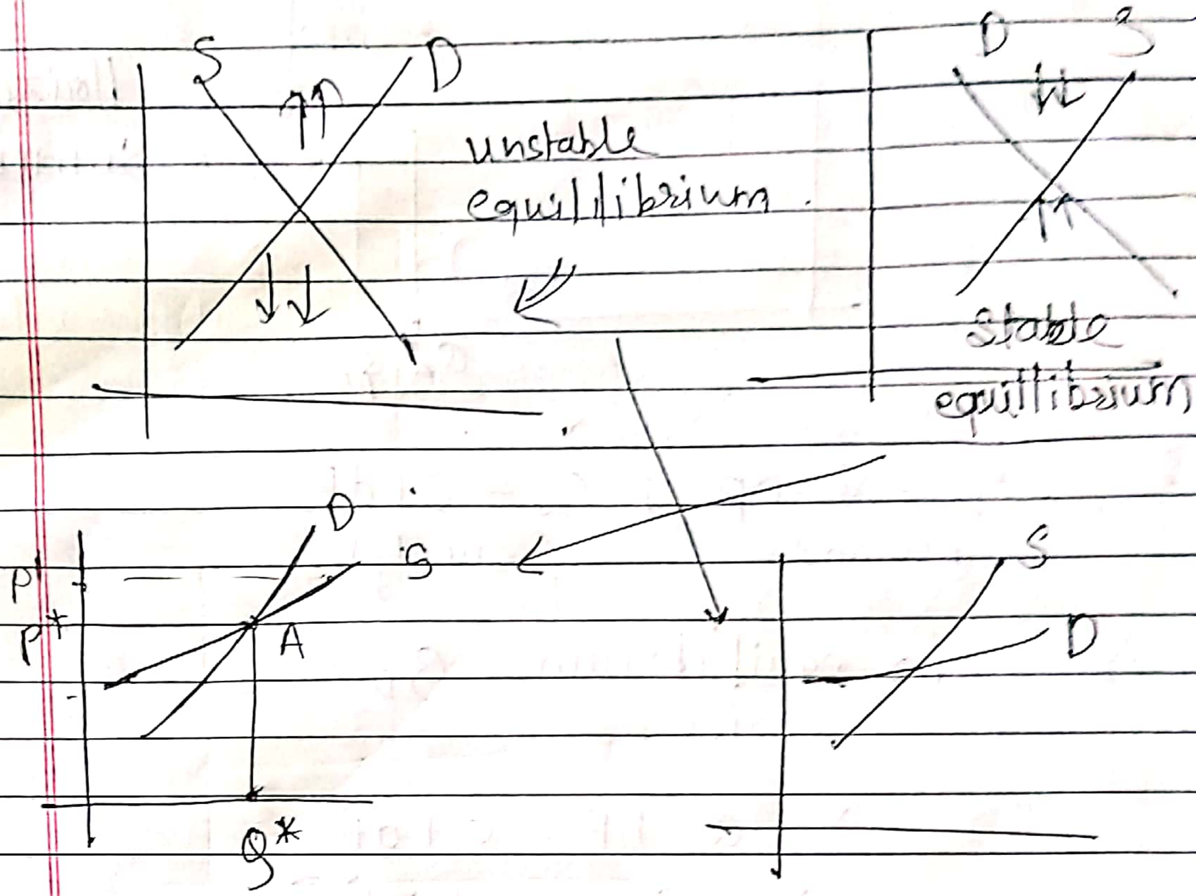
$$\Rightarrow \boxed{P^* = \left(\frac{a-c}{b+d}\right)}$$

$$\Rightarrow Q^* = a - b\left(\frac{a-c}{b+d}\right).$$

$$= \frac{a(b+d) - b(a-c)}{b+d}$$

$$= \frac{\cancel{ab} + ad - \cancel{ab} + bc}{b+d}$$

$$\Rightarrow \boxed{Q^* = \frac{ad + bc}{b+d}}$$



If supply curve is steeper than the demand curve (if both are +vely sloped) then it is an unstable equillibrium.

