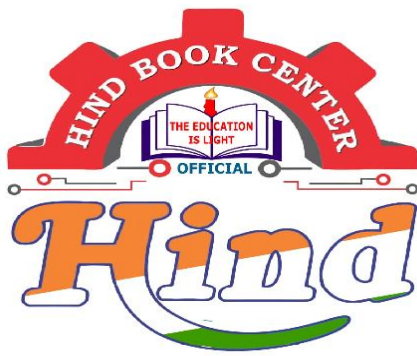




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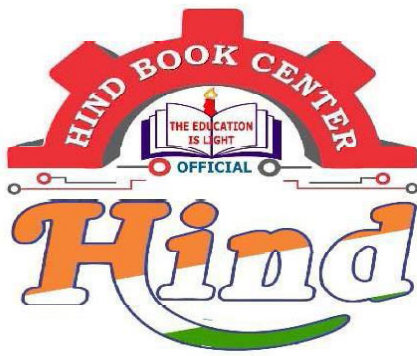
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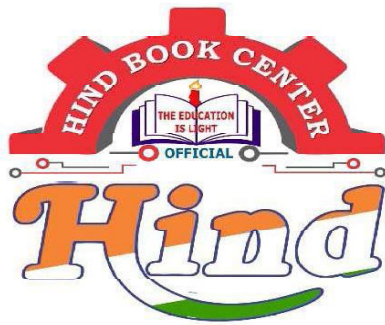
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STRENGTH OF MATERIAL

OR

MECHANICS OF MATERIAL

OR

MECHANICS OF SOLIDS

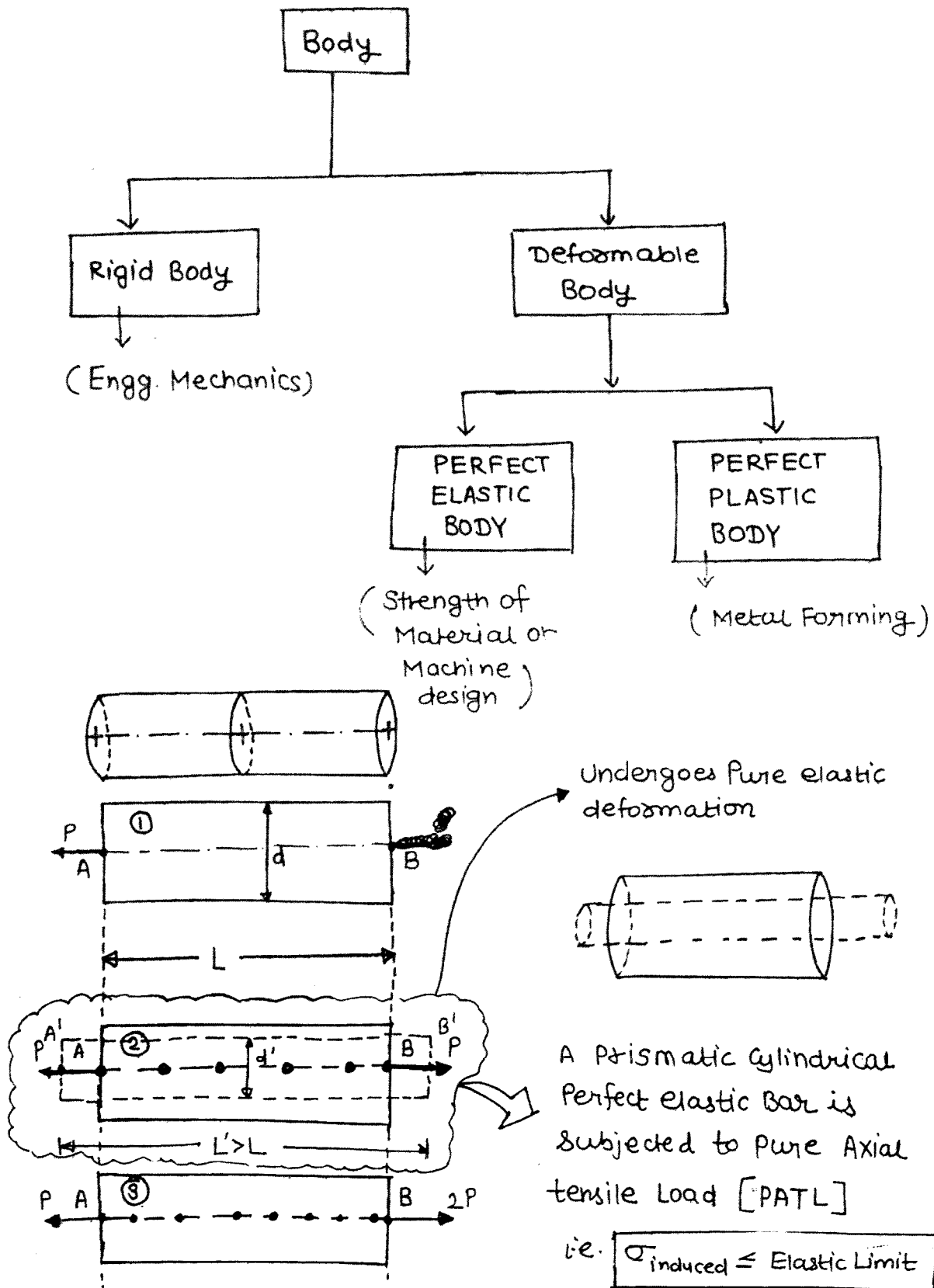
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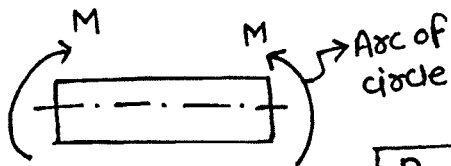
MECHANICS OF STRUCTURE

OR

MECHANICS OF PERFECT ELASTIC BODIES

- $\sigma_{\text{induced}} \leq \text{Elastic Limit} \Rightarrow \text{Perfect elastic Body}$
- $\sigma_{\text{induced}} > \text{Yield Strength} \Rightarrow \text{Perfect Plastic Body}$





Pure Bending
i.e.

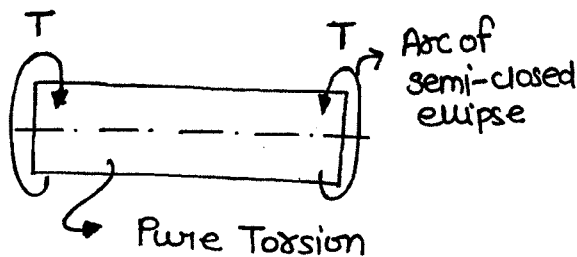
Axial load = Shear Force = Twisting Moment = ZERO

Bending moment = Constant

i.e. Shear Force = Bending moment = Twisting moment = 0

Axial load = Constant

Bending → Two equal Parallel opposite Couple eccentric axial load



Torsional Couple → Two equal and opposite Parallel eccentric transverse shear Load.

Axial load = Shear force = Bending Moment = zero

Torsional Moment = Constant

Pure Axial Load

$$\sigma_a = \frac{P}{A} ; \delta_L = \frac{PL}{AE}$$

$$\delta_V = \frac{PL}{E} (1 - 2\mu)$$

$$FOS = \frac{\text{Failure stress}}{\text{Per Stress}}$$

Aim of SOM Subject →

Aim of SOM Subject is to derive expressions for stress, strain and deformation under different loading conditions by using experimentally obtained elastic properties like, Young's modulus, Poisson's ratio.

• Input data for strength of material problem

- (I) Load
- (II) dimensions
- (III) elastic properties like E and μ

• Parameters to be determined

- (I) stress
- (II) strain, by using elastic constants (properties)
- (III) deformations, change in length, change in cross-sectional dimensions and change in volume

• Assumptions made while deriving SOM equations

1. Perfect elastic member (stress, strain ^{are} ~~at~~ within the elastic region)
2. Homogeneous and Isotropic material is assumed.
3. Prismatic member is assumed.
4. Self-weight is neglected.
5. Static load (gradually applied load) is assumed.
6. Member is under static equilibrium condition.

To obtain safe dimensions in presence of above mentioned assumptions factor of safety (FOS) should be used in design calculations.

• Aim of Machine design

Ultimate aim of design is to develop a drawing in such a way that It should perform its given functionality Satisfactorily. (that's without any failure)

• Steps in design of a Component: — used

1. Specify the functionality of that Component.
2. determination of Loads acting on that Component during its functionality.
3. Selection of an appropriate shape.
4. Selection of an appropriate Material.
5. Calculation of dimensions by using strength of Material equation.

Ist Method: By using strength & rigidity Criterion

IInd method: By using Theory of failure (T.O.F.)

6. selection of manufacturing process detail (i.e. type of manufacturing, appropriate Surface finish, Limits and fits).
7. Part drawing should be Prepared for that Component.

$$E = \frac{\text{Normal stress}}{\text{Longitudinal strain}}$$

↙
Young's
Modulus

$$G = \frac{\tau}{\gamma}$$

$$\mu = \frac{-\text{Lateral strain}}{\text{Longitudinal strain}}$$

↙
Poisson
ratio

★
cylinder
Hollow → Better for weight
Solid → Better for Torsion
cylinder

Strength $\rightarrow$ Uniaxial
Theories of failure $\rightarrow$ Uniaxial, biaxial, triaxial

HOMOGENEOUS MATERIAL:-

A material is said to be homogeneous when it exhibits same elastic properties at any point in a given direction (that is elastic properties are independent of point).

• ISOTROPIC MATERIAL:-

A material is said to be isotropic when it exhibits same elastic properties in any direction at a given point (i.e. elastic properties are independent of direction).

$\rightarrow$ A material is said to be both homogeneous and isotropic when it exhibits same elastic properties at any point and in any direction (i.e. elastic properties are independent of both point and direction).

$\rightarrow$ Every homogeneous material need not be isotropic material and vice-versa. but few materials are both homogeneous and isotropic.

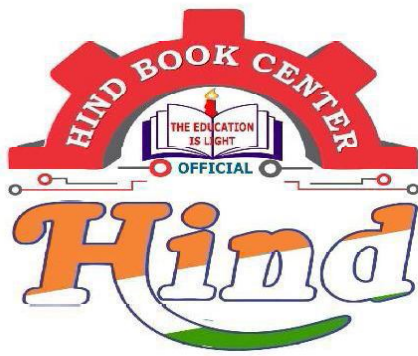
• Anisotropic Material $\rightarrow$ (Composite material eg. fiber)

A material is said to be anisotropic when it exhibits direction dependent elastic properties at a given point.

~~Higher weight to strength ratio~~

* Advantage of Anisotropic material

- desirable property can be achieved as per requirement.
- Higher strength to weight ratio



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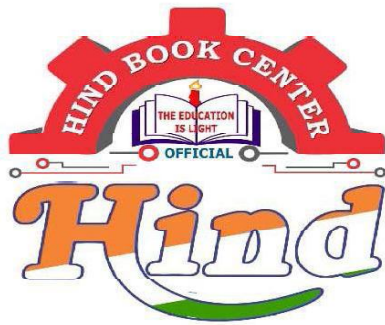
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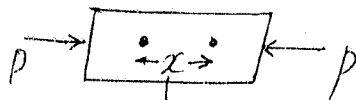
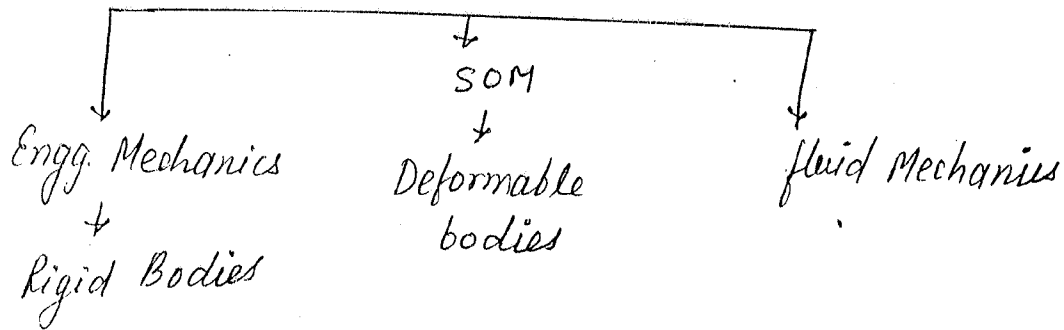
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Fluid Mechanics

load

effect

is the study of application of load and its effects on structure, machine, fluid etc.



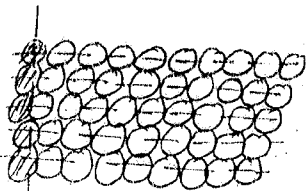
fixed $\rightarrow$ do not changes with load.

Fluid $\rightarrow$ A fluid is a substance that is having the ability to Flow OR Deform continuously under the action of shear force.

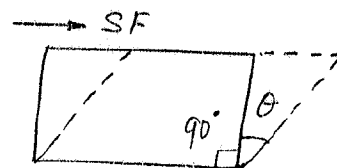
tangential force

No matter how much small the force is.

Solid



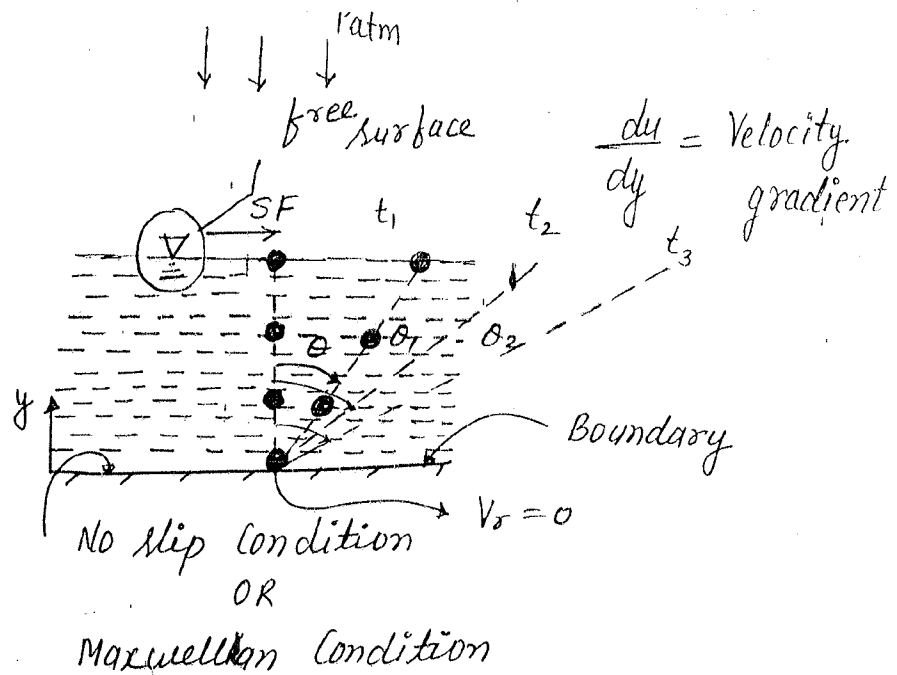
Continuum



deformation Const with t

Static fluid

$$\Rightarrow SF = 0$$



$\frac{d\theta}{dt} \rightarrow$ Rate of angular deformation (Not constant)

$$S \rightarrow \text{SOM}$$

$$\left. \begin{matrix} L \\ G \end{matrix} \right\} \rightarrow \text{fluids (FM)}$$

Introduction

- $\rightarrow$ A fluid is a substance that is having the ability to flow and deform continuously under the action of shear force (No matter how much small the force is)
- $\rightarrow$ Liquids and gases are generally taken in category of fluids example, air, water, steam, mercury etc.
- $\rightarrow$ A static fluid is the one over which shear force is zero.

→ ** No slip condition means that the molecule which is in contact with boundary will stick to boundary if boundary at rest the molecule is also at rest. if boundary is moving the molecules sticking to boundary will also move.

it means the relative motion will be zero

→ Free surface is the surface over which p_{atm} is acting. OR Normal force is acting.

→ Differences b/w solids and fluids

① in case of solids the deformation is const with respect to time. whereas in case of fluids the deformation is continuous wrt time and hence in case of fluids do rate of deformation is Important than $\frac{d}{dt}$ deformation.

② In case of solids on removal of load, solids will try to regain their original shape or size whereas fluids will never try to regain there original shape and size.

Note The intermolecular forces of attraction b/w molecules of same Nature is known as cohesion.

whereas intermolecular force of attraction b/w molecules of diff Nature is known as Adhesion.

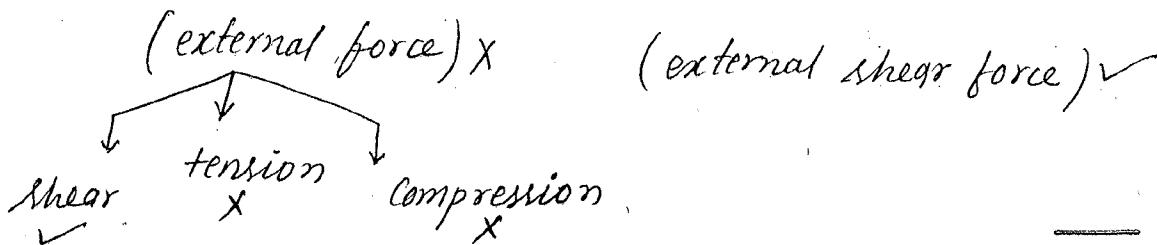
*** Cohesion and adhesion are dependent on Nature of surfaces in contact.

$H_2O + \text{glass} \rightarrow$ Adhesion is more

$Hg + \text{glass} \rightarrow$ Cohesion is more

$H_2O + \text{plastic sheet} \rightarrow$ Cohesion is more

Note $\rightarrow$ A fluid will never show resistance to shear under static condition but it will show resistance to shear under dynamic condition
 $\rightarrow$ A fluid will flow, as long as external shear force is applied or deform continuously



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Note liquids has the ability to form free surface whereas gases don't have the ability to form a free surface.

A free surface is the special interface b/w liquid and gas.

→ gases have the ability to expand without limits.

Concept of Continuum:- (mainly for interview)

(Assumption)

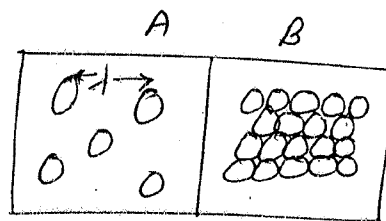
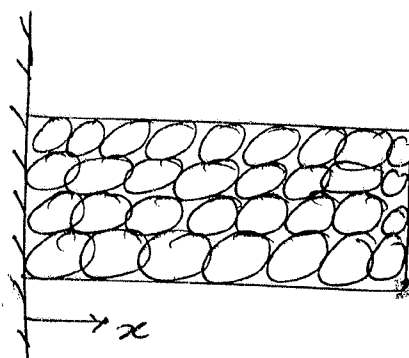
- Uniformly
- Continuously
- Voids must be very less
- No. of molecules are large in comparison to voids and hence voids can be neglected

$$\text{Knudsen (Kn)} = \frac{1}{\text{No}} \frac{1}{L}$$

$$\text{Kn} < 0.01$$

Empirical relation

$L \rightarrow$ system dimension



λ - mean free path

Note if λ is very small in comparison to system dimension L such that $\text{Kn} < 0.01$ then concept of continuum is applicable

Continuum fails → ① Rarefied gas field
② High vacuum

Fluid Properties

properties are certain measurable characteristic that can be quantified.

with the help of properties we can identify a fluid.

① Density (OR) mass Density (ρ)

$$\rho = \frac{\text{mass}}{\text{Volume}} \quad (\text{Kg/m}^3)^{\text{SI}}$$

$$\rho_{\text{H}_2\text{O}} = 10^3 \text{ Kg/m}^3$$

$$\rightarrow \rho_{\text{liq}} > \rho_{\text{gas}}$$

$$\rho_{\text{Hg}} = 13.6 \times 10^3 \text{ Kg/m}^3$$

$\rightarrow$ Heaviness of fluid

$$\rho_{\text{air}} = 1.2 \text{ Kg/m}^3$$

$$\rho \begin{cases} \rightarrow P \uparrow \Rightarrow \rho \uparrow \text{ [molecules will come closer]} \\ \rightarrow T \uparrow \Rightarrow \rho \downarrow \text{ [Bonds will break]} \end{cases}$$

applicable for both liquid and gas.

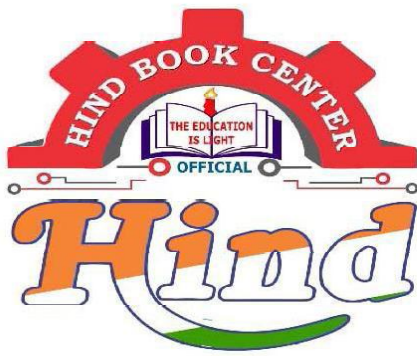
② Weight Density OR Specific Weight (w)

$$w = \frac{\text{Weight}}{\text{Volume}} \quad (\text{N/m}^3)^{\text{SI}}$$

$$w = \frac{mg}{V} \Rightarrow w = \rho g$$

Note Hg is approx. 13.6 time heavier than water.

$$w_{\text{H}_2\text{O}} \rightarrow 10^3 \times 9.81 \rightarrow 9810 \text{ N/m}^3$$



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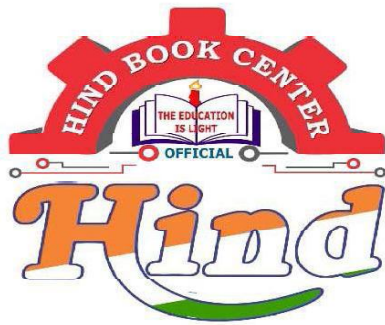
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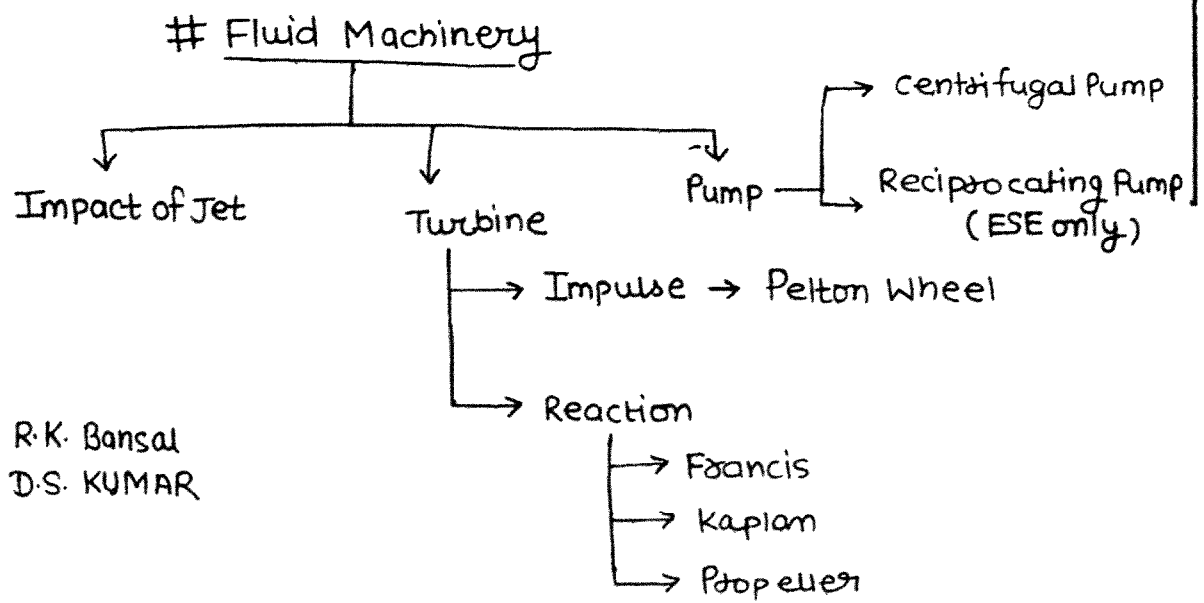
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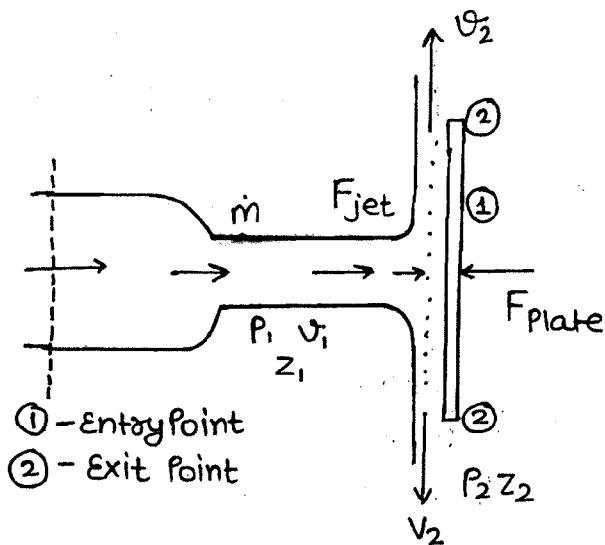
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Book:-> R.K. Bansal
D.S. KUMAR

Impact of Jet : →



Newton's II Law

$F_{\text{Plate}} = \text{Rate of change in Linear Momentum of jet}$

$F_{\text{Plate}} = (\text{Final} - \text{Initial}) \text{ momentum of water}$

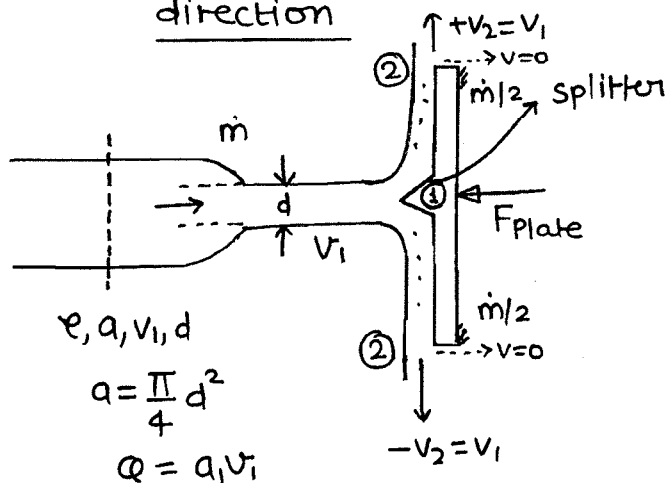
$$F_{\text{jet}} = -F_{\text{plate}} = \dot{m}\vec{V}_1 - \dot{m}\vec{V}_2$$

$\dot{m}$ = mass flow rate of water which strikes the Plate/body.

Water → Reaction force
Plate → Initial force

Case: I

Jet strikes Stationary flat Plate in Normal direction



$$P_1 = P_2 = P_{\text{atm}}$$

$$z_1 = z_2$$

$$\rightarrow F_x = F_N = \dot{m}v_1$$

$$= \rho a v_1^2 N$$

$$\rightarrow F_y = F_T = \dot{m} \times 0 - \left[\frac{\dot{m}}{2} \times v_2 + \frac{\dot{m}}{2} (-v_2) \right]$$

$$F_y = F_T = 0$$

→ Smooth Plate ($v_2 = v_1$)

→ Rough Plate ($v_2 < v_1$)

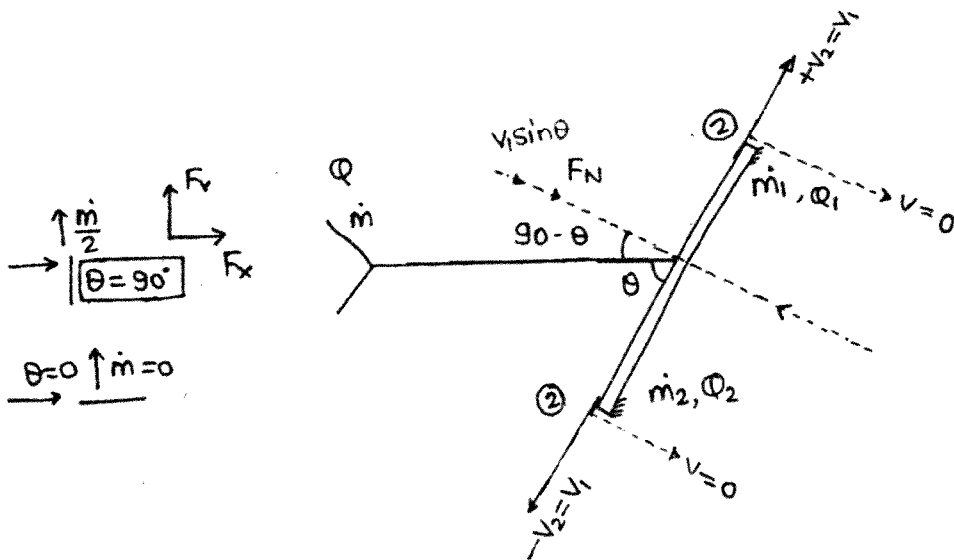
$$\dot{m} = \rho a v_1 = \rho Q$$

$$\rightarrow F_x = F_N = \dot{m}v_1 - \left[\frac{\dot{m}}{2} \times 0 + \frac{\dot{m}}{2} \times 0 \right]$$

NOTE → When Jet strikes over a ^{Flat} Plate then it will apply the force only in Normal direction to Plate, there will not be any force in tangential direction to Plate.

Case: II

Jet Strikes Stationary Inclined Plate



$$\dot{m} = \dot{m}_1 + \dot{m}_2 \Rightarrow \boxed{\varphi = \varphi_1 + \varphi_2} \rightarrow (1)$$

$$\boxed{\dot{m} = \rho a V_1 = \rho \varphi}$$

$$F_N = \dot{m} V_1 \sin \theta - [\dot{m}_1 x_0 + \dot{m}_2 x_0]$$

$$F_N = \dot{m} V_1 \sin \theta = \rho a V_1^2 \sin \theta$$

$$F_x = F_N \sin \theta = \rho a V_1^2 \sin^2 \theta$$

$$F_y = F_N \cos \theta = \rho a V_1^2 \sin \theta \cdot \cos \theta$$

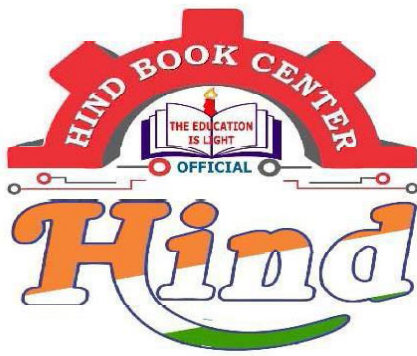
$$\dot{m}_1, \dot{m}_2 / \varphi_1, \varphi_2 = ?$$

$$\therefore \boxed{F_T = 0}$$

$$\rightarrow \dot{m} V_1 \cos \theta - (\dot{m}_1 x_0 + \dot{m}_2 (-x_0)) = 0$$

$$\varphi \cos \theta - \varphi_1 + \varphi_2 = 0 \rightarrow (11)$$

$$\varphi = \varphi_1 + \varphi_2 \rightarrow (1)$$



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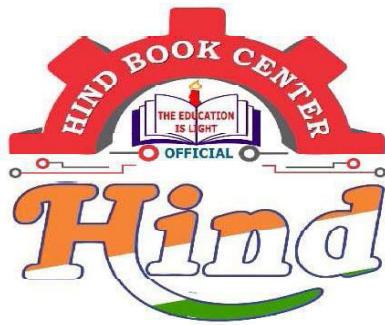
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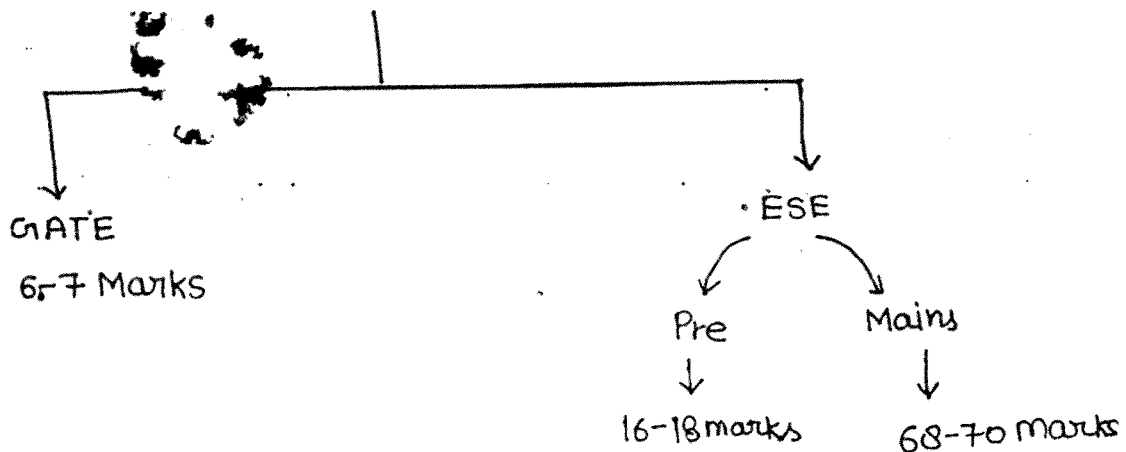
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(or)

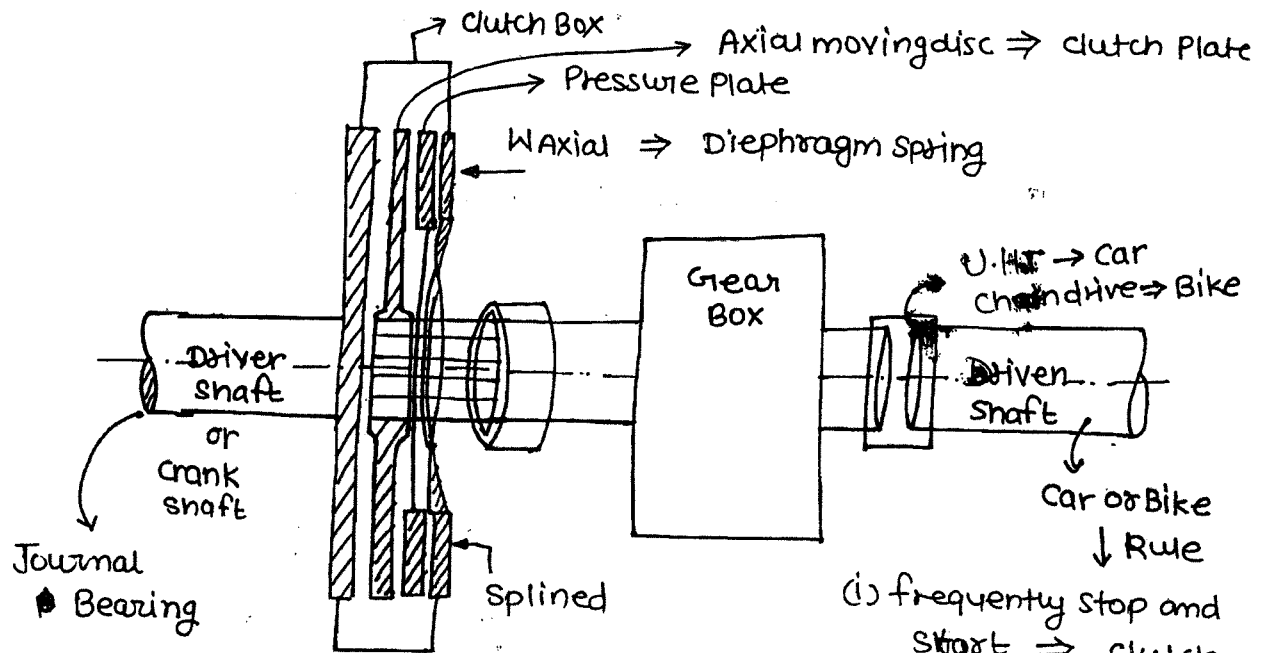
DESIGN OF MACHINE ELEMENT (DME)



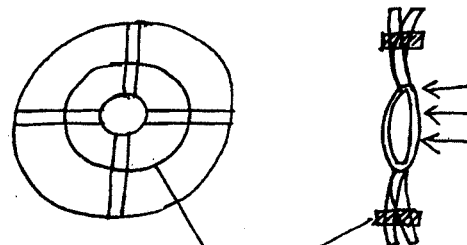
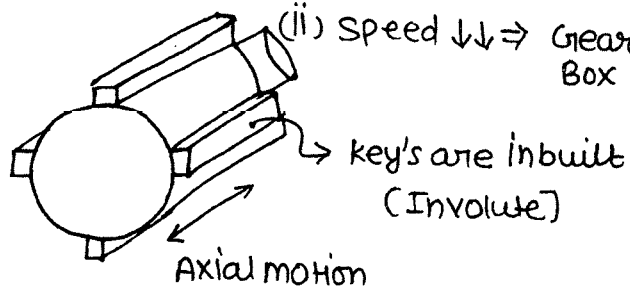
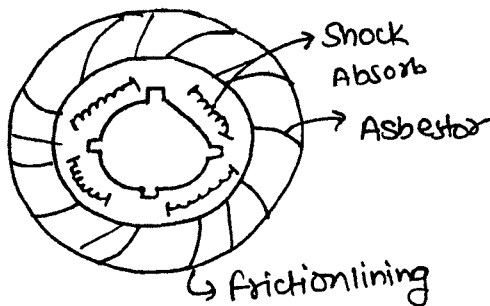
- (i) clutches
- (ii) Brakes
- (iii) Gear $\Rightarrow$ (spur Gear)
- (iv) Riveted Joint
- (v) Bolted Joint
- (vi) Welded Joint
- (vii) Bearing
- (viii) Fatigue design of shaft
- (ix) Spring
- (x) Design of flywheel [only ESE]

clutch:→

It is defined as a machine element which is use to engage and disengage driver and the driven shaft at the wheel without stopping the prime mover.



- (1) Run continuously
- (1) Speed ↑↑



Q Why clutches are Prefer at High speed side

Ans → Power = $T_f \times \omega$ ↑↑↑
High speed

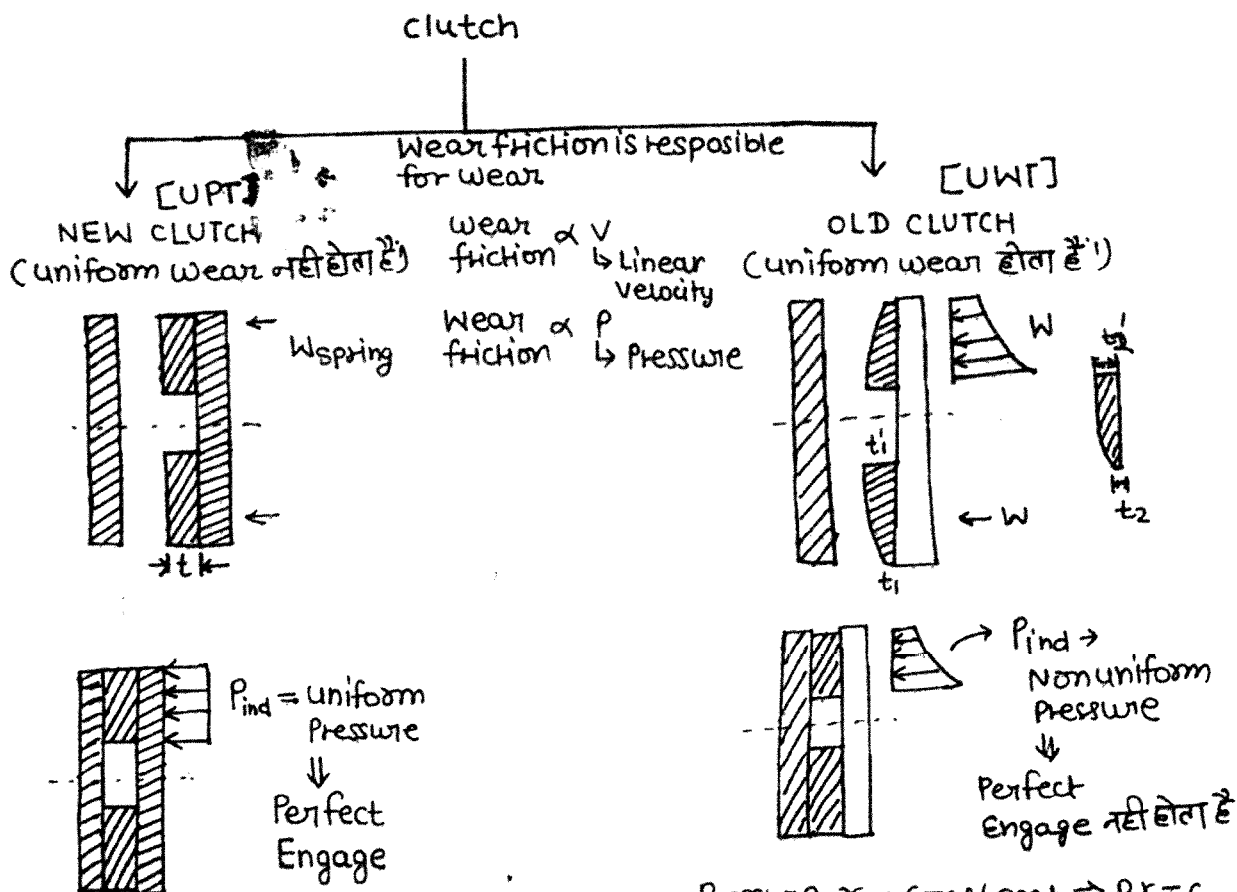
$T_f \rightarrow$ Required torque Less

↓
Clutch design Simple

→ To minimize wear and losses
clutch @ Low speed side

Power = $T_f \cdot \omega$ ↓↓↓

↓
(Torque Required will be more)



Pressure $\cdot r = \text{constant} \Rightarrow P \cdot r = C$
wear friction = constant

↓
uniform wear Theory (UWT)

$$\int_{R_i}^{R_o} 2\pi r P \cdot dr = \int dw$$

$$2\pi \int_{R_i}^{R_o} \frac{C}{r} \cdot dr = W \Rightarrow C = \frac{W}{2\pi (R_o - R_i)}$$

$$P_{ind} = \frac{W}{2\pi r (R_o - R_i)}$$

$$t - t_1 > t - t_1', \quad t_1 - t_2 = t_2 - t_2'$$

For safe condⁿ

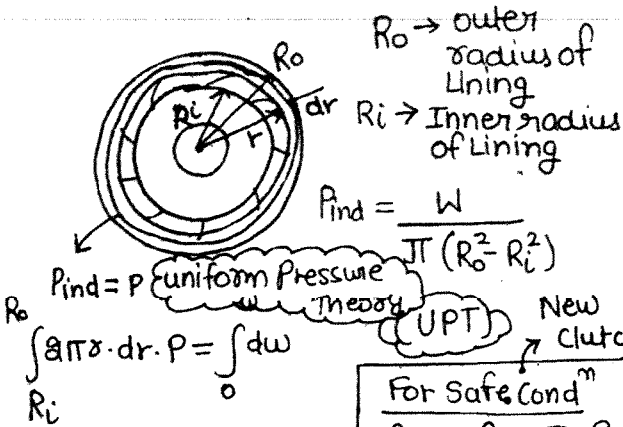
$$(P_{ind})_{max} \leq P_{per}$$

$$\uparrow P_{ind} = \frac{W}{2\pi r (R_o - R_i)}$$

$$(P_{ind})_{max} = \frac{W}{2\pi R_i (R_o - R_i)}$$

$$\frac{W}{2\pi R_i (R_o - R_i)} \leq P_{per}$$

$$W_{max} = 2\pi R_i (R_o - R_i) P_{per}$$



$$P_{ind} = \frac{W}{\pi (R_o^2 - R_i^2)}$$

For safe condⁿ

$$P_{ind} \leq P_{per} \text{ (or) } P_{allow}$$

$$\frac{W}{\pi (R_o^2 - R_i^2)} \leq P_{per}$$

$W_{max} = \pi (R_o^2 - R_i^2) P_{per} \rightarrow$ Strength of New Lining in terms of Load