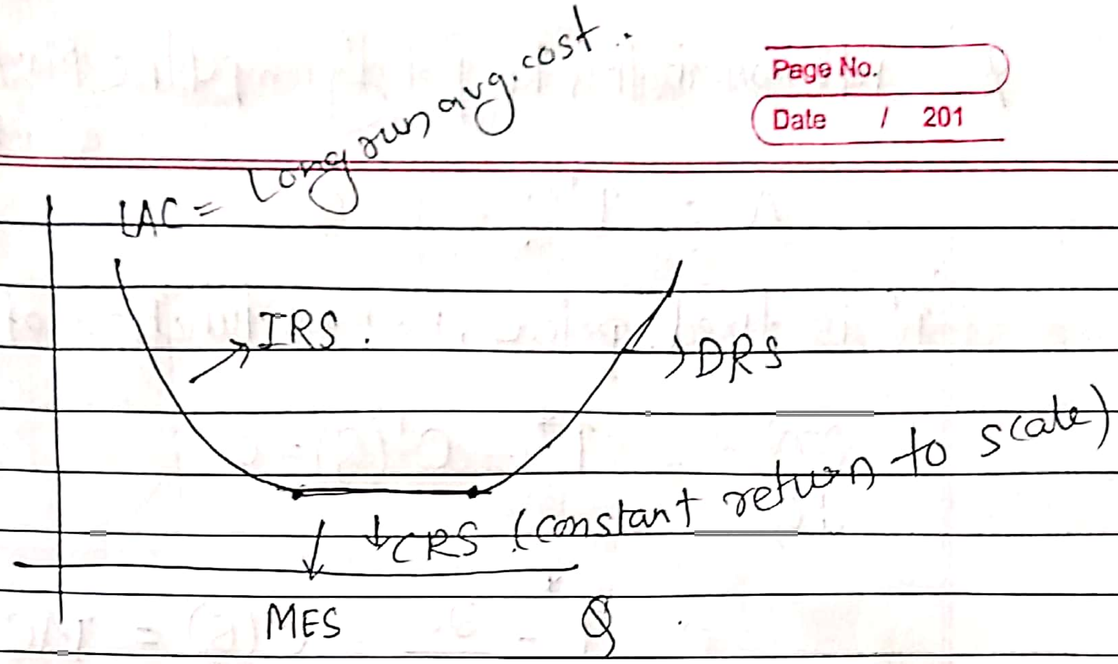
$$C = wL + rK$$

$$AC = \frac{wL + rK}{Q}$$

for increasing (IRS) return to scale. $\frac{K(wL + rK)}{K'Q}$

where $K' > K$; AC ↓.

vice-versa for decreasing return to scale (DRS).



Efficient Scale of Production.
(Min. efficient scale) (MES)

→ Amount of output for which AC reaches minimum.

~~Market Structure~~

Perfect Competition → Oligopoly ← Monopolic compn ← Duopoly ← Monopoly.

* Perfect Competition :-

Assumptions :-
Everybody has equal perfect information.
Nobody has any advatange.
Entry and Exit ~~are~~ free for producer.

Auction
Bidding
Dutch — Price high to low
English — Price low to high.

① many sellers
② perfect information.
③ entry and exit are free.
④ Every seller is a price taker.
⑤ Product is homogeneous.

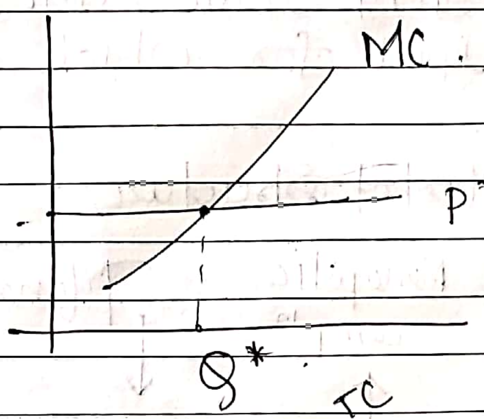
☆ Profit maximization for Perfectly competitive Market Structure