New clutch
Frictional torque

$$F_r = \mu R_N = \mu dW = 2\pi r dr \cdot p \cdot \mu$$

$$\int_{R_i}^{R_o} dT_f = \int_{R_i}^{R_o} 2\pi \mu p r^2 dr = 2\pi \mu p \int_{R_i}^{R_o} r^2 dr$$

$$T_{f_{\max}} = \frac{2}{3} \mu \pi p_{\text{per}} (R_o^3 - R_i^3)$$

old clutch

$$\int dT_f = \int 2\pi \mu \cdot p \cdot r^2 dr$$

$$T_f = 2\pi \mu \int_{R_i}^{R_o} \frac{c}{r} \cdot r^2 dr$$

$$T_f = \pi \mu c (R_o^2 - R_i^2)$$

$$c = \frac{W}{2\pi (R_o - R_i)}$$

$$T_{f_{\max}} = \mu W_{\max} \left(\frac{R_o + R_i}{2} \right)$$

$$T_{f_{\max}} = \mu \pi p_{\text{per}} R_i (R_o^2 - R_i^2)$$

NEW CLUTCH $\Rightarrow$ U.P.T

$$\downarrow$$

$$p_{\text{ind}} = c$$

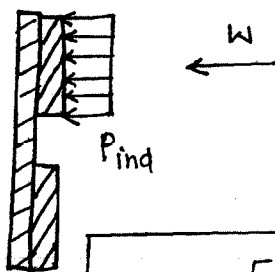
$$p_{\text{ind}} = \frac{W}{\pi (R_o^2 - R_i^2)}$$

Safe condition

$$p_{\text{ind}} \leq p_{\text{per}}$$

$$W_{\max} = \pi (R_o^2 - R_i^2) p_{\text{per}}$$

$$T_{f_{\max}} = \frac{2}{3} \mu \pi p_{\text{per}} (R_o^3 - R_i^3)$$



$$R_{\text{eff}} = \frac{2}{3} \left[\frac{R_o^3 - R_i^3}{R_o^2 - R_i^2} \right]$$

OLD CLUTCH $\Rightarrow$ U.W.T

$$\downarrow$$

$$p \cdot r = c$$

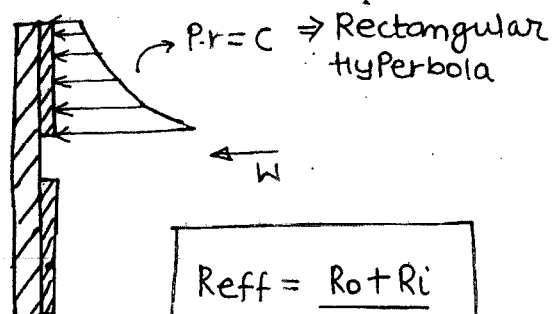
$$p_{\text{ind}} = \frac{W}{2\pi r (R_o - R_i)}$$

Safe condition

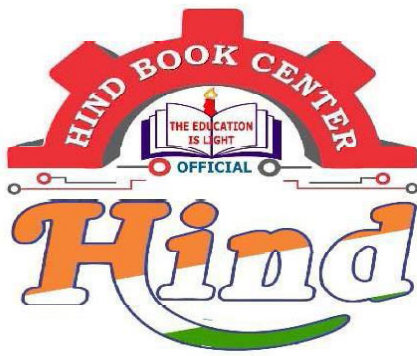
$$(p_{\text{ind}})_{\max} \leq p_{\text{per}}$$

$$W_{\max} = 2\pi R_i (R_o - R_i) p_{\text{per}}$$

$$T_{f_{\max}} = \mu \pi p_{\text{per}} (R_o^2 - R_i^2)$$



$$R_{\text{eff}} = \frac{R_o + R_i}{2}$$



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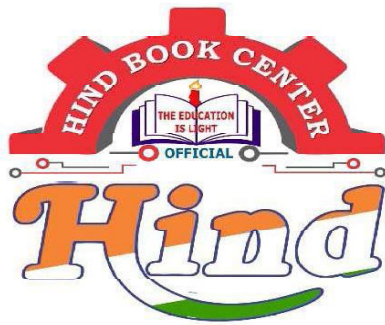
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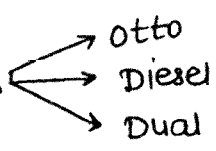
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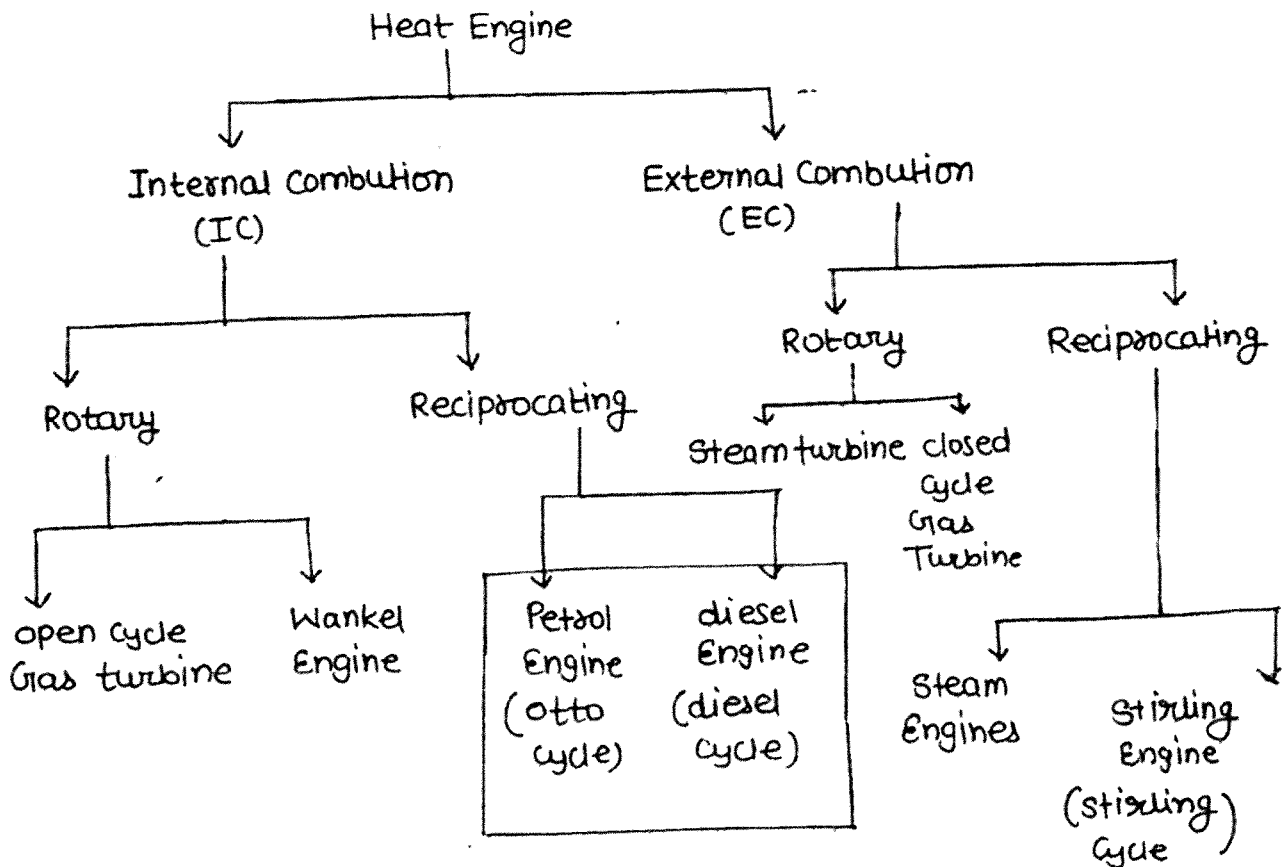
IC ENGINE

Books :

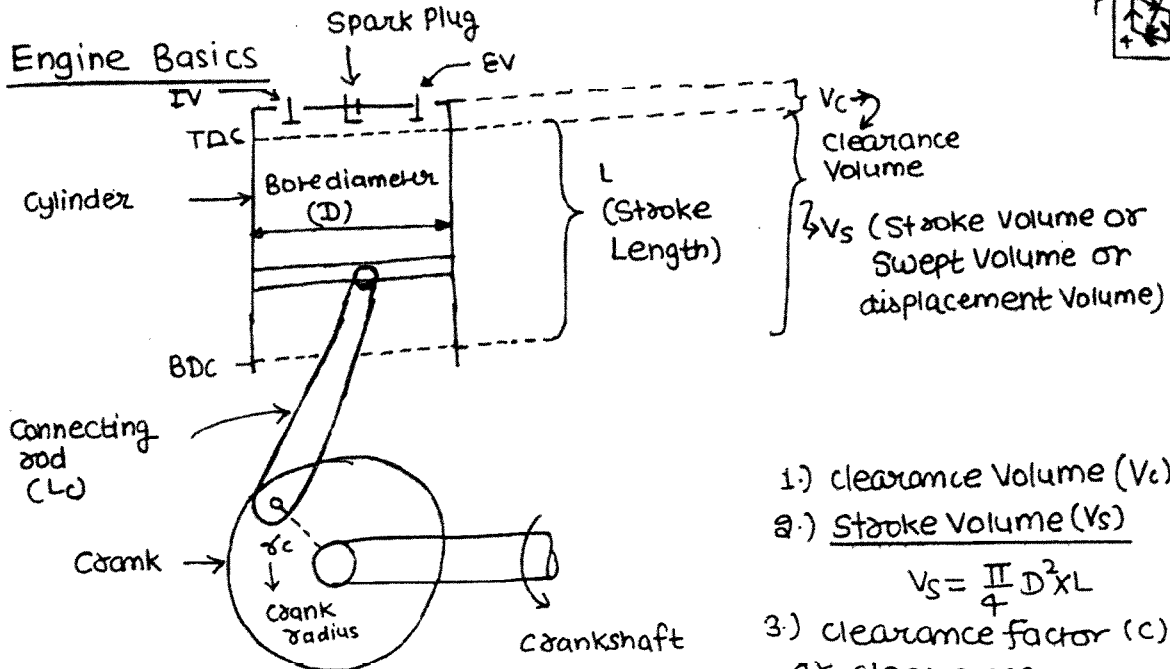
- V. Ganeshan
- Mathur and sharma

- (i) Engine Basics
- (ii) Air Standard cycles 
 - Otto
 - Diesel
 - Dual
- (iii) Thermochemistry
- (iv) Performance Parameters
- (v) Engine tests

Various types of Engines:→



• Engine Basics



NOTE:→

IV : Inlet Valve
 EV : Exhaust Valve
 TDC : Top dead Centre
 BDC : Bottom dead centre

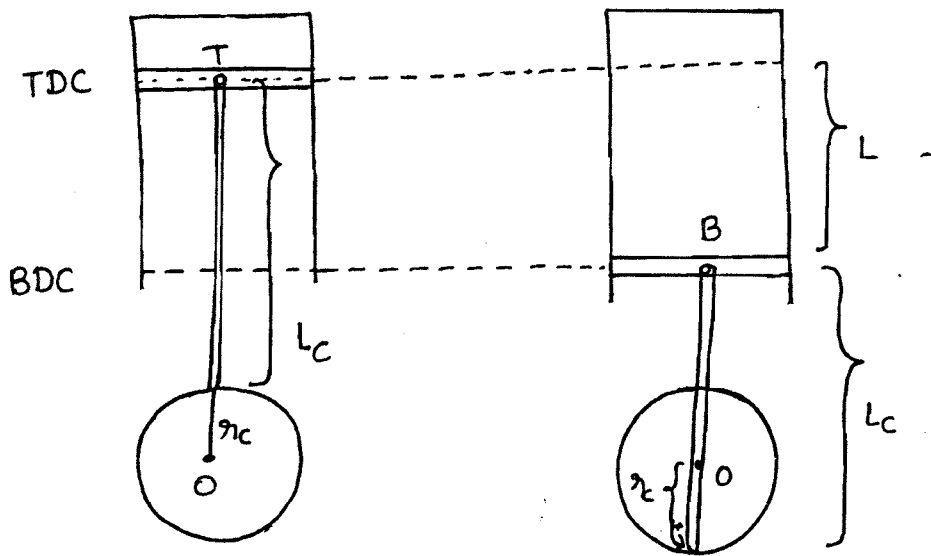
- 1) clearance Volume (V_c)
- 2) Stroke Volume (V_s)

$$V_s = \frac{\pi}{4} D^2 L$$

- 3) clearance factor (c)
 or clearance ratio
 or clearance Volume ratio

$$C = \frac{V_c}{V_s}^*$$

$$4.) L = 2r_c$$



$$L = OT - OB$$

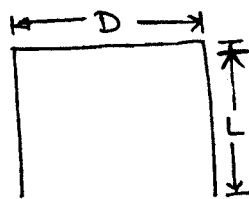
$$= (L_c + r_c) - (L_c - r_c)$$

$$L = 2r_c$$

(5) Average Piston Velocity ($\bar{V}_p$)

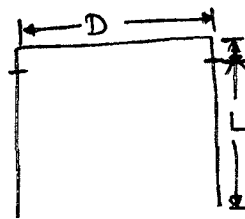
$$\bar{V}_p = \underbrace{2L}_{\text{dis/rev.}} \times \underbrace{\frac{N}{60}}_{\text{rpm}} = \frac{2L \times N}{60} \text{ rev/sec}$$

(6)



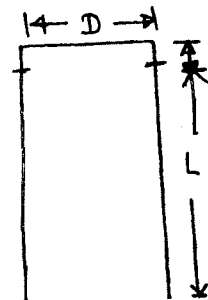
oversquare or
Short stroke

$$\frac{D}{L} > 1$$



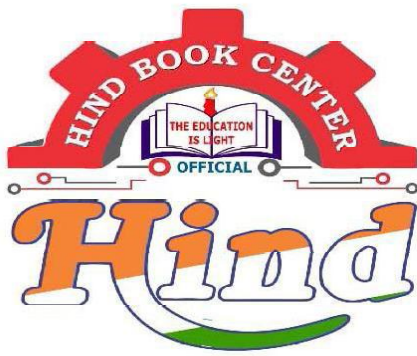
Square
engine

$$\frac{D}{L} = 1$$



Under or Long
square stroke

$$\frac{D}{L} < 1$$



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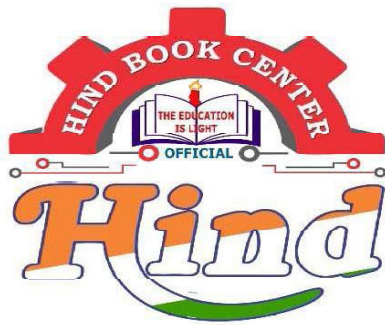
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Refrigerator and Air Conditioning

Basic Concept

VCRS

Ref

VARs

RBC

Ref Equipment

Books: CP Appa

PL Ball

Psychrometry

Summer & Winter AC

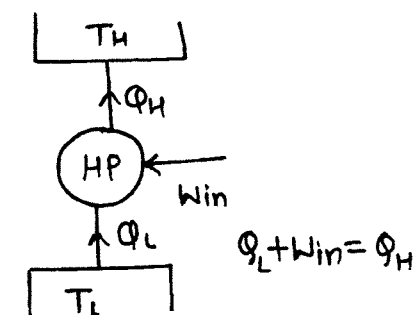
BASIC CONCEPTS

- Refrigeration Effect :- It is the amount of heat which is required to extract from the storage space in order to provide & maintain lower temperature than that of surroundings.

Refrigerant $\rightarrow$ It is the working fluid or working substance which is used to extract the heat from the storage space

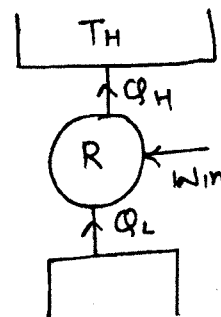
COP $\rightarrow$ Coefficient of Performance or Energy Performance or EPR ratio $\rightarrow$

$$\boxed{COP = \frac{DE}{W_{in}}}$$



$$\boxed{(COP)_{HP} = \frac{Q_H}{Q_H - Q_L}} \quad \text{Actual}$$

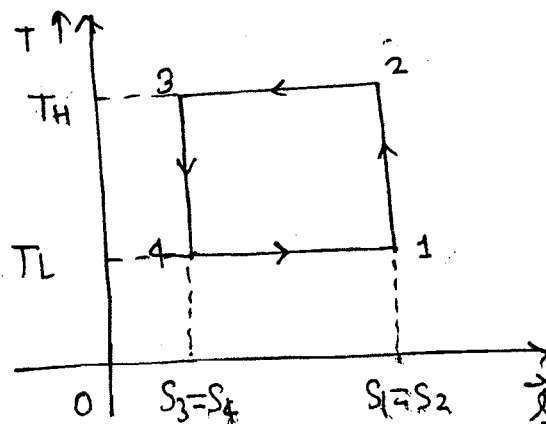
$$\boxed{(COP_{HP})_{ideal} = \frac{T_H}{T_H - T_L}}$$



$$\boxed{(COP)_R = \frac{Q_L}{Q_H - Q_L}} \quad \text{Actual}$$

$$\boxed{(COP_R)_{ideal} = \frac{T_L}{T_H - T_L}}$$

- Ideal Refrigeration Cycle or Reversed Carnot Cycle $\rightarrow$



Process 1-2 Rev. adiabatic compression

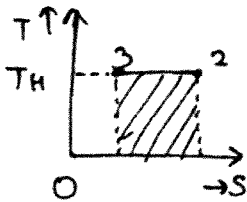
Process 2-3 Isothermal Heat rejection

3-4 Isentropic Expansion

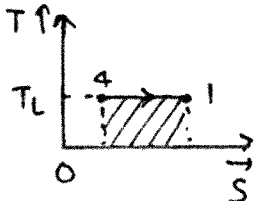
4-1 Isothermal heat addition

$$\text{COP} = \frac{DE}{W_{\text{NET}}}$$

$$W_{\text{Net}} = Q_{\text{Net}} = \cancel{Q_{1-2}} + Q_{2-3} + \cancel{Q_{3-4}} + Q_{4-1}$$



$$dQ_{2-3} = T(S_F - S_I) = T_H(S_3 - S_2) = -T_H(S_1 - S_4) \quad \text{--- (2)}$$



$$dQ_{4-1} = T_L(S_1 - S_4) \quad \text{--- (3)}$$

Use eqⁿ (2) & (3) in eqⁿ (1)

$$W_{\text{Net}} = Q_{\text{Net}} = -T_H(S_1 - S_4) + T_L(S_1 - S_4)$$

$$W_{\text{Net}} = Q_{\text{Net}} = (T_L - T_H)(S_1 - S_4) \quad \text{--- (4)}$$

$$W_{\text{Net}} = \text{-ive}$$

From eqⁿ (4) we can say that our system under consideration is a work absorbing device.

$$W_{\text{Input}} = (T_H - T_L)(S_1 - S_4)$$

$$\text{COP} = \frac{DE \rightarrow Q_{4-1} = T_L(S_1 - S_4)}{(T_H - T_L)(S_1 - S_4)}$$

$$\text{COP} = \frac{T_L}{T_H - T_L}$$

NOTE:-

1. Reversed Carnot COP is a function of temp. limits only
2. If there are 'n' number of Rev. Refrigerator are operating between same temp. limits with different working fluids, then the value of max. possible COP or Ideal COP or Reversed Carnot COP are having same value.
3. Reversed Carnot COP is independent of working fluid
4. Producing Ice at 0°C

(a) $(\text{COP})_{\text{summer}} > (\text{COP})_{\text{winter}}$

~~(b) $(\text{COP})_s < (\text{COP})_w$~~

(c) $(\text{COP})_s = (\text{COP})_w$

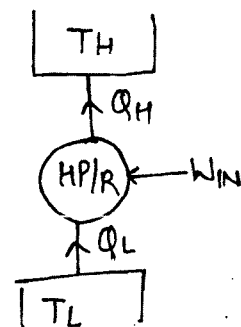
(d) Can't say

Summer	Winter
$T_L = 0^{\circ}\text{C}$	$T_L = 0^{\circ}\text{C}$
$T_H = 30^{\circ}\text{C}$	$T_H = 10^{\circ}\text{C}$
$T_L = \text{constant}$	
$(\text{COP})_s < (\text{COP})_w$	
$(T_H)_s > (T_H)_w$	

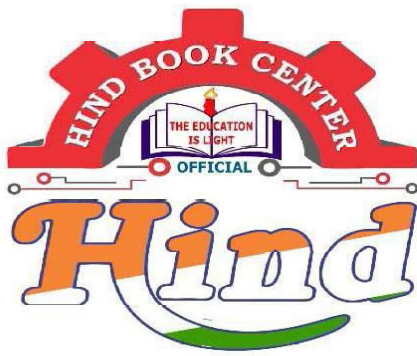
Relationship between Heat Pump COP & COP of Refrigerator: $\rightarrow$

$$\boxed{\text{COP}_{\text{HP}} = \text{COP}_R + 1}$$

$$1 + \text{COP}_R = \frac{T_L}{T_H - T_L} + 1 = \text{COP}_{\text{HP}}$$



The above expression is applicable b/w same temp. limits



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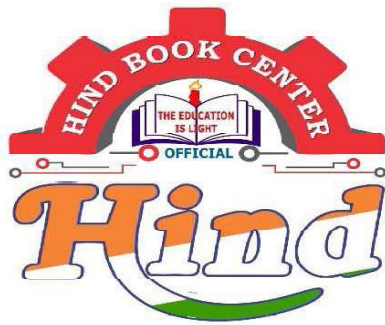
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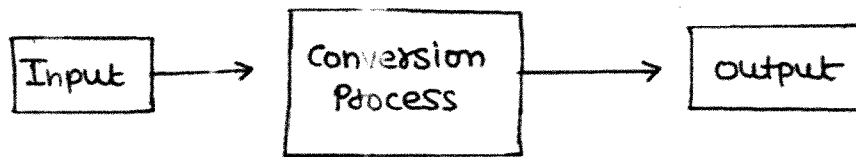
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Kanti Swarup
or
ND Vohra

→ For
OR

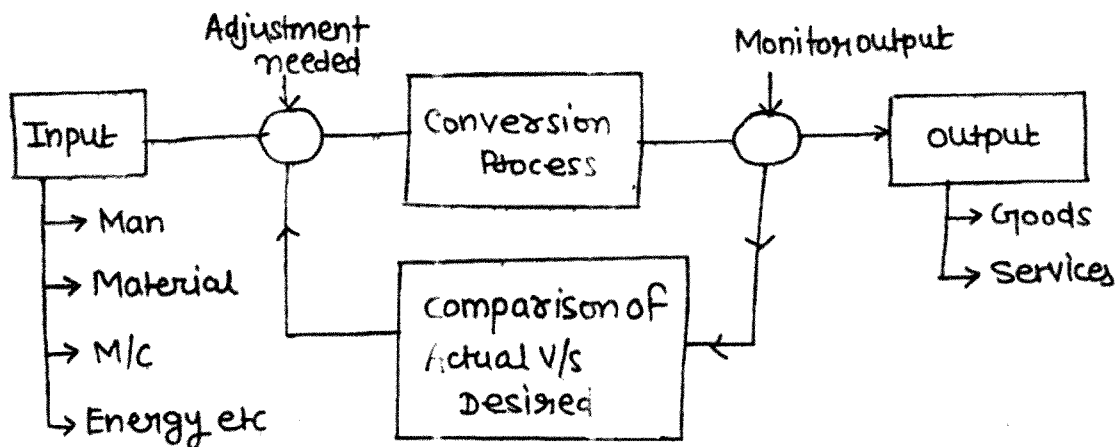
O.P. Khanna
or
Mahajan
or
Ravi Shankar

→ IE

Production: → It is a step by step value addition process of converting one form of material into another form to increase a utility of the product for the user.