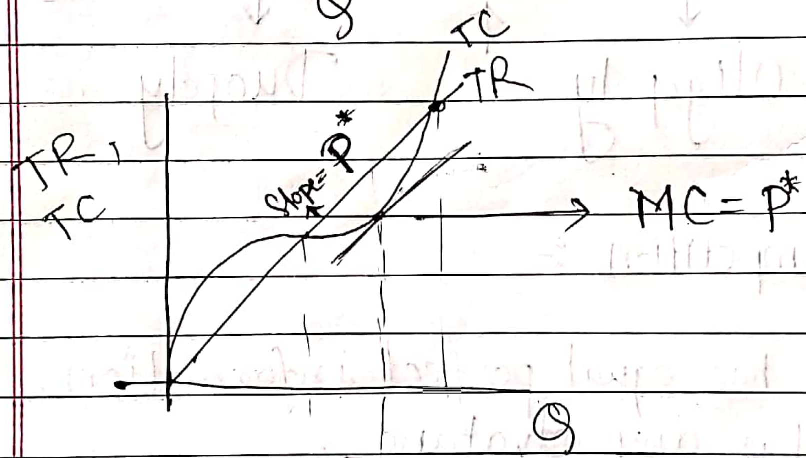
$$\pi = P^* Q - C(Q)$$

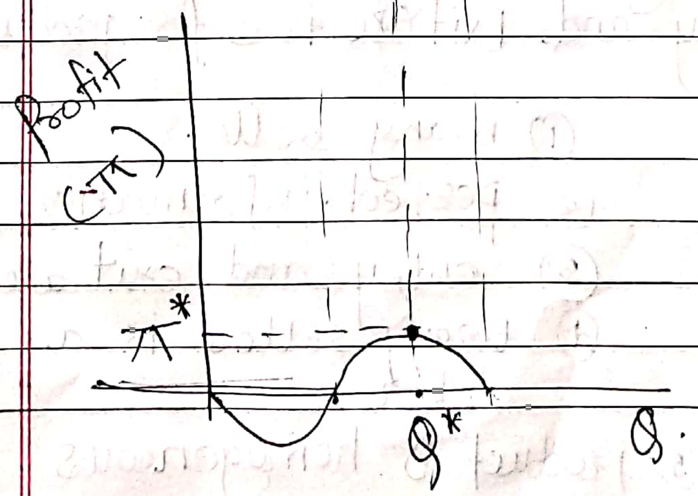
(P^* is fixed price; no more function of Q)

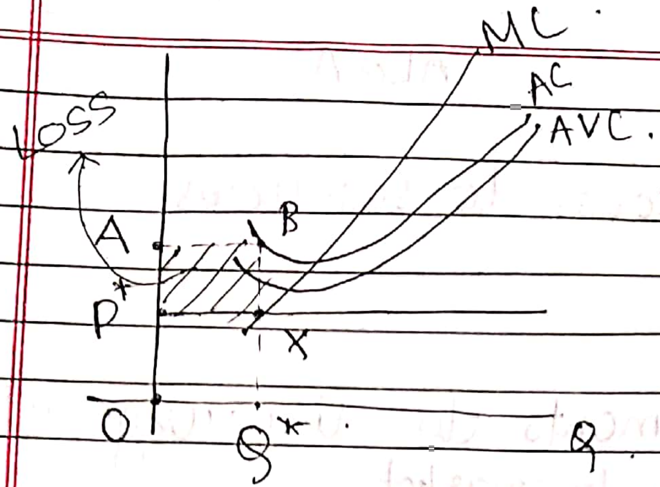
$$\frac{\partial \pi}{\partial Q} = P^* - C'(Q) = 0$$

$$\Rightarrow P^* = \frac{\partial C}{\partial Q} = C'(Q) = MC$$









Total revenue

$= P^*Q^* = \text{Area}(\square P^* X Q^* O)$

Total cost.

$= AC \times Q = \text{Area}(\square ABQ^*O)$

$P > AC \Rightarrow \pi > 0$

$P < AC \Rightarrow \pi < 0$

$P = AC \Rightarrow \pi = 0$.

Quiz

$$C = aQ^3 + bQ^2 + cQ + d.$$

$$MC = 3aQ^2 + 2bQ + c.$$

$$\frac{dMC}{dQ} = 6aQ + 2b = 0.$$

$$Q^* = \frac{-2b}{6a} = \frac{-b}{3a}$$

$$MC_{min} = 3a\left(\frac{-b}{3a}\right)^2 + 2b\left(\frac{-b}{3a}\right) + c.$$

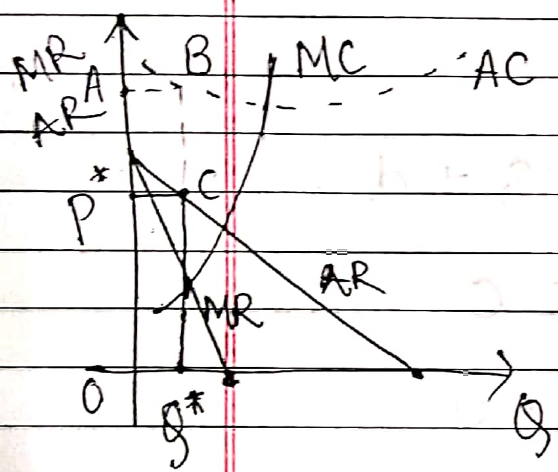
$$= \frac{3ab^2}{9a^2} + \frac{-2ab^2}{3a^2} + \frac{c3a^2}{3a^2}.$$

$$MC_{min} = \frac{3ac - b^2}{3a} > 0$$

$$\boxed{3ac > b^2}$$

* Monopoly :- ALcoA.

Reasons
1. Exclusive Access to resources
2. Patents.
3. Cartel
↓
Making Arrangements to discourage other people coming to market.
4. Economies of Scale.



$P = a - bQ$

$TR = PQ = aQ - bQ^2$

$MR = a - 2bQ$

$AR = a - bQ$

$TC = C(Q)$

$MC = C'(Q)$

$$TR = P(Q) \cdot Q$$

$$MR = \frac{d(P(Q))}{dQ} \cdot Q + P(Q) \frac{dQ}{dQ}$$

$$= P(Q) \left[\frac{dP}{dQ} \frac{Q}{P} + 1 \right]$$

$$MR = P(Q) \left[1 - \frac{1}{e} \right]$$ $e \rightarrow$ elasticity.

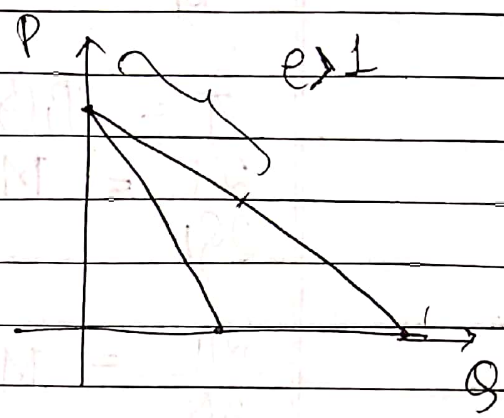
$$e = \frac{dQ/Q}{dP/P} < 0$$ (in general).

Break-even (When AC is tangential to P* line) — amt. of Q produced for which $\pi = 0$.

For max profit (π^*),

$MR = MC$

$\rightarrow P\left(1 - \frac{1}{e}\right) = MC$



So, producer should produce where $e > 1$.

★ **Price Discriminations :-**

First Degree

For each unit of output, Price is different.

Second Degree

Electricity Bills. — Upto certain extent of output, Price is similar.

Third Degree

Price difference based on consumers.
Based on — Age, Income, etc.

Total cost (C) = $C(Q_1+Q_2)$.

$P_1(Q_1)$ $P_2(Q_2)$

Q_1 Q_2.