Production System: → It is an organised and effective process of converting Raw Material into final product with a feedback loop.



Productivity: →
$$\text{Productivity} = \frac{\text{Output}}{\text{Input}}$$

It is a quantitative ratio b/w what we produce and what we use as resources to produce them. Every organization always wants to increase productivity by applying new technique and method.

Industrial Engineer: →

Industrial Engineer will be concerned with design, installation and improvement of production system, his objective is to eliminate unproductive operations from the production system in order to increase productivity.

Production Manager: → Production manager is concerned with planning, controlling and directing the day to day working of production system. His objective is to produce goods & services of high quality and quantity at predetermined time and cost.

• Cost in Production: →

1. Prime or direct Cost = Direct Material + Direct Labour + Direct Expenses

2. Factory overhead or Factory Expenses = Indirect Material + Indirect Labour + Indirect Expenses

→ cutting fluid,
→ Grease, Lubricants,
→ Cotton, Jute, Stationary
items etc

→ Watchman,
Supervisor,
Higher
officers
etc.

→ Land, Rent
Telephone
bills,
facility
development,
electricity bills
etc.

3. Factory Cost = Prime Cost + Factory overhead.

4. Total Cost = Factory Cost + Marketing, Advertising, transportation cost
etc.

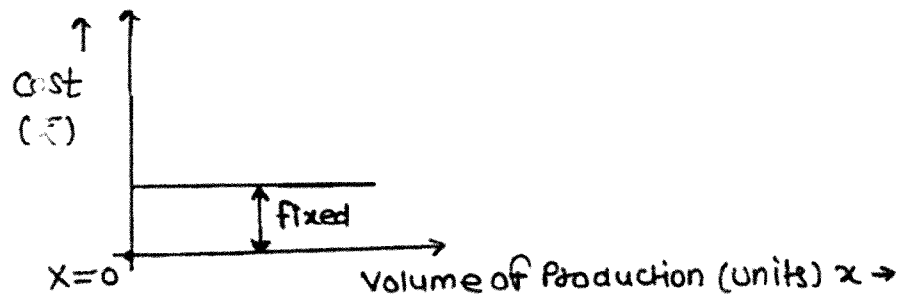
5. Selling Cost = Total Cost + Profit

BREAK EVEN ANALYSIS (BEA):→

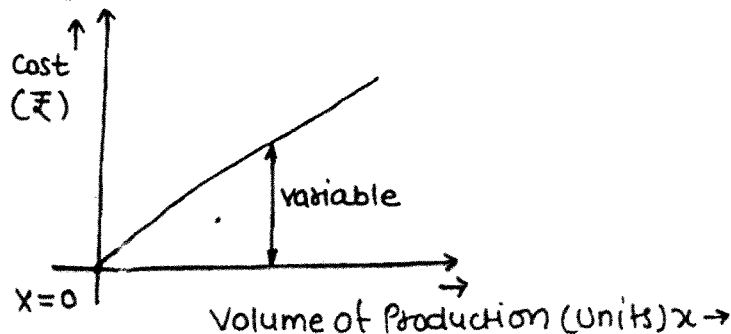
Total Cost , Selling Cost , Volume of Production

It is an important tool used by Production manager to Analysis the Potential Profit or loss Possible in future

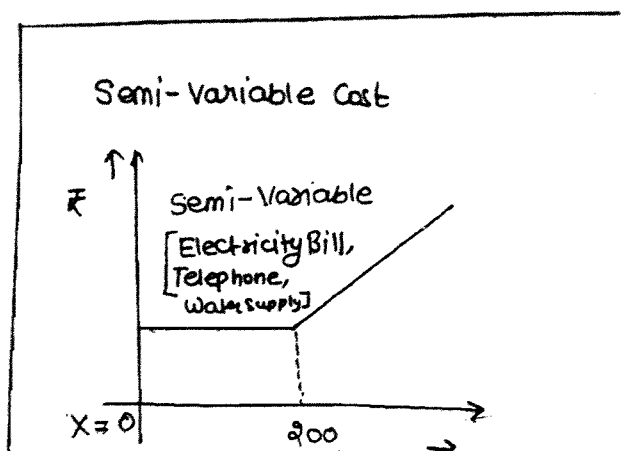
1. Total Cost → It indicates expenditure required in order to Produce Certain number of unit and it is a Sum of Fixed and Variable cost



- Fixed Cost → this cost remains constant or fixed irrespective of Volume of Production. it include cost of Machine, equipment, Salary of Watchman, Higher officers, rent of Store Room, ware-house, Advertisement Cost, Set-up cost, insurance cost, interest etc
- Variable Cost → ($V = V \cdot x$)



This cost increases directly and Proportionally with the Volume of Production. it include direct material, direct labour and running cost.



• Notations →

F → Fixed cost in ₹

x → No. of units produced or Volume of Production

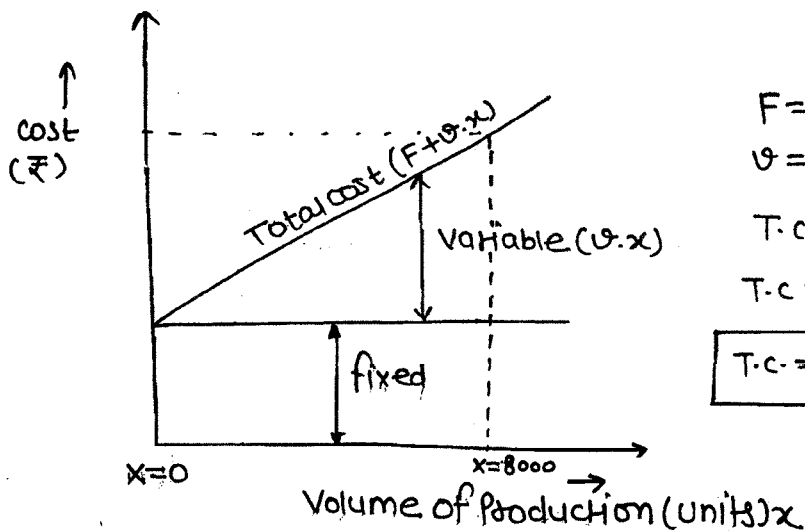
ϑ → Variable cost Per unit (₹/unit)

V → Total variable cost in ₹
 $\vartheta \cdot x$

s → Selling cost Per unit (₹/unit)

S → Total Sales or revenue in ₹
 $s \cdot x$

• Total Cost : →



$$F = 25000 \text{ ₹}$$

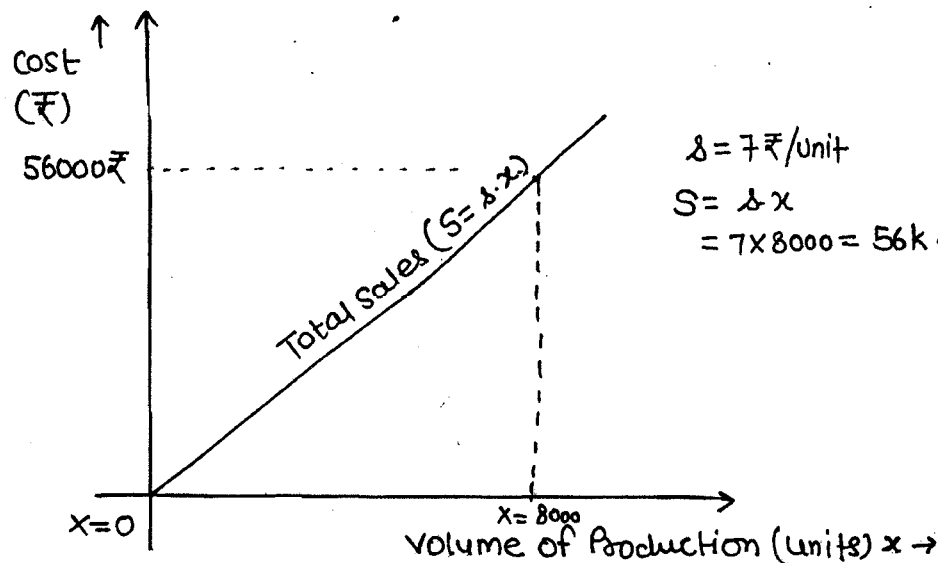
$$\vartheta = 3 \text{ ₹/unit}$$

$$T.C. = F + \vartheta \cdot x$$

$$T.C. = 25000 + 24000$$

$$T.C. = 49000 \text{ ₹}$$

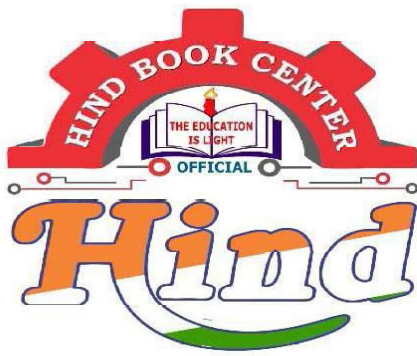
• Total Sales ($S = s \cdot x$) : →



$$s = 7 \text{ ₹/unit}$$

$$S = s \cdot x$$

$$= 7 \times 8000 = 56 \text{ k ₹}$$



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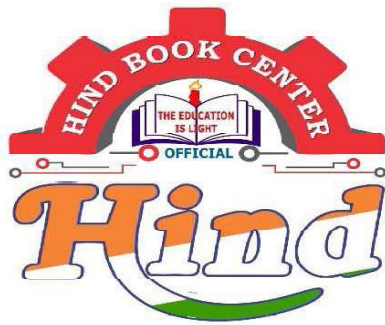
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THEORY OF MACHINES

- : By

AMIT KAKKAR SIR

Amit Kakkar Speaks (Telegram
channel)
(YOUTUBE)
channel

• 3-Points [ways to making Easy Life]

1. Have some Patience
2. कुछ बर्दाश्त करना है।
3. बहुत कुछ नजरअंदाज करना है।

- Syllabus [Gate, ESE, ISRO, DRDO, BARC....]
↓
TOM

Kinematics of machines

kinetics (dynamics) of machine

Mechanical Vibrations

1. Simple Mechanism

2. Motion Analysis

↳ Velocity Analysis

- I-centre method
- Relative Velocity method

↳ Acceleration Analysis

3. Gears

4. Gear Trains

5. Governors

6. Motion Analysis of single-slider crank Mechanism

7. Flywheels

8. Balancing

9. Gyroscope

• Mechanical Vibrations

• CAM & FOLLOWERS

Mechanical Engineering

↓
Engg. of Mechanics

↓
Study of Motion (DYNAMICS)

(kinematics) ↓

Study of motion without considering the basic cause of motion i.e. force

$$\vec{V} = \frac{d\vec{s}}{dt}$$

$$\vec{a} = \frac{d\vec{V}}{dt}$$

$$\vec{j} = \frac{d\vec{a}}{dt}$$

• Text Book

→ S.S. Rattan

→ Prof V.P. Singh

• Reference Book (For Teachers)

→ Shigley

→ Norton

→ Thomas Beven

↓ (kinetics)

Study of motion with the considering the basic cause of motion i.e. force.

Dynamics viscosity (μ) → $\frac{N-s}{m^2}$

Kinematic viscosity (ν) = $\frac{\mu}{\rho}$
 $= \frac{m^2}{s}$

• Weightage of TOM :→

GATE → Min 8 marks from TOM

ESE

↳ Prelims : (22-30) Questions of TOM
(150 Total Questions)

↳ Mains : min. 125 marks of TOM
(300 marks of Paper-II)

After Learning Concepts

SIMPLE MECHANISM : →

- Kinematic Link / Link / Element / Member : →

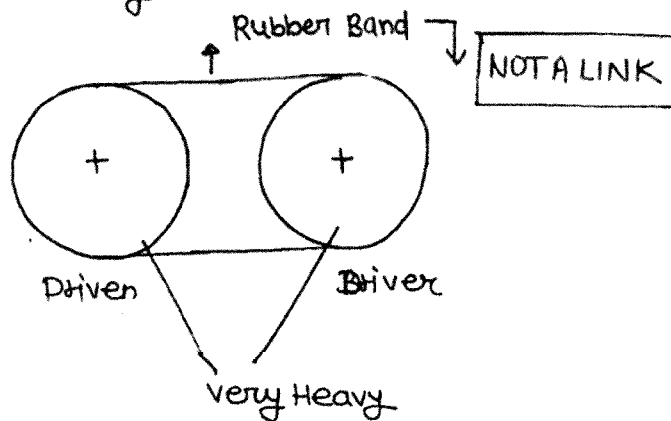
"Every Part of a machine which is having some relative motion w.r.t. some other parts will be known as Kinematic Link / Link / Element / member."

It is necessary for the Link to be a Resistant Body so that it is capable of transmitting power and motion from one element to the other element.

Whether a Body is working like Resistant Body or not, it depends upon

- (i) Body itself
- (ii) it's Surrounding

for eg



• Types of Links : →

1. Rigid Link → Deformation are Negligible as Compared to the size of the Link.

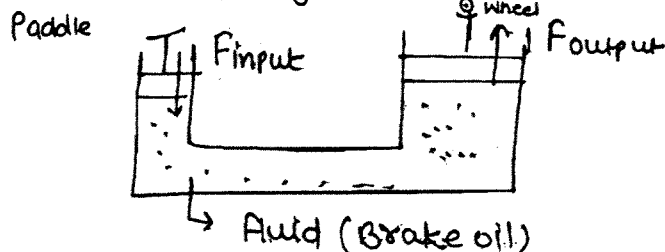
for eg: crank, Connecting Rod, piston, cylinder etc.

2. Flexible Link → Deformations are not Negligible as Compared to the size of the ~~link~~ Body (Link).

for eg: Belt, Rope, chain drives.

3. Fluid Link → (Liquid, Gas) →

For eg. Hydraulic Brakes



When Power is transmitted because of fluid Pressure.

other eg: →

- Hydraulic Ram
- Hydraulic Lift
- Hydraulic Jack
- Hydraulic crane

• Different types of [Relative motion]: →

↓
System will be having
Two Links

only those two Links will be the Part of system in blw
Relative motion is observed.

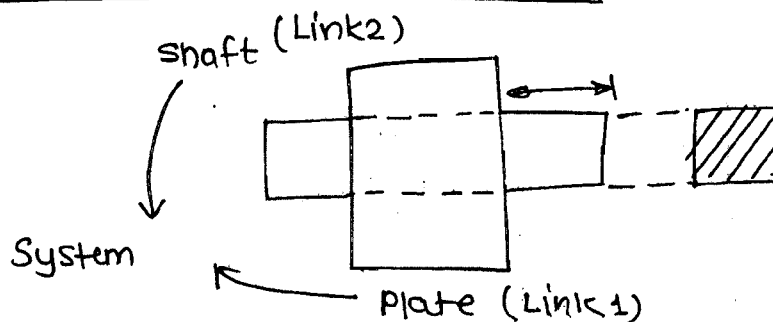
- | | |
|-----------------------------------|---|
| • completely constrained motion |] Constrained motion
↓
(desired motion)
↓
one & only one output |
| • Successfully constrained motion | |
| • Incompletely constrained motion |] unconstrained motion
↓
(Undesired motion output) |

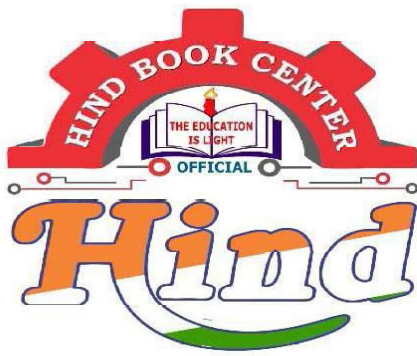
• Completely constrained motion: →

motion is getting constrained by its own Properties
(By system)

For Eg

1. Square shaft in Square hole: →





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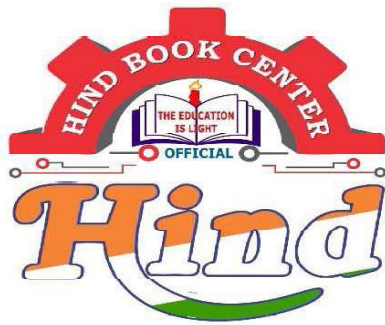
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Heat Transfer

- Introduction to Heat Transfer
- Thermal conduction
 - Basic of Thermal Conduction
 - Steady state 1-D Thermal conduction
 - ↳ Without heat Generation
 - ↳ With heat Generation
 - conduction through Extended Surfaces (Fins)
 - unsteady-state Heat conduction
- Thermal Radiation
 - Basics of Radiation
 - Solid angle concept
 - Shape factor concept
 - Radiative heat transfer
- Heat Exchanger (DEVICE) Application
- Thermal Convection
 - forced Convection (External flow)
 - forced Convection (Internal flow)
 - free (Natural convection)
External flow

GATE ⇒ min 5 to 6 marks

ESE ⇒ Prelims : (15-20) questions of HT
150 questions

main :- (60-70) marks out of 300

Text Books

1. R. C. Sachdeva
2. P. K. Nag

Ref. Book

1. Incropera & Dewitt
 2. Cengel
- } for Ref. only

Worksheet → Telegram (AMIT KAKKAR SPEAKS)
↓ (Sir) ←

Workbook

↓
GATE (PYQ)

↓
ESE

↓
Any Text Book

Thermodynamics: →

This course is dealing with thermodynamic system b/w two equilibrium states i.e. we are able to calculate the energy transfer in forms of Heat or work during the process (change in equilibrium state)

But thermodynamics unable to tell about time consumed during the process this is because thermodynamics is not dealing with mechanism of heat transfer.

Where mechanism of Heat transfer is clear then we can also calculate the time involved during the process therefore "when the time associated in study of energy transfer then we study heat transfer course."

As well as this course helps in designing of different equipments like Refrigerator, air conditioner or any Heat Exchanger like boiler, condenser, Radiator, evaporator, Economiser to achieve a desire heat transfer rate under given temp. different

• Introduction to heat transfer.

• Basic Cause of heat transfer : →

Basic Cause of heat transfer existance of temperature different.

whenever the difference of temp. exist within the medium or between media, heat transfer takes place. It always takes place from High temp. to Low temperature

• Different mechanisms of heat transfer : →

Heat transfer takes place by three different mechanisms

- (I) Thermal Conduction
- (II) Thermal convection
- (III) Thermal Radiation

• Symbols in heat transfer →

$\Phi =$ Heat transfer $\Rightarrow$ Unit = J

$q =$ Rate of Heat transfer $\Rightarrow$ unit = J/sec (W)

$q'' =$ Rate of Heat flux $\Rightarrow$ unit = W/m²

$Q \rightarrow$ Total heat transfer Per sec

$q'' \rightarrow$ Local Heat transfer Per sec

(Rate of Heat transfer Per unit Area)

• Thermal conduction

Heat Transfer due to temp. difference through the stationary medium or b/w the media.