$$\pi = P_1(Q_1)Q_1 + P_2(Q_2)Q_2 - C(Q_1+Q_2).$$

$$\frac{\partial \pi}{\partial Q_1} = MR_1 - MC = 0$$

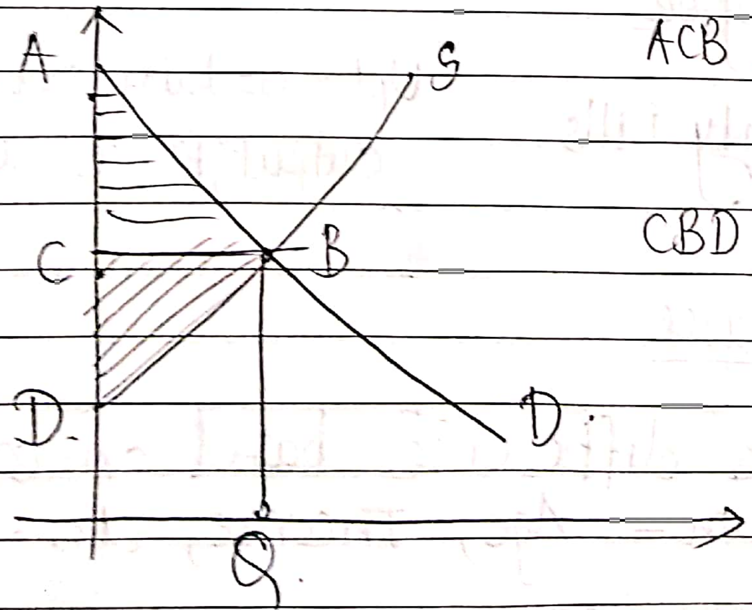
$\Rightarrow MR_1 = MR_2 = MC$

$$\frac{\partial \pi}{\partial Q_2} = MR_2 - MC = 0.$$

$$\Rightarrow P_1\left(1-\frac{1}{e_1}\right) = P_2\left(1-\frac{1}{e_2}\right) = MC.$$

If $P_1 > P_2$; $e_1 < e_2$
$P_1 < P_2$; $e_1 > e_2$

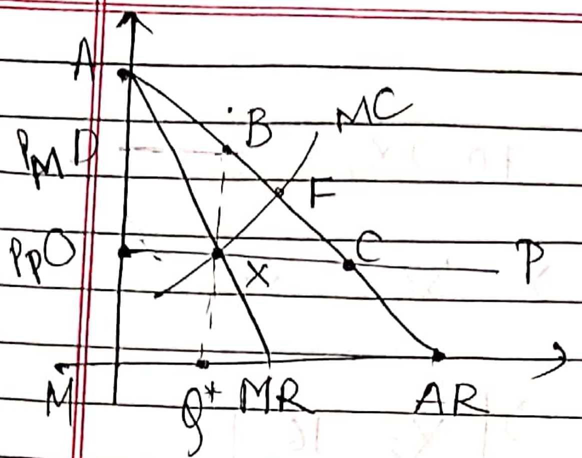
Those who respond less with price change can be charged more. (Rich).



ACB $\Rightarrow$ Consumer Surplus

CBD $\Rightarrow$ Producer Surplus.

How Perfectly Competitive Environment & Monopoly relate for both Consumer & Producer



$$\bar{P} \times Q = TR$$
$$TC = C(Q)$$
$$\pi = \bar{P} \times Q - C(Q).$$
$$\frac{d\pi}{dQ} = \bar{P} - MC = 0.$$

ΔACO = Consumer Surplus in Perfectly Competitive environment
= CS_P.

ΔADB = Consumer Surplus in Monopoly.
= CS_M.

Loss in CS = DBCO.

~~PS_P = 0~~ Gain of Producer in Monopoly = DBXO.

ΔBXC = Deadweight Loss.

Q.1). $C = 8X + 100$.
C → Total Cost.
X → Total Output.

$X_1 = 100 - 0.5P_1$
$X_2 = 40 - P_2$,

→

$X_1 + X_2 = X$.

$TR_1 = P_1 X_1$
$= 200X_1 - 2X_1^2$

$P_1 = 200 - 2X_1$
$P_2 = 40 - X_2$.

$TR_2 = 40X_2 - X_2^2 = P_2 X_2$

$MC = 8$

$MR_1 = 200 - 4X_1$

$MR_2 = 40 - 2X_2$

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$$MR_1 = MR_2 = MC$$

$\Rightarrow 200 - 4X_1 = 8$ $\quad\Rightarrow 40 - 2X_2 = 8$

$\Rightarrow \frac{192}{4} = X_1$ $\quad\Rightarrow 32 = 2X_2$

$\Rightarrow \boxed{X_1 = 48}$ $\quad\Rightarrow \boxed{X_2 = 16}$

$P_1 = 200 - 2(48)$ $\quad P_2 = 40 - X_2$

$= 40 - 16$

$\boxed{P_1 = 104}$ $\quad\boxed{P_2 = 24}$

$$\boxed{P_1\left(1 - \frac{1}{e_1}\right) = P_2\left(1 - \frac{1}{e_2}\right)}.$$