No Bulk Motion (No Flow)

Conduction is there

- Gases
- Liquids
- Solids

* Root cause: →

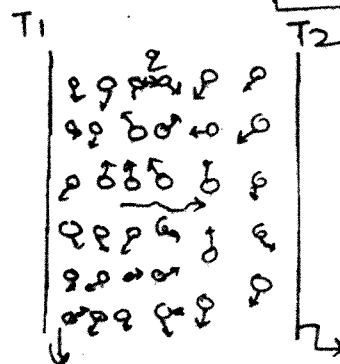
• In Gases

↳ molecules are in Random motion

↳ Random Translation ⇒ Highly dominating
Random Rotation
Random vibration

Root cause mean square speed

$$V_{rms} \propto \sqrt{T}$$



High Energy molecules

Low Energy molecules

$$T_1 > T_2$$

↓
Basic Cause of Conduction
⇒ Collision b/w molecule

Sum is known as
Total molecular energy

• In Liquids ⇒ By Collision b/w the molecules

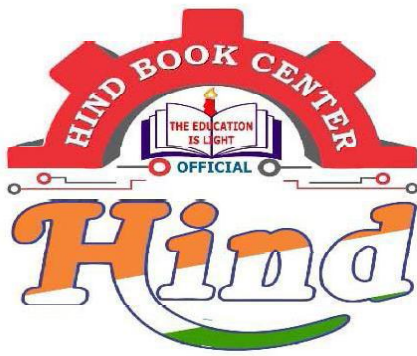
• In Solids ⇒ By Lattice vibrations

In metals or metal alloy ⇒

one more reason



By motion of free electron



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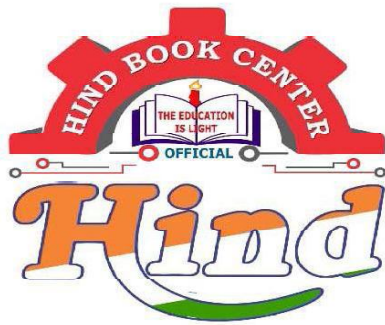
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Thermodynamics

Books : Cengel & Boles $\Rightarrow$ Theory
P.K. Nag $\Rightarrow$ Questions

Questions $\leftarrow$ Work Book $\begin{matrix} \rightarrow \text{Class} \\ \rightarrow \text{Gr drive} \end{matrix}$
 $\rightarrow$ Theory Book

- $\rightarrow$ GATE Previous Year
- $\rightarrow$ ESE PYQ (5 Year)
- $\rightarrow$ GATE OTS

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P-224
Q8, Q9

"Reversible & Irreversible"

$\rightarrow$ Video
Pme

Youtube

Amrinder Sir entropy

"Civil Services questions"

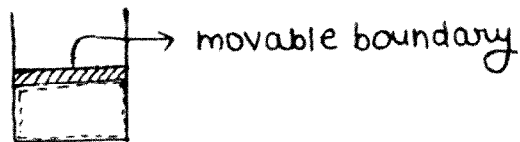


* Thermodynamics -

It is a branch of science which deals with energy interaction and its effect on system and surrounding.

→ Energy - It is the Ability to Cause changes.

→ System - It is a fixed mass (control mass) system or a region in a space (control volume) where our study is focused.

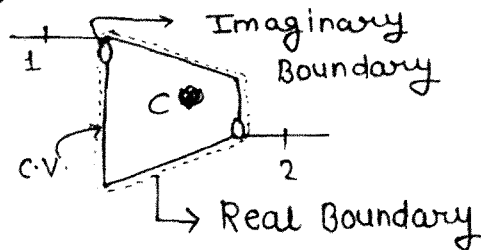


→ Surrounding - Everything except the system becomes surrounding.

- The Part of surrounding which is directly affected by the system is called Immediate surrounding.

→ Boundary - It is a real or imaginary surface which separates the system from the surrounding.

Boundary can be fixed or movable.

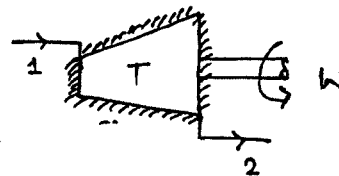


Type of System:→

Type of system	Mass	Energy	Example
1. closed	X	✓	Piston cylinder without valves
2. open	✓	✓	Piston cylinder with valves
3. Isolated	X	X	Perfectly insulated thermos universe

	Mass	Work	Heat
Insulated	✓	✓	x
Isolated	x	x	x

eg. insulated turbine



• Properties of the System : →

Any characteristics of the system is called as the Property of the system. and the Properties can be classified as :

1. Intensive (Intrinsic) : →

Independent of mass of the system under consideration.

eg. P, T, ρ, μ , velocity (c), thermal conductivity (k)

NOTE: All specific Properties are intensive Properties,
eg. h, s, u, w, z, C
specific heat

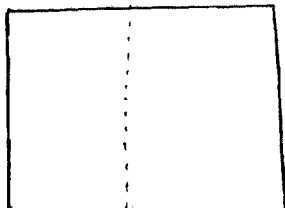
2. Extensive (Extrinsic) : →

Depense of mass of the system Under consideration.

eg. E, V, m , Entropy, Enthalpy, Internal Energy

$$C_{rms}^2 < T$$

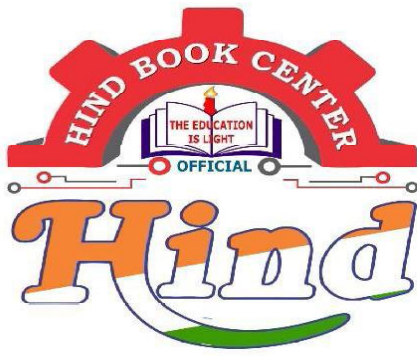
$$\frac{1}{2} m_1 c_1^2 + \frac{1}{2} m_2 c_2^2 + \dots = \frac{1}{2} \sum m c_{rms}^2$$



$$P_L = P$$

$$T_L = T$$

$$V_L = V/2$$



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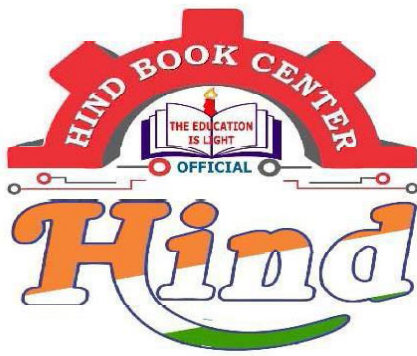
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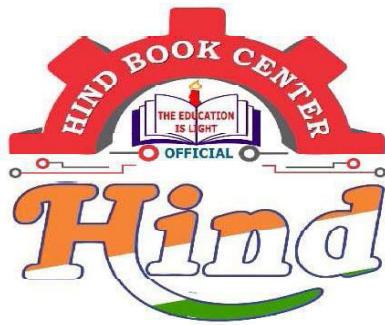
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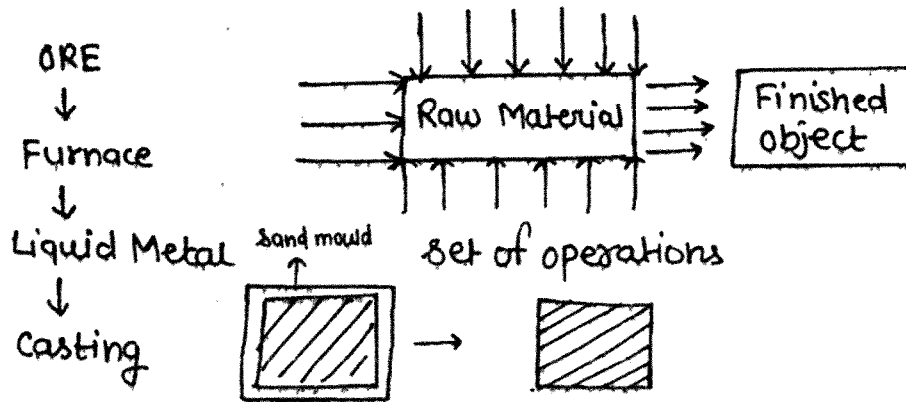
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• Manufacturing Process :→

Manufacturing :→ It is a process of converting raw material into a finished product.

It is a process of value addition to raw material such that final object is having more value in market when compare to raw material.



• Classification of Manufacturing Process :→

1. Casting
2. Forming
3. Fabrication Process
4. Material removal Process

A. zero Process

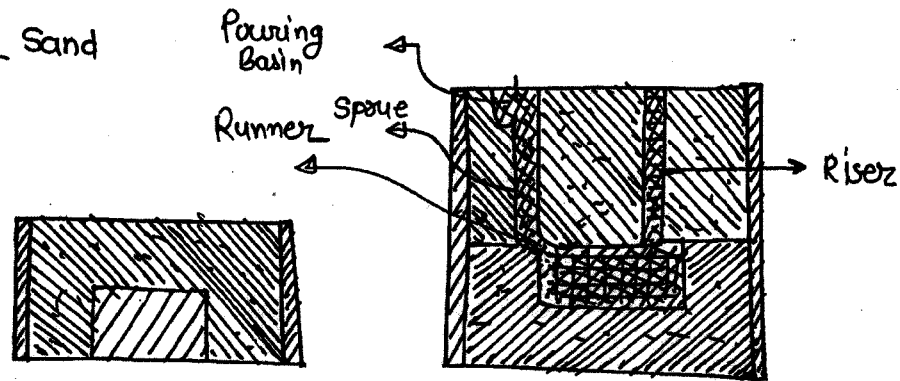
B. Additive Process

C. Subtractive Process

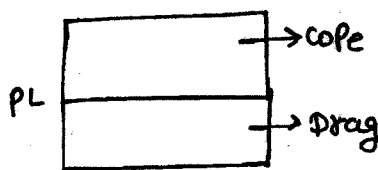
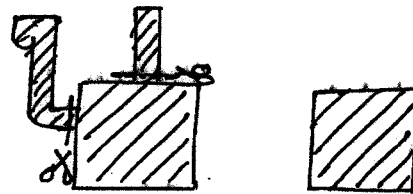
casting → It is a process in which molten liquid metal is allowed to solidify in a predefined mould cavity.

After solidification by breaking the mould required shape of the object is produced.

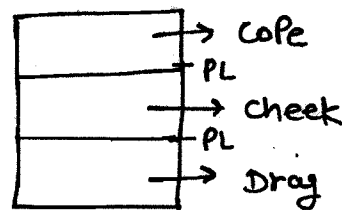
1. Pattern
2. Moulding Sand
3. Tools



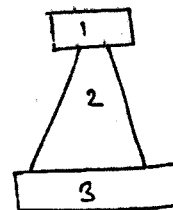
draw spike



Two Box



Three Box



Advantages →

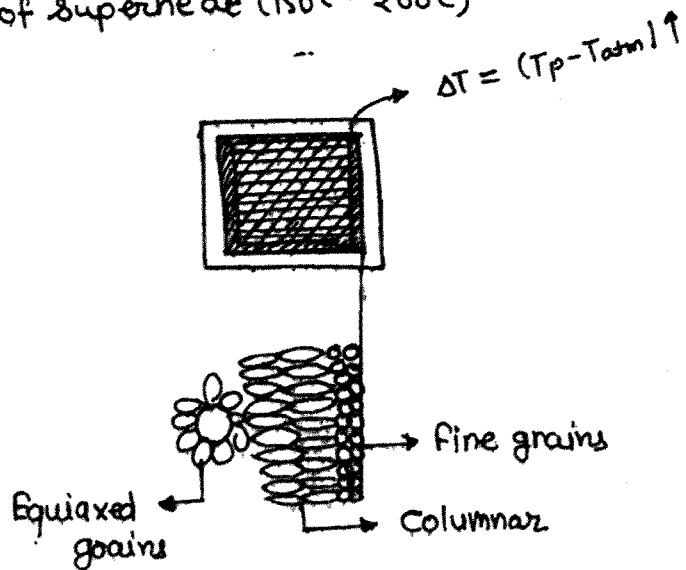
1. Complex shapes of the object can be easily produced
2. Less expensive process
3. Ductile and Brittle materials can be easily produced.
4. Large size objects can be produced by casting only.

(100-150 Ton)

eg. Machine tools Bed (lathe Bed), Road Roller, Turbine housing etc

$$T_p = T_m + \Delta t$$

Δt → degree of superheat ($150^\circ\text{C} - 200^\circ\text{C}$)
 T_m → melting temp.
 T_p → Pouring temp.



Limitations of casting: →

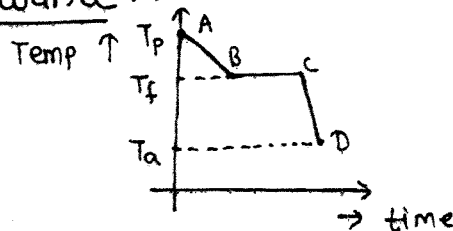
1. Casting objects are not having smooth surface finish.
2. It is laborious and time consuming process.
3. There is a possibility of gas defects can be formed in the casting.
4. Due to Non-uniform cooling, non-uniform Grain-structure is produced in the casting because of this Non-uniform Mechanical Properties will be produced in the casting.

Pattern: → It is replica of final casting to produced with some allowances.

Allowances: →

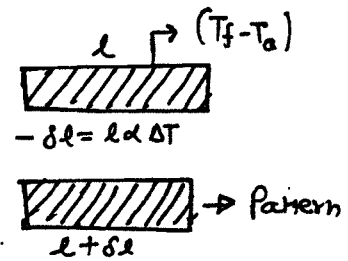
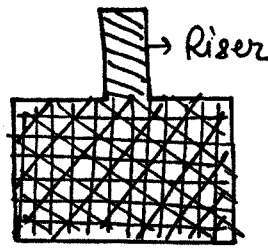
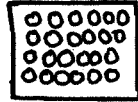
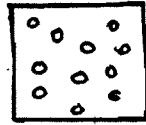
1. Shrinkage or contraction
2. Draft or Taper
3. Machining or finish
4. Shake or Rapping
5. Distortion or camber

1. Shrinkage Allowance: →

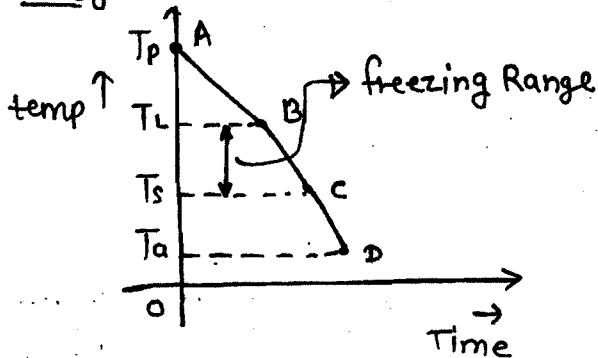


$$(t_s)_r > (t_s)_c$$

$t_s \rightarrow$ Solidification time



Alloy:



when Liquid metal is allowed to solidify in the cavity there is a contraction or shrinkage of the material. When the Liquid Metal is cooled from pouring to freezing temp. shrinkage is Liquid shrinkage.

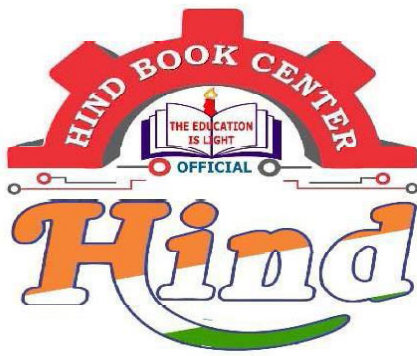
During Phase transformation shrinkage is Solidification Shrinkage.

With the solid casting is cooled from freezing to ambient temp. the shrinkage is solid shrinkage.

Liquid and Solidification shrinkage can be compensated by providing riser. Solid shrinkage can be compensated by providing shrinkage allowance in the pattern.

• Shrinkage Value $\rightarrow$

- | | |
|---|--|
| (i) Bismuth $\rightarrow$ Negligible | (vi) Copper $\rightarrow 17 \text{ mm/m}$ |
| (ii) White metal $\rightarrow 5 \text{ mm/m}$ | (vii) Steels $\rightarrow 20 \text{ mm/m}$ |
| (iii) Cast Iron $\rightarrow 10 \text{ mm/m}$ | (viii) Lead & Zinc $\rightarrow 23 \text{ mm/m}$ |
| (iv) Aluminium $\rightarrow 13 \text{ mm/m}$ | |
| (v) Brass $\rightarrow 15 \text{ mm/m}$ | |



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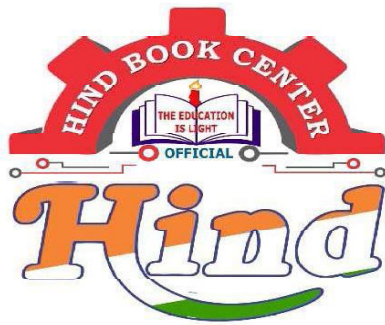
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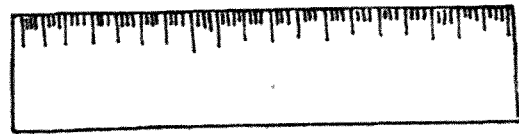
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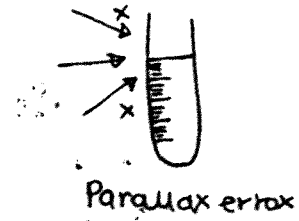
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Metrology: → [Science of Measurement]

Standard is required



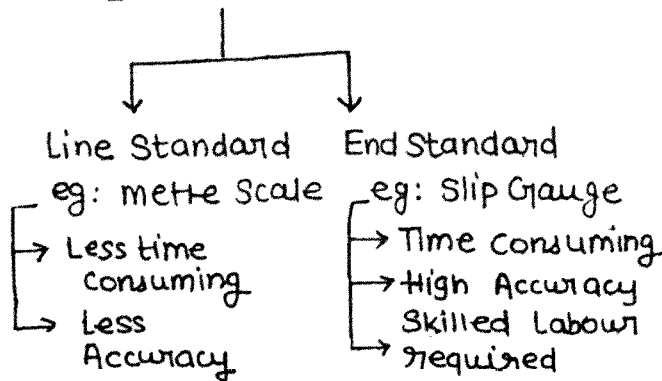
Line Standard



Standard → It is an authority which is set-up or established to measure Length, Weight, quantity, quality, angle etc.

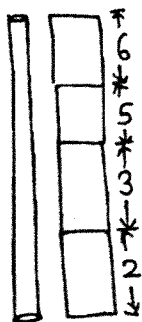
eg: IOML → International organisation for measurement of Length.

LENGTH STANDARD



IS - 919 - 1996

Range	Step size	Number
1.001 - 1.009	0.001	9
1.01 - 1.49	0.01	49
1.5 - 9.5	0.5	19
10 - 100	10	10

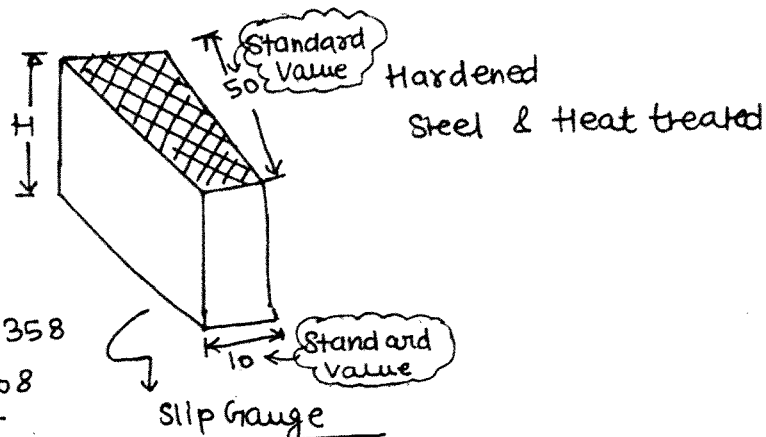


eg:

96.999
1.009
1.49
4.5
90
96.999

eg:

72.358
1.008
1.35
6.5
50
58.975



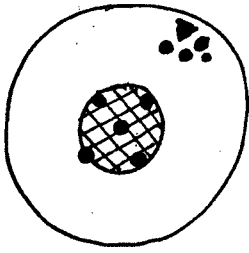
Ground to High Accuracy and Surface finish

eg:

58.975
1.005
1.47
6.5
50
58.975

• Accuracy: →

It is the degree of closeness of a value with respect to true value.



• Precision: → Degree of Repeatability

It is the degree of closeness of a value w.r.t. other measured values

No Dimension is Exact

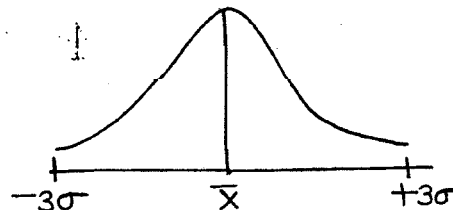
↳ Tolerance

• Limits And Tolerance: →

Limit → Permissible range within which value must lie

Ecart
Supérieur

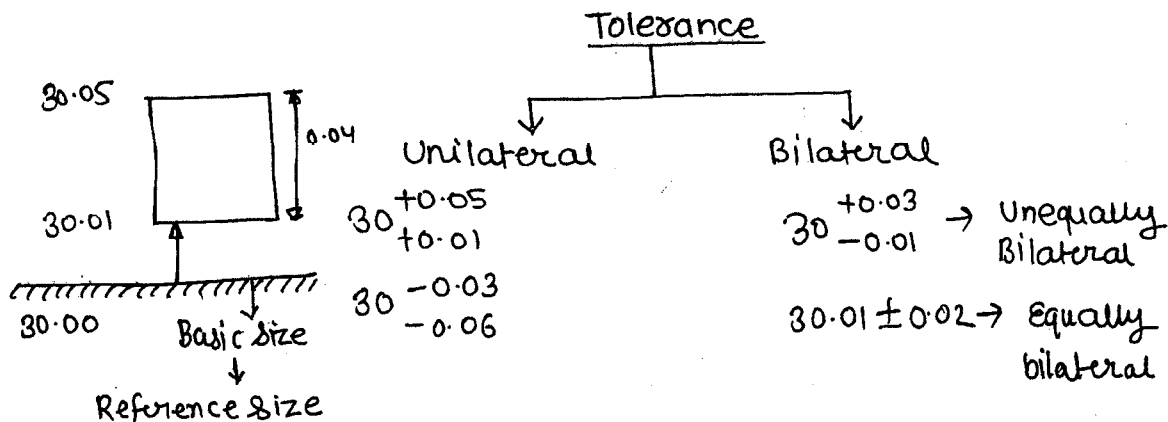
Ecart
Inférieur

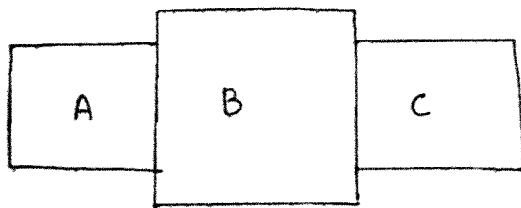


$$\text{Value} = \bar{X} \pm 3\sigma$$

$$\text{Tolerance} = ES - EI$$

↓
Difference b/w Upper Limit &
Lower Limit





$$B = L - (A + C)$$

$$= 30.01 \pm 0.06$$



$$A = 30^{+0.02}_{-0.04} = 29.99 \pm 0.03$$

$$B = ?$$

$$C = 40 \pm 0.02$$

$$L = 100 \pm 0.01$$

$$B = 30^{+0.07}_{-0.05}$$

$$B = 30.01 \pm 0.06$$

$$B_{\max} = L_{\max} - A_{\min} - C_{\min}$$

$$= 100.01 - 29.96 - 39.98$$

$$= 30.07$$

$$B_{\min} = L_{\min} - A_{\max} - C_{\max}$$

$$= 99.99 - 30.02 - 40.02$$

$$= 29.95$$

Steps:

- (i) Convert all tolerance as equal bilateral.
- (ii) Use B.S. only in arithmetic operation.
- (iii) Add all tolerances.

Que → 17/WB/ch-13

$$R = 13.01 \pm 0.03$$

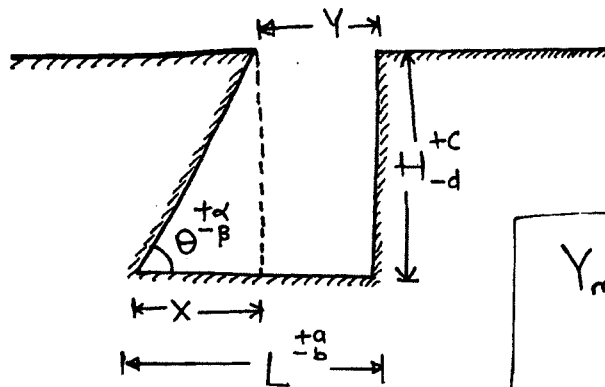
$$W = 35 - 12 - 13.01 = 9.99$$

$$W = 9.99 \pm 0.13$$

$$\begin{array}{r} 0.08 \\ 0.02 \\ 0.03 \\ \hline 0.13 \end{array}$$

→

• Compound Tolerance :→



$$Y = L - X$$

$$Y_{\max} = L_{\max} - X_{\min}$$

$$= L^{+a} - \frac{H^{-d}}{\tan \theta^{+\alpha}}$$

$$Y_{\min} = L_{\min} - X_{\max}$$

$$= L^{-b} - \frac{H^{+c}}{\tan \theta^{-\beta}}$$

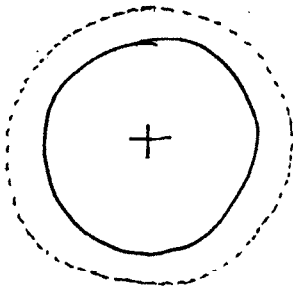
$$\tan \theta = \frac{H}{X}$$

$$X = \frac{H}{\tan \theta}$$

$$X_{\max} = \frac{H_{\max}}{(\tan \theta)_{\min}} = \frac{H^{+c}}{\tan \theta^{-\beta}}$$

$$X_{\min} = \frac{H_{\min}}{(\tan \theta)_{\max}} = \frac{H^{-d}}{\tan \theta^{+\alpha}}$$

• Shaft Plating



t = Plating thickness

D_i = diameter before Plating

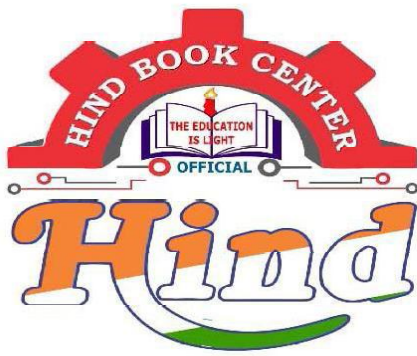
D_f = diameter after Plating

$$D_f = D_i + 2t$$

$$t = 80 \pm 2 \mu\text{m}$$

$$\text{dia after plating} = 20^{+0.05}_{-0.03} \text{ mm}$$

Find the diameter of shaft before Plating.



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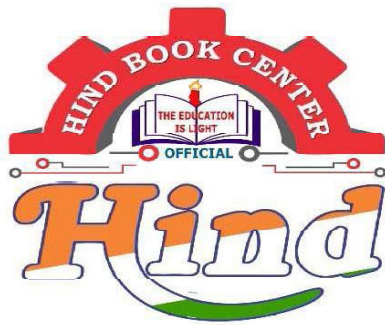
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• Metal Forming : →

Bulk forming

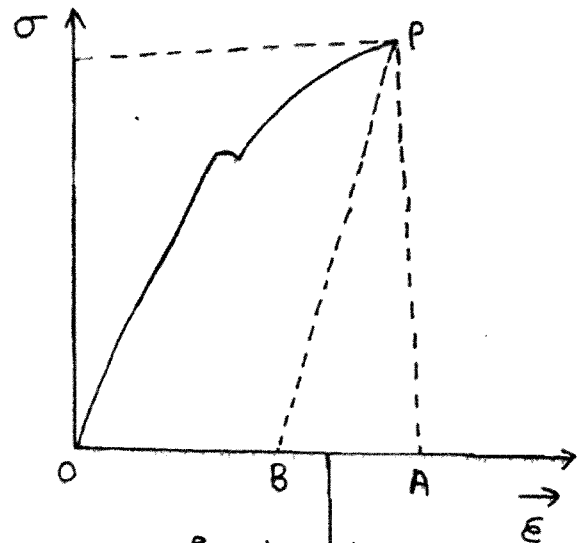
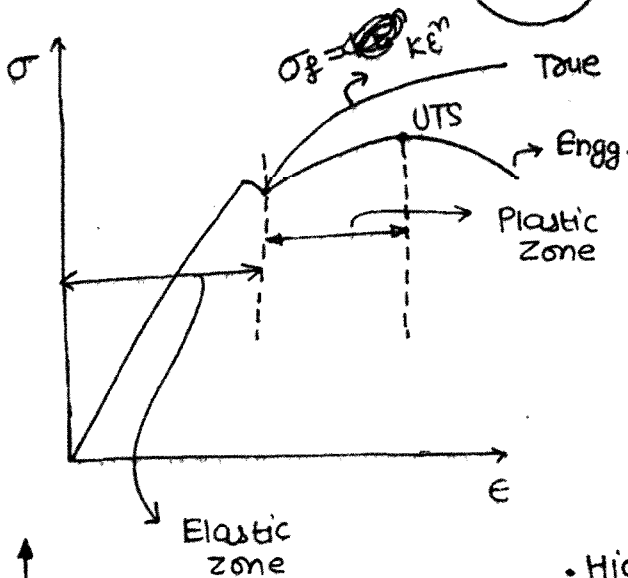
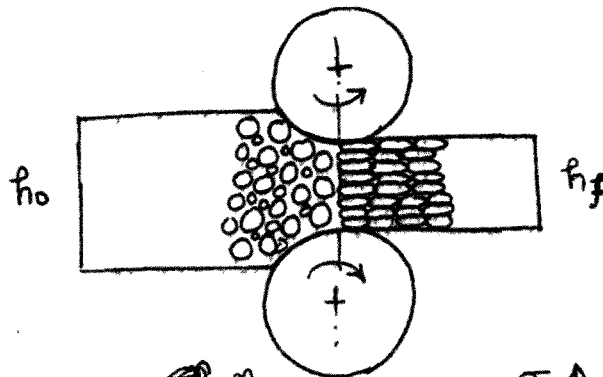
1. Rolling
2. Forging
3. Drawing
4. Extrusion

$$\left(\frac{A}{V}\right) \downarrow$$

Sheet Metal forming

1. Punching / Blanking
2. Deep drawing
3. Stretch forming
4. Bending

$$\left(\frac{A}{V}\right) \uparrow$$



$$\sigma_f = K \epsilon^n$$

→ flow stress
Hollomon Equation

$0 < n < 1$
n: Strain
Hardening
Exponent

• High Energy rate forming

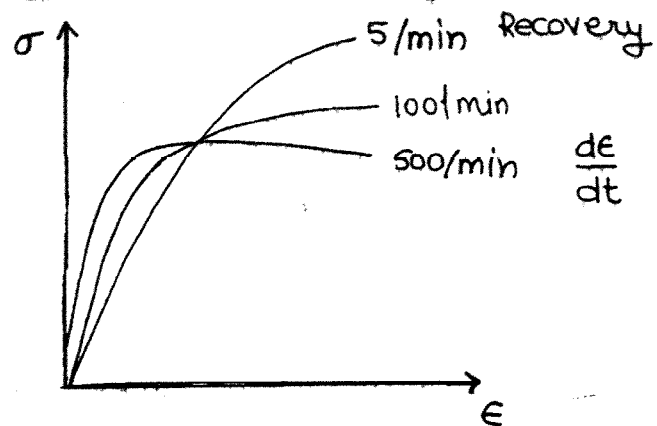
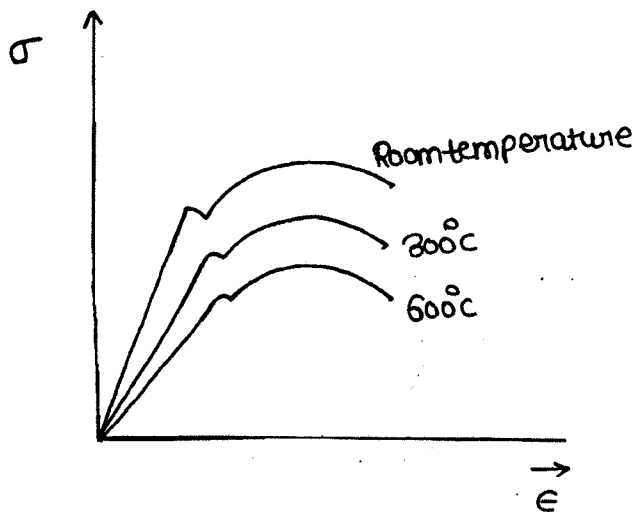


fig: At Room temperature



$$\text{Elastic Recovery} \propto \frac{1}{E} \propto \text{Yield Stress}$$

$$\propto \frac{1}{(B/t)}$$

K = Strength coefficient

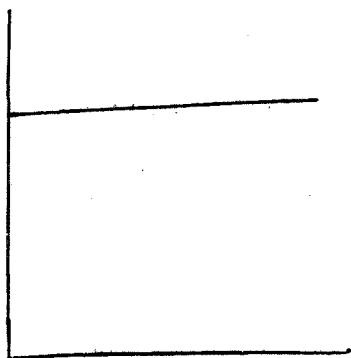
ϵ = true strain

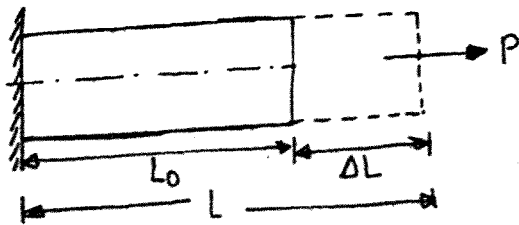
$$\frac{\sigma}{\epsilon} = \frac{E}{1 + \frac{\sigma}{E}}$$

Mechanical Properties appearing in stress-strain diagram like yield strength, ultimate tensile strength and % of elongation depends upon rate of deformation. (Strain rate)

As the rate of deformation increases stress-strain diagram shift towards left and there is an increase in yield strength of the material and elastic Recovery is reduced. In case of High Energy rate forming techniques due to high strain rates Elastic Recovery is Negligible and the accuracy of the Component is high.

If the temperature is increasing stress-strain diagram shift towards right and yield strength of this material is decrease.





$A_0 \rightarrow$ Initial Area

$L_0 \rightarrow$ Initial Area Length

$A \rightarrow$ Instantaneous Area

$L \rightarrow$ Instantaneous Length

$e \rightarrow$ Engg. Strain $= \frac{\Delta L}{L_0}$

$\epsilon \rightarrow$ True strain

$\sigma \rightarrow$ Engg. stress

$\sigma_t =$ True stress

$$L = L_0 + \Delta L$$

$$\frac{L}{L_0} = 1 + \frac{\Delta L}{L_0} \Rightarrow \boxed{\frac{L}{L_0} = 1 + e}$$

$$\sigma_t = P/A$$

$$= \frac{P}{A} \times \frac{A_0}{A_0}$$

$$\sigma_t = \frac{P}{A_0} \times \frac{A_0}{A}$$

$$\boxed{\sigma_t = \sigma(1+e)}^*$$

$$A_0 L_0 = A L$$

$$\frac{A_0}{A} = \frac{L}{L_0}$$

$$d\epsilon = \frac{dL}{L}$$

$$\epsilon = \int_{L_0}^L \frac{dL}{L} = \ln\left(\frac{L}{L_0}\right)$$

$$\boxed{\epsilon = \ln(1+e)}^*$$

$$\boxed{\epsilon = \ln\left(\frac{l_f}{l_0}\right) = \ln\left(\frac{A_0}{A_f}\right) = \ln\left(\frac{d_0}{d_f}\right)^2}^*$$

Q Determine engineering strain, true strain, % elongation, % Reduction in Area.

For rod which is double in Length

Solⁿ

$$L_f = 2L_0 \Rightarrow \boxed{\frac{L_f}{L_0} = 2}$$

$$A_0 L_0 = A_f L_f$$

$$\frac{L_f}{L_0} = \frac{A_0}{A_f} = 2$$

$$e = \frac{2L_0 - L_0}{L_0} = 1$$

$$\boxed{e = 1}$$

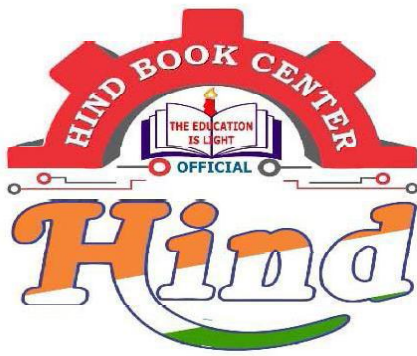
$$\epsilon = \ln(1+e)$$

$$\boxed{\epsilon = \ln 2 = 0.693}$$

% Reduction in Area =

$$\frac{A_0 - A_f}{A_0} = \left(1 - \frac{1}{2}\right) \times 100 = 50\%$$

% elongation = 100%



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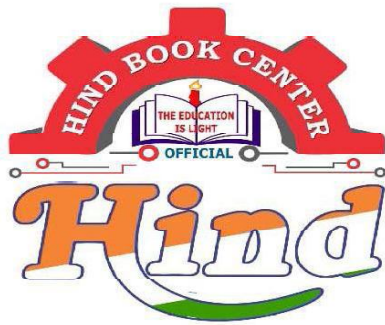
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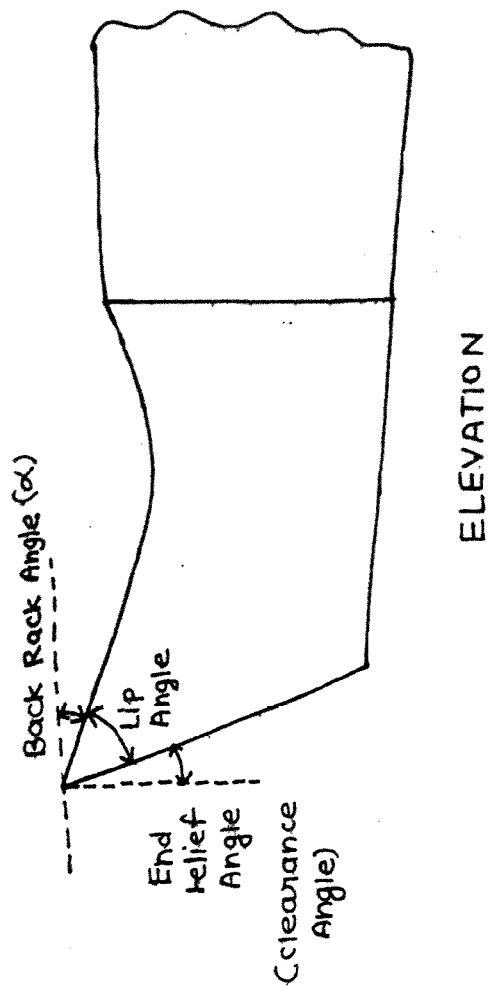
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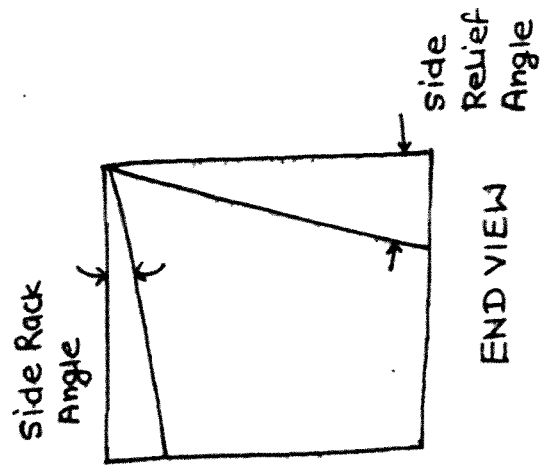
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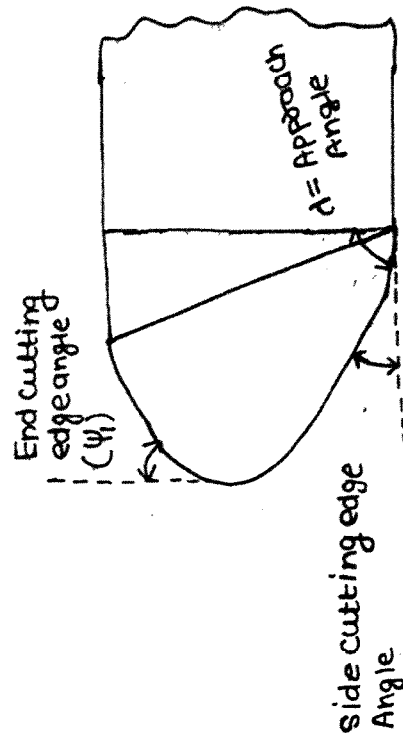
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ELEVATION



END VIEW

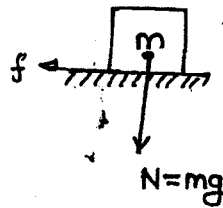
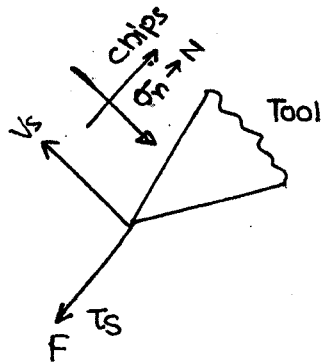


PLAN

• Back Rack Angle

A Line is drawn Parallel to the tool Axis Passing through the tip of the tool, the angle this makes with the Rack Face is called Back Rack Angle.

This Angle is measured in a Plane Parallel to the tool Axis Perpendicular to the base Plane.



$$f = \mu N$$

$$\text{Temp. } \uparrow \quad \mu \uparrow \quad T_s = \mu \sigma_m$$

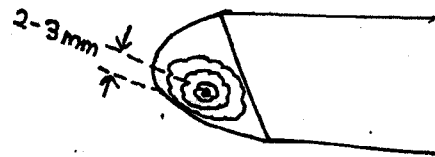
$$T_s \uparrow \quad T_s \neq K' \quad \rightarrow \text{Yield strength in shear}$$

$$T_s = K' \text{ Sticking}$$

$$T_s < K' \rightarrow \text{Slipping}$$

$$F_c V = F_s V_s + F V_c$$

$\downarrow$ $\downarrow$ $\downarrow$
 Cutting energy Shear Energy Friction Energy
 (Total)



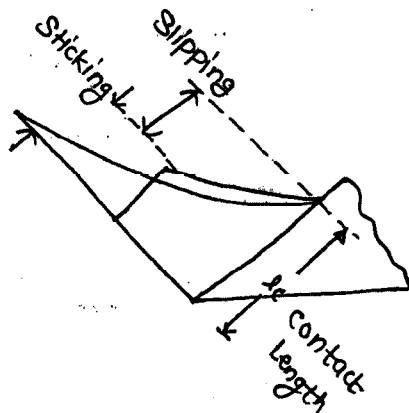
$$\alpha \uparrow, l_c \downarrow, A \downarrow$$

$$F \downarrow$$

Amonton's Law

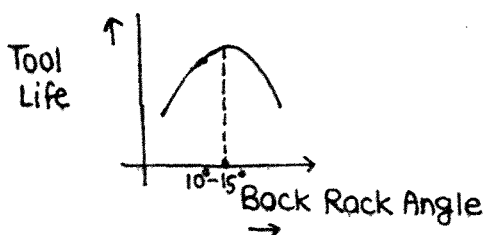
$$F = \oint T_s$$

$$N = \oint \sigma_m$$



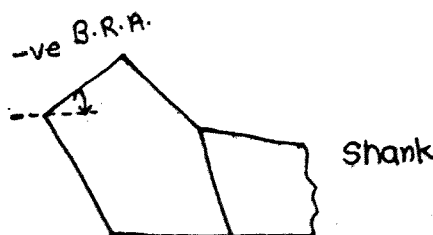
Machining takes place by breaking the crystal structure of work material. The velocity with which crack is propagating inside the material is called shear velocity. As the crystals are breaking a portion of the energy comes out in the form of Heat. Increase in temperature will increase the coefficient of friction and when the shear stress becomes equal to the yield strength in shear there will be sticking between the two materials.