$e_1 = \frac{dX_1}{X_1} \cdot \frac{P_1}{dP_1}$ $\quad e_2 = \frac{dX_2}{X_2} \cdot \frac{P_2}{dP_2}$

$= \frac{P_1}{X_1} \cdot \frac{dX_1}{dP_1}$ $\quad = \frac{P_2}{X_2} \cdot \frac{dX_2}{dP_2}$

$e_1 = \frac{104}{48}(-0.5)$ $\quad e_2 = \frac{24}{16}(-1)$.

$e_1 = -\frac{104}{96}$ $\quad e_2 = -\frac{24}{16}$

$\boxed{e_1 = -1.08}$ $\quad\boxed{e_2 = -1.5}$

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price, quantity, Advertisement cost parameter, cost

Q. $P = 100 - 3q + 4\sqrt{A}$; $C = 4q^2 + 10q + A$.

$\Rightarrow$ $TR = Pq$

$TR = (100 - 3q + 4\sqrt{A})q = 100q - 3q^2 + 4\sqrt{A}q$.

$TC = C = 4q^2 + 10q + A$

$\pi = TR - TC$

$= (100q - 3q^2 + 4\sqrt{A}q) - (4q^2 + 10q + A)$

$\pi = 90q - 7q^2 + 4\sqrt{A}q - A$.

$\frac{\partial \pi}{\partial q} = 90 - 14q + 4\sqrt{A} = 0$

$\frac{\partial \pi}{\partial A} = -1 + \frac{4}{2\sqrt{A}} q = 0$.

$\Rightarrow 4q = 2\sqrt{A}$

$\Rightarrow 2q = \sqrt{A}$.

$\Rightarrow 90 - 14q + 4(2q) = 0$

$\Rightarrow 90 - 6q = 0 \Rightarrow \boxed{q = 15}$

$\Rightarrow 30 = \sqrt{A} \Rightarrow \boxed{A = 900}$

$\boxed{q = 15, A = 900}$ for profit maximization individual production

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Q. Long Run cost function for 1 producer. $C = q^3 - 4q^2 + 8q$.

There are in total n producers.
Producer will stay if $\pi > 0$.
What is industry's long run supply function?

Demand function for total market $= 2000 - 100P$.

$n, P, q \Rightarrow$ (Optimal Value). (P = price)

$\Rightarrow \quad = \quad D = nq$

AC = Average Cost $= \frac{C}{q} = q^2 - 4q + 8$.

for min AC. $\Rightarrow \quad \frac{\partial (AC)}{\partial q} = 2q - 4 = 0 \quad \boxed{q^* = 2}$

$\Rightarrow \quad AC_{min} = 4 - 4(2) + 8$

$\Rightarrow \boxed{AC_{min} = 4}$

If $P > 4$ Stay
$P \leq 4$ leave. $\boxed{P^* = 4}$

$D = 2000 - 100(4) = 1600$.

$\Rightarrow nq = 1600$.

$\Rightarrow \boxed{n^* = 800}$

P	n	q
4	800	2

Solve both for Monopoly & P.C. Markets. (P, q, π).

Q. $P = 100 - 4q$; $TC = 50 + 20q$.

Monopoly $\quad MC = 20$.

$\Rightarrow$

$TR = Pq$ $\quad 100 - 8q = 20$

$= (100 - 4q)q$. $\quad 8q = 80$

$TR = 100q - 4q^2$ $\quad \boxed{q = 10}$

$MR = 100 - 8q$ $\quad MC = 20$. $\quad \boxed{P = 60}$

$\pi = TR - TC = (600) - (250) = 350$

Perfectly Competitive.

$P = MC \Rightarrow P = 20$.

$q = 20$.

$\pi = TR - TC = (100q - 4q^2) - (50 + 20q)$

$= (2000 - 1600) - (50 + 400)$

$= 400 - 450$

$\boxed{\pi = -50}$