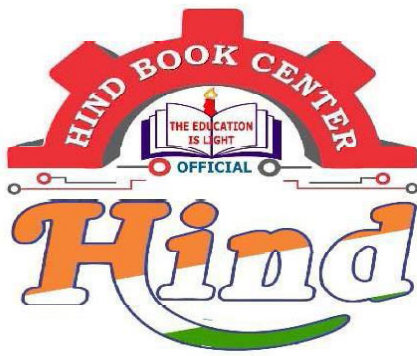
After machining as chips are flowing over the Rake face there will be sticking between the chip and the Rake face due to which chips continue to experience a heavy drag. So max. temperature over the Rake face appears 2-3mm away from the cutting edge. By increasing the back Rake Angle there will be decrease in the contact length between the chip and the Rake face. Hence contact area will decrease, so lesser energy will be required to overcome the friction between Rake face and the chip. This will decrease the overall power consumption. Secondary function of Back Rake Angle to Guide the chip flow.



• Select

- 1> work - strong cu alloys
(Brass & Bronze)
- 2> Threading or Plunge cut
 - (i) $\alpha = 0$
 - (ii) Aluminium, Pb $\alpha = 5-10^\circ$
- 3> carbides or Ceramics $\alpha = -ve$





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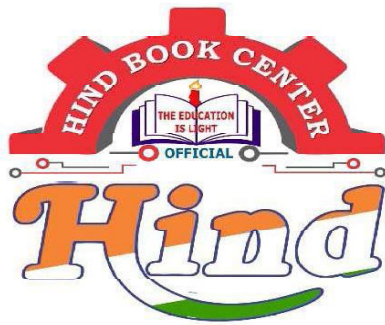
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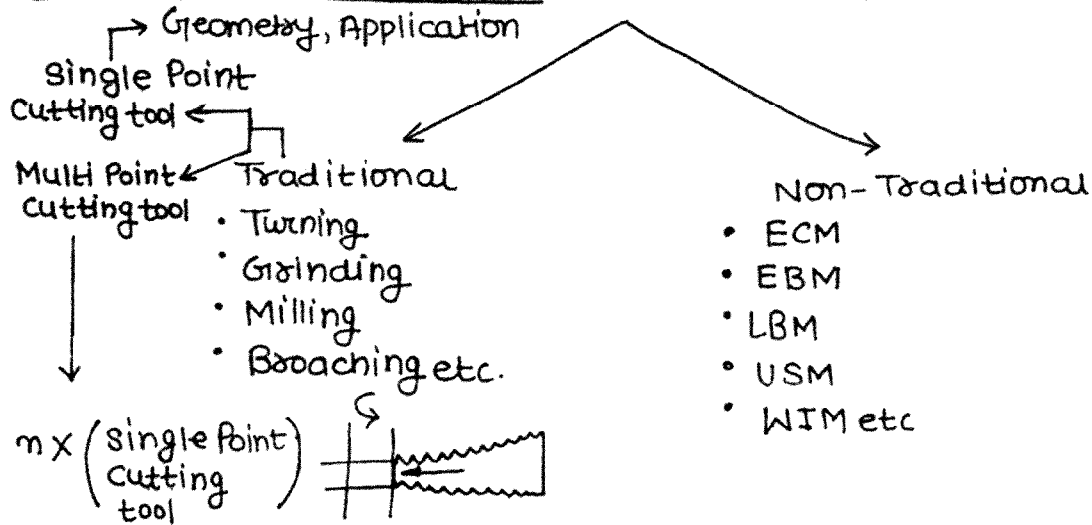
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MANUS + FACTUS

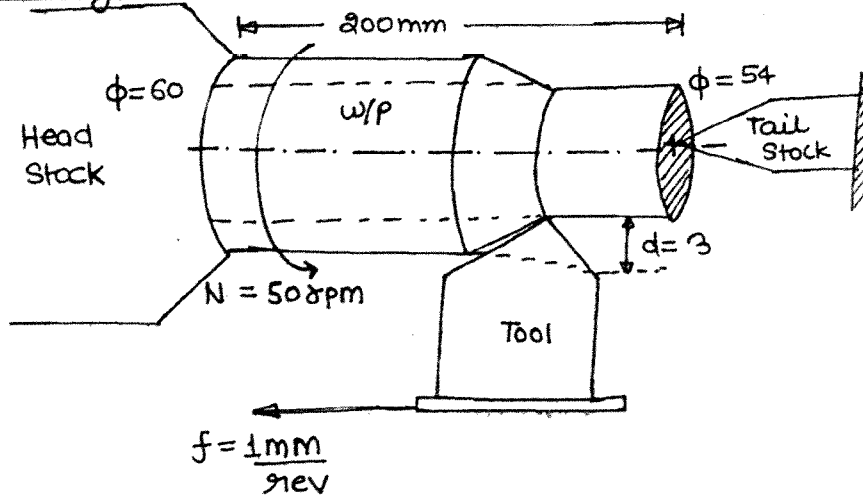
To make by
Hand

New grains are forming

Material Removal Process: → "MACHINING"



• Turning: →

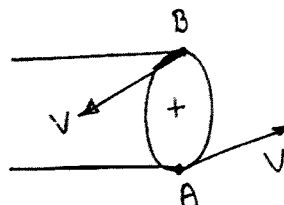


$$t_m = \frac{L \rightarrow \text{w/p}}{V \rightarrow (D, N) \rightarrow \text{w/p}}$$

$$t_m = \frac{L_e}{f N} = \frac{200}{1 \times 50} = 4 \text{ min}$$

Axial
Speed

where $L_e = L_{w/p} + \text{Allowance}$



tangential
velocity

$$V = \phi(D, N)$$

$$V = \frac{\pi D N}{1000} \frac{\text{m}}{\text{min}}$$

Q → Evaluate the time of machining a Brass bar of dia 50mm and Length 50mm, final dia is 42 mm. Spindle speed is 450rpm feed 0.2mm/rev, depth of cut 3mm and Length of approach is 3mm.

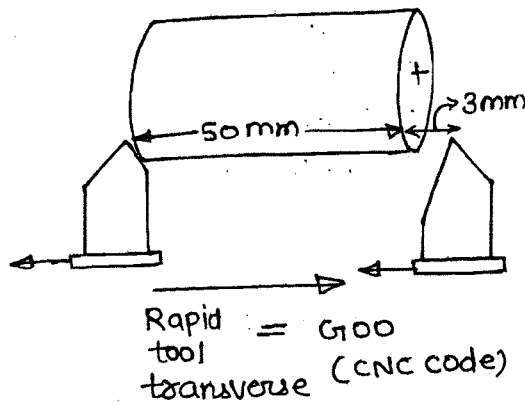
Solⁿ

$\begin{array}{l} \text{D} = 50\text{mm} \\ \downarrow d = 3\text{mm} \\ \text{D} = 44\text{mm} \\ \downarrow d = 1\text{mm} \\ \text{D} = 42\text{mm} \end{array} \left\{ \begin{array}{l} \text{Roughing} \\ \text{Finishing} \end{array} \right.$

$$t_m = \frac{L_e}{fN} \times n$$

$$t_m = \frac{53}{0.2 \times 450} \times 2$$

$$t_m = 1.177 \text{ min}$$



→

Que → Find the machining time for mild steel Bar of diameter 52mm which is to be reduced to 44mm dia along the length of 200mm with an approach allowance of 5mm. Cutting Parameter are as follows

Roughing Pass :- $V_{max} = 35 \text{ m/min}$, $d = 3\text{mm}$, $f = 0.3 \text{ mm/rev}$.

Finishing Pass :- $V_{max} = 50 \text{ m/min}$, $d = 1\text{mm}$, $f = 0.1 \text{ mm/rev}$.

$$N = \frac{V \times 1000}{\pi \times D_{max}}$$

$$V = \frac{\pi D N}{1000} \quad \frac{\text{m}}{\text{min}}$$

Roughing

$$N = \frac{35 \times 1000}{\pi \times 52} = 214.248 \text{ rpm}$$

$$t_{m1} = \frac{205}{0.3 \times 214.24} = 3.189 \text{ min}$$

$$t_m = t_{m1} + t_{m2}$$

$\text{Total time (t_m)} = 9.11 \text{ min}$
--

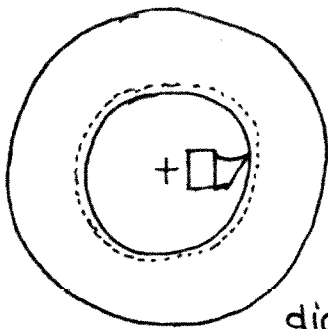
Finishing

$$N = \frac{50 \times 1000}{\pi \times 46} = 345.98 \text{ rpm}$$

$$t_{m2} = \frac{205}{0.1 \times 346} = 5.92 \text{ min}$$

If $V_{\max}$ is given $N = \frac{V \times 1000}{\pi \times D_{\max}}$

is V_{avg} is given $N = \frac{V \times 1000}{\pi \times D_{\text{avg}}}$



Hollow Cylinder

Internal Turning $\Rightarrow$ "Boring"

dia enlargement

$L = 100 \text{ mm}$ Hollow Cylinder
 $30 \text{ mm} \rightarrow 40 \text{ mm}$

$d = 2 \text{ mm}$

$V = 30 \text{ m/min}$

$f = 0.1 \text{ mm/rev}$

time of machining

Solⁿ

30
 $\downarrow d=2$

34
 $\downarrow d=2$

38
 $\downarrow d=1$

40

1st Pass

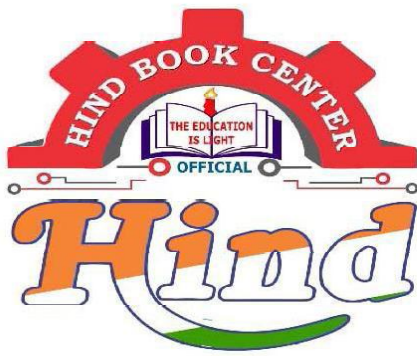
$$N = \frac{30 \times 1000}{\pi \times 32} = 298.41 \text{ rpm}$$

$$t_1 = \frac{100}{0.1 \times 298.41} = 3.35 \text{ min}$$

2nd Pass

$$N = \frac{30 \times 1000}{\pi \times 36} = 265.25 \text{ rpm}$$

$$t_2 = \frac{100}{0.1 \times 265.25} = 3.77 \text{ min}$$



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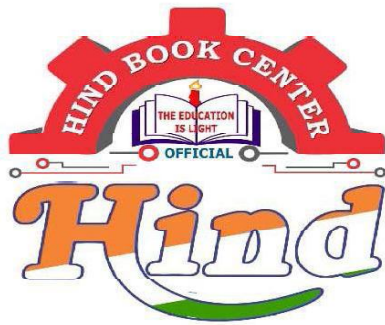
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Material Science

Ref.

Callister's Matl Sc & Engg.

Email Id

~~mgsu~~

materialsciencemadeeasy@gmail.com

• Crystal Structures

(Glass $\rightarrow$ Supercooled Liquid)

1. Material science is basically study of relationship between structure and Properties of Engineering materials.
2. Based on the structure all engineering materials are classified into two basic types: They are Crystalline materials and Amorphous material.
3. Amorphous material which do not exhibit regular, repeated & orderly arrangement of atoms/Ions/molecules
eg: Waxes, Polymers, Glass, charcoal etc.
4. Crystalline materials are those materials which exhibit 3-D, Long range, Periodicity of arrangement of atom, Ions or molecule in the Internal Structure.

Crystalline Materials

- $\rightarrow$ Atomic Solids $\rightarrow$ Metals
- $\rightarrow$ Ionic Solids $\rightarrow$ Ceramics
- $\rightarrow$ Molecular Solids $\rightarrow$ Crystalline Polymers

Amorphous materials

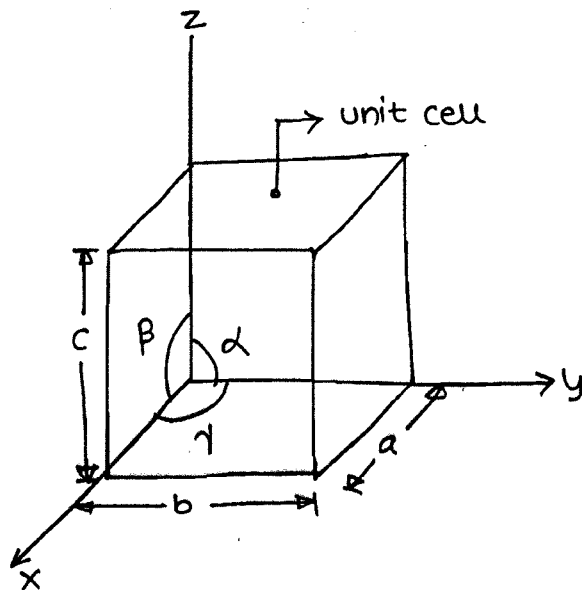
Can exist any state
Can be converted into Crystalline materials

Crystalline $\xrightarrow[\text{Cooling}]{\text{Fast}}$ Amorphous

Material type

(We cannot judge by Naked eye)

5. Crystal structure of unknown material are determined by X-Ray diffraction technique. This is experimental technique.
6. Based on X-Ray diffraction technique all crystalline materials are classified into seven crystal systems and these are sub-classified into 14 Bravais Lattices.
7. The term crystal system refers to basic shape of unit cell whereas Bravais Lattices refers to Atomic Arrangements within a unit cell.
8. A unit cell is defined as the smallest representative group of atoms, which when repeated in all the crystallographic directions for infinite number of times results in the development of crystal lattice.



x, y, z = crystallographic axes

a, b, c = Lattice Parameter

α, β, γ = Interaxial angles

Stability $\rightarrow$ minimization of potential energy

Crystal System	Geometry	Bravais Lattices
<u>Cubic</u> L $\rightarrow$ Metal	$a = b = c$ $\alpha = \beta = \gamma = 90^\circ$	Simple (S), <u>BCC</u> , <u>FCC</u>
Tetragonal	$a = b \neq c$ $\alpha = \beta = \gamma = 90^\circ$	<u>ST</u> , <u>BCT</u>
orthorhombic	$a \neq b \neq c$ $\alpha = \beta = \gamma = 90^\circ$	<u>SO</u> , <u>BCO</u> , <u>FCO</u> <u>ECO</u>
Rhombohedral	$a = b = c$; $\alpha = \beta = \gamma \neq 90^\circ$	<u>SR</u>
<u>Hexagonal</u> For metal	$a = b \neq c$ $\alpha = \beta = 90^\circ, \gamma = 120^\circ$	<u>SH</u>
Monoclinic	$a \neq b \neq c$ $\alpha = \beta = \gamma = 90^\circ \neq \beta$	<u>SM</u> , <u>ECM</u>
Triclinic	$a \neq b \neq c$ $\alpha \neq \beta \neq \gamma \neq 90^\circ$	<u>STr</u>

Simple (S)
Body centered (BC)
Face centered (FC)
End centered (EC)

$\rightarrow$ Generally

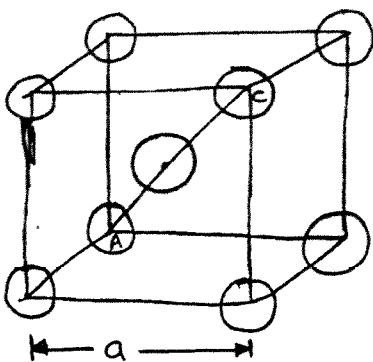
• Some Important definitions

1. crystal lattice is defined as a 3-D dimensional Network of Lines in Space, It is also known as Line Lattice.
2. Space Lattice is defined as 3-D dimensional Network of Points in Space, It is also known as Point Lattice.
3. Primitive cell is defined as a simple cubic unit cell having atoms only at the corners.
4. Lattice Parameter is defined as the distance b/w centres of neighbouring corner atoms
5. crystal structures characteristics

characteristic	BCC	FCC	HCP
a to r relation	$a = \frac{4r}{\sqrt{3}}$	$a = \frac{4r}{\sqrt{2}}$	$a = 2r$
Average no. of atoms (N_{av})	2	4	6
Coordination Number	8	12	12
Atomic Packing Factor (APF)	0.68	0.74	0.74

Let 'a' = Lattice Parameter
r = Atomic Radius

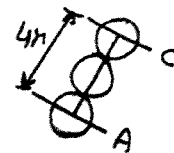
• BCC



AC = Body diagonal of unit cell

$$= a\sqrt{3} = 4r$$

$$a = \frac{4r}{\sqrt{3}}$$

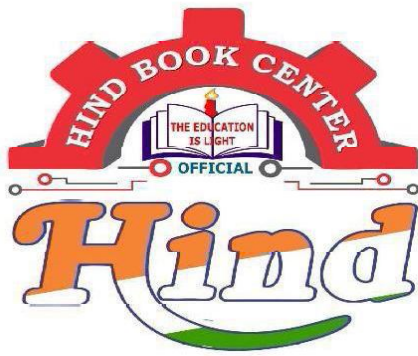


example →

Fe [Except in 910 - 1400°C]

W, Cr, V, Mo, Ta etc.

Hard & Brittle



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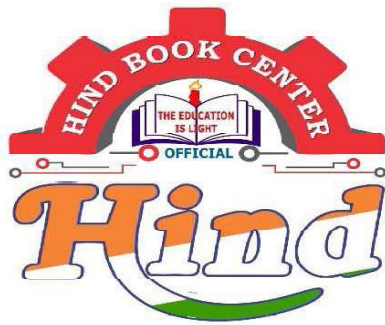
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Power Plant

- ① Gas Turbine.
 - ② Rankine Cycle $\rightarrow$ (PS/VCRS)
 - ③ Rec. Comp
 - ④ Cen. Comp
 - ⑤ AFC
 - ⑥ IT
 - ⑦ RT
 - ⑧ Binary vapour cycle
 - ⑨ Boilers & its comp.
 - ⑩ Conda & Cooling Towers
 - ⑪ Comp. Flow - Gate
 - ⑫ Misc? Topic
(nozzle & diffuser) x
(nuclear PP) x
- } ESE

Ref. Books:

P K Nag	$\rightarrow$	Inter
R - Yadav	$\rightarrow$	Num.
Ganeshan	$\rightarrow$	Gas Turbine
S.M. Yaha	$\rightarrow$	Comp. flow



GAS TURBINE

Engine:

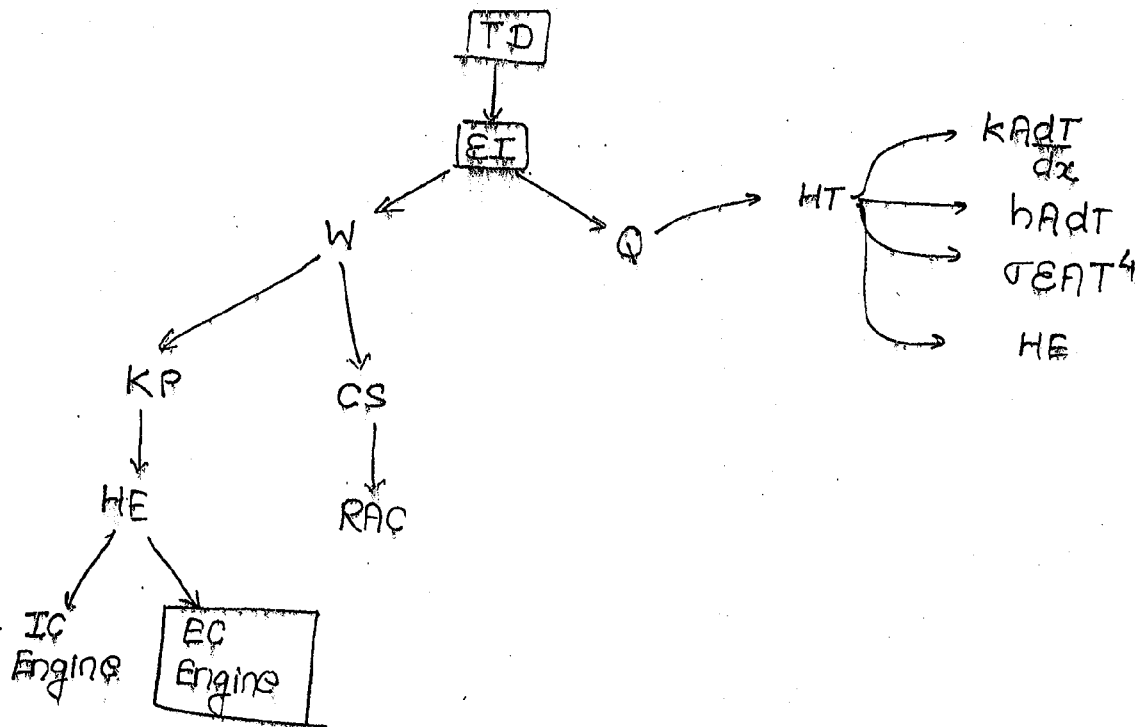
It is a Mechanical device which convert 1 form of Energy into another useful form of energy.

IC Engine:

In this, combustion & expansion takes place at a same location. @ fuel itself is the working fluid.

EC Engine:

In this, combustion & expansion takes place at diff. location @ products of combustion are transfer their heat to the another working fluid. which is utilized for producing some useful output.



Advantage of Gas Turbine over IC Engine:

- (i) compact i.e. Weight to Power Ratio is less.
- (ii) These can be rotating at high speed.
- (iii) ~~Easy~~ Easy Balancing.
- (iv) Simple Mechanism.

Disadvantage of Gas Turbine:

- (i) As the compressor is used in the gas turbine, handling the gaseous phase of the working fluid. Therefore the compressor work is not negligible in comparison to the turbine work which will reduce the net work o/p. & finally the efficiency decreases.

$$(i) \quad \eta = \frac{W_{net}}{Q_s} = \frac{W_T - W_C}{Q_s}$$

$$\downarrow W_{net} = W_T - W_C \uparrow$$
$$\downarrow \qquad \qquad \downarrow$$
$$\int v_g dp \qquad \int v_g dp$$

- (ii) High Heat Resistance Material are required as these are subjected to Higher Temp continuously.

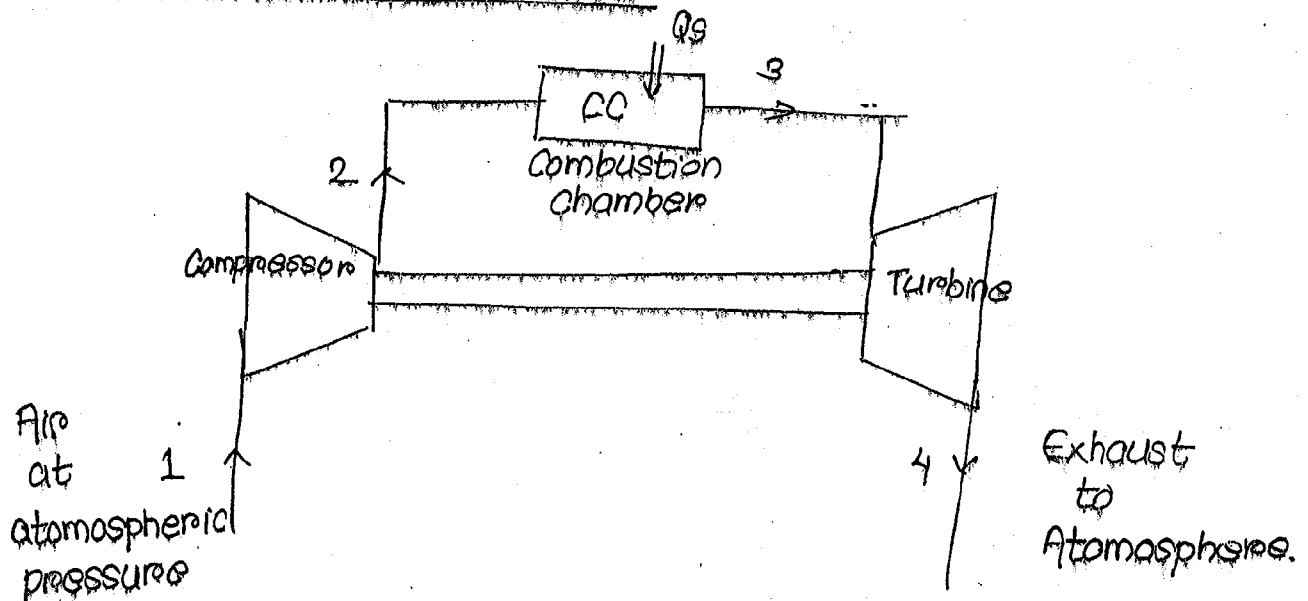
- (iii) High speed Reduction Gears are required as the value of centrifugal forces are high at Higher speed.

$$F_c = m r \omega^2$$

$$F_c = m r \left(\frac{2\pi N}{60} \right)^2 \quad \therefore F_c \propto N^2$$

Types of Gas Turbine:

① Open Cycle Gas Turbine:

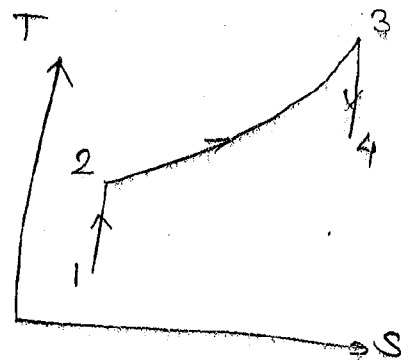
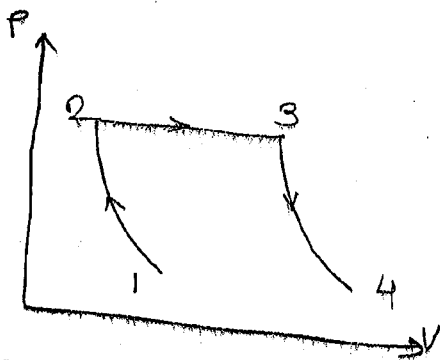


→ In this case, in every cycle, fresh charge is introduced.

Process ① - ② : Isentropic compression.

Process ② - ③ : Constant Pressure Heat Addition.

Process ③ - ④ : Reversible Adiabatic Expansion.

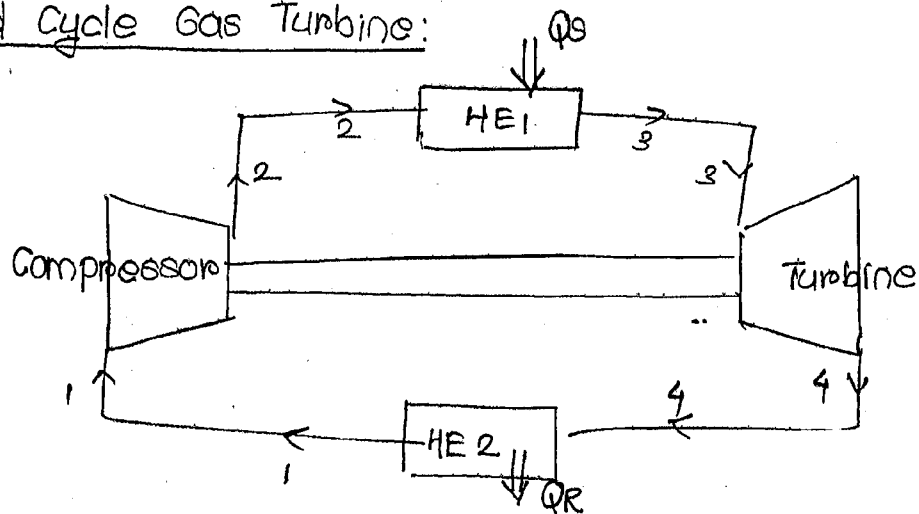


②-③

$$PV = mRT$$

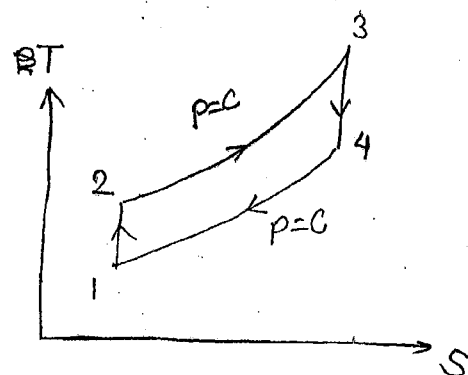
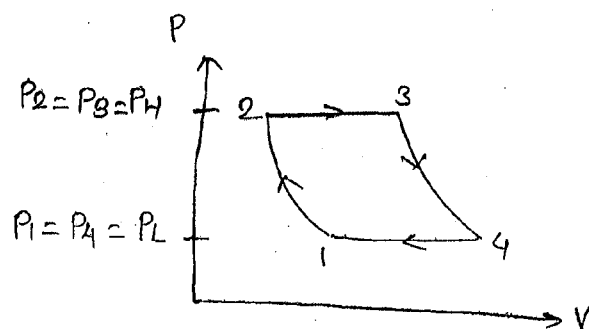
at $P=C \therefore \boxed{T \propto V}$

Closed Cycle Gas Turbine:



→ In case of closed cycle gas turbine, same working fluid is recirculated again & again.

Process ④-①: Constant Pressure Heat Rejection.



$$\text{rp} = \frac{\text{Pressure}}{\text{Ratio}} = \frac{P_H}{P_L}$$

$$(4 \rightarrow 1) = PV = mRT \\ \downarrow T \propto V \downarrow$$

Advantage of closed cycle Gas Turbine over Open cycle.

- (i) Better working fluids like Ar & He can be used having the value of index Ar/He, $\gamma = 1.67$
- (ii) It can operate even ^{below} atm. pressure.
- (iii) Wide variety of fuel can be used as the products of combustion does not enter the Turbine Blade.
- (iv) Better Thermal efficiency can be obtained betⁿ the same maximum & minimum temp limits.

$$\text{as } r \uparrow \rightarrow \eta_{\text{otto}} \uparrow \\ \rightarrow \eta_{\text{Braton}} \uparrow$$

$$\eta_{Otto} = 1 - \frac{1}{(r_c)^{\gamma-1}}$$

$\therefore$ as $\gamma \uparrow \Rightarrow \eta_{Otto} \uparrow$
& $\eta_{Brayton} \uparrow$.

$$\eta_{Brayton} = 1 - \frac{1}{(r_p)^{\frac{\gamma-1}{\gamma}}}$$

Disadvantage of Closed Cycle Gas Turbine:

- ① Absolute Leak Proofing is very difficult to achieve.
- ② A coolant is required to cool down the Turbine Exhaust before entering the compressor, whereas in the case of open cycle gas turbine, Atmosphere is acting like a sink.
- ③ $\therefore$ system is complicated, Bulky, more weight. Therefore These are not preferred for aircraft Application.

Back Work Ratio: (r_{bw})

$$r_{bw} = \frac{-ve \text{ work}}{+ve \text{ work}}$$

GAS Turbine

Brayton cycle

$$\textcircled{1} \quad r_{bw} = \frac{W_c}{W_T} \rightarrow \int v_g dp$$

(40% to 60%)

Rankine cycle.

$$\textcircled{1} \quad r_{bw} = \frac{W_p}{W_T} \rightarrow \int v_f dp$$

(1% to 2%)

Work Ratio: (r_w)

$$r_w = \frac{\text{Net Work}}{+ve \text{ Work}}$$

$$\therefore r_{bw} = \frac{W_T - W_c}{W_T} = 1 - \frac{W_c}{W_T}$$

$$\therefore r_w = 1 - r_{bw}$$

Brayton cycle

$$r_w = (60\% \text{ to } 40\%)$$

Rankine cycle.

$$r_w = (98\% \text{ to } 99\%)$$

Expression for Efficiency of Simple Brayton cycle:

$$\eta = \frac{O/P}{I/P} \Rightarrow \eta = \frac{W_{net}}{Q_s} \Rightarrow \eta = \frac{Q_{net}}{Q_s}$$

$$\eta = \frac{\cancel{Q_{1-2}} + \cancel{Q_{2-3}} + \cancel{Q_{3-4}} + Q_{4-1}}{Q_s} \quad \text{--- } Q_R$$

$$\eta = \frac{Q_s - Q_R}{Q_s} = 1 - \frac{Q_R}{Q_s} = 1 - \frac{(h_4 - h_1)}{(h_3 - h_2)}$$

$$\boxed{h = c_p T \text{ (air)}}$$

$$\eta = 1 - \frac{(T_4 - T_1)}{(T_3 - T_2)} \quad \therefore \eta = 1 - \frac{T_1 (T_4/T_1 - 1)}{T_2 (T_3/T_2 - 1)} \dots \textcircled{1}$$

Process (1-2): $PV^r = C$

$$\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^x = \left(\frac{P_H}{P_L}\right)^x = r_p^x \dots \textcircled{2}$$

$$\dots \quad \boxed{x = \frac{\gamma - 1}{\gamma}}$$

Process (3-4): $PV^r = C$

$$\frac{T_3}{T_4} = \left(\frac{P_3}{P_4}\right)^x = r_p^x \dots \textcircled{3}$$

$$\therefore \quad \boxed{\frac{T_2}{T_1} = \frac{T_3}{T_4}} \quad \text{from } \textcircled{2} \& \textcircled{3}$$

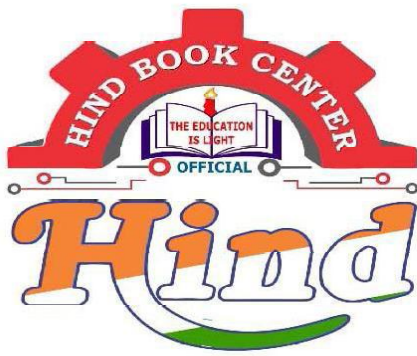
$$\therefore \quad \boxed{T_2 T_4 = T_1 T_3} \quad \text{even} \quad \text{odd} \quad \text{OBS}$$

→ Use in equⁿ $\textcircled{1}$:

$$\frac{T_4}{T_1} = \frac{T_3}{T_2} \quad \eta = 1 - \frac{T_1}{T_2}$$

$$\boxed{\eta = 1 - \frac{1}{(T_2/T_1)}}$$

$$\boxed{\eta_{\text{Brayton}} = 1 - \frac{1}{(r_p)^{\frac{\gamma-1}{\gamma}}}} \quad x$$



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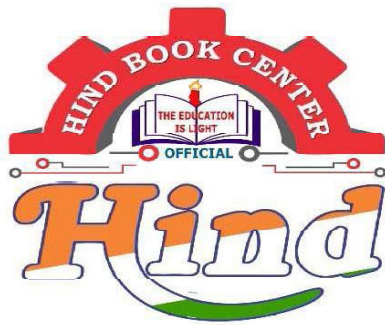
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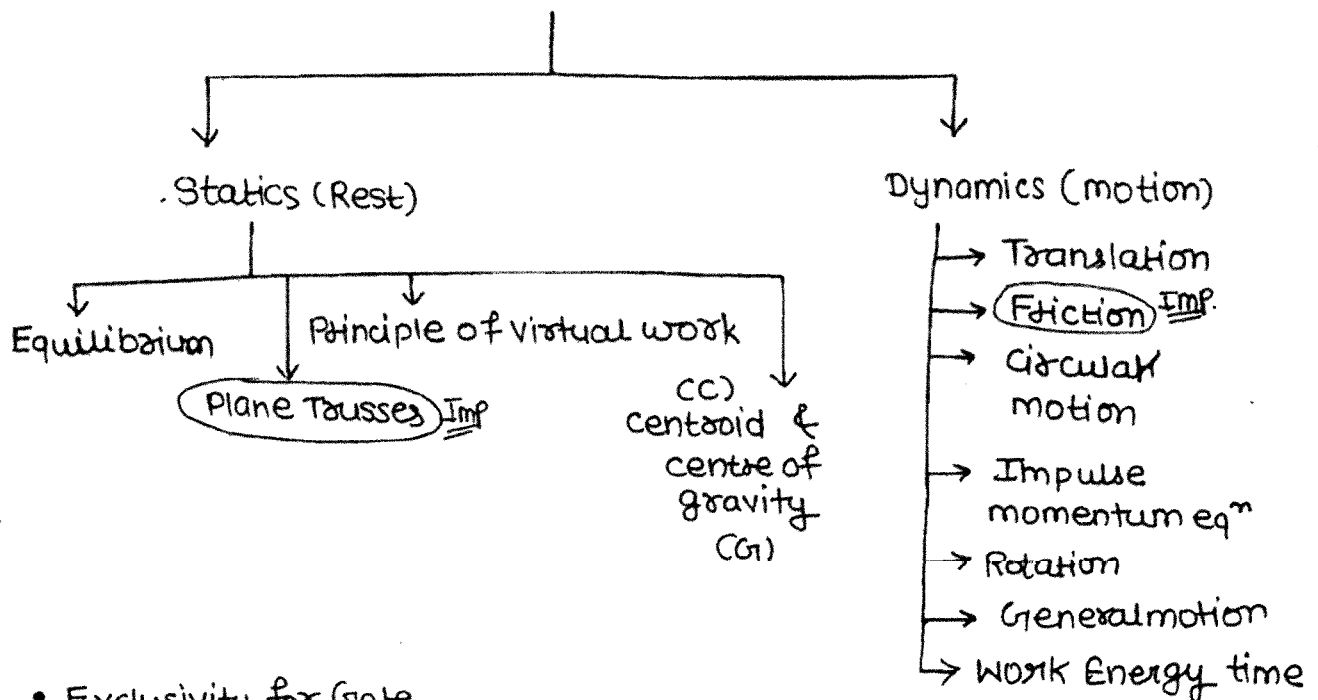
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Engg. Mechanics

"Study of motion of rigid bodies under the action of external forces."



• Exclusivity for Gate

- ◆ friction & its application
 - Rolling friction
 - wedge
 - Screw Jack
 - Application in vehicles
 - Belt friction
- * Lagrange's Equation

• Actual Force :→

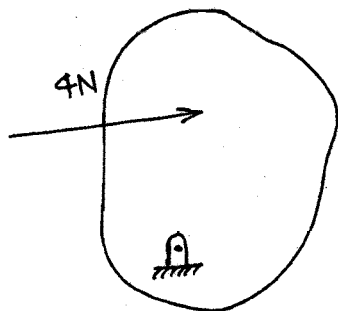
If a force has been Acted on the body then it must have been applied by some other Body

• Pseudo force :→

If a force is acted upon a body ~~but~~ but has Not been applied by any other body.

To define a force —→

- Magnitude (Intensity)
- direction (orientation)
- Point of application



• Types of forces

1. Gravity (W)

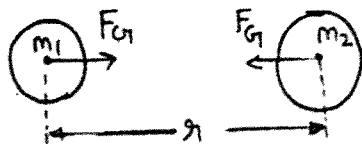
2. Contact force (R) —→

- Normal Reaction (N)
- friction (f)

3. Tension (T)

4. Spring force (F_s)

• Gravity →



$$F_{G1} = \frac{G m_1 m_2}{r^2}$$

$$G = 6.67 \times 10^{-11}$$

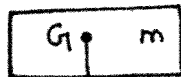
$$g = \frac{G M_E}{R_E^2}$$

M_E = Mass of Earth

R_E = Radius of Earth

$$W = mg$$

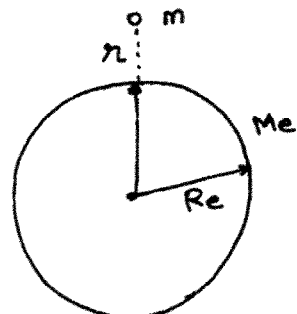
(Pulling)



$\downarrow mg \Rightarrow$ on mass m by Earth

$$F_G = \frac{G M_E m}{R_E^2}$$

$$F_G = mg$$

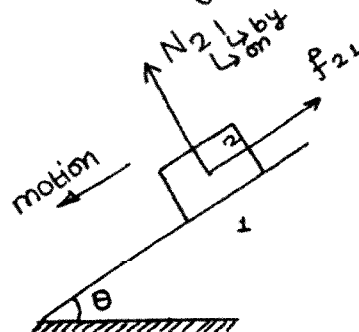
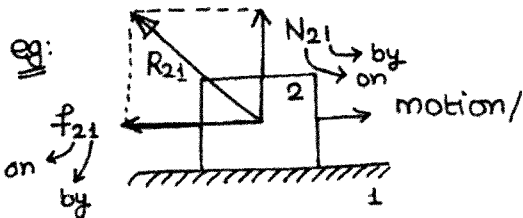


$(R_E + r \approx R_E)$

• Contact Force →

Normal Reaction (Pushing)

Friction

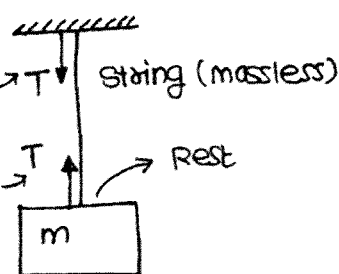


• Tension →

ex → 1. (Pulling)

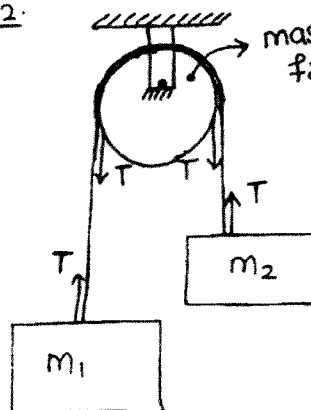
on support by string

on mass m by string



ex → 2.

massless & frictionless



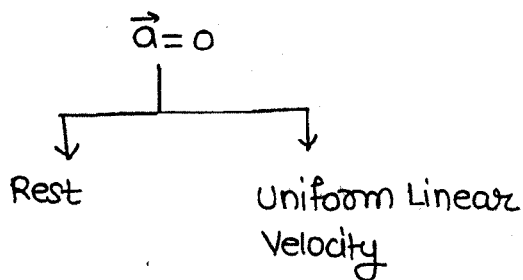
• Spring Force (F_s) →
(Can be Pulling or Pushing)

$$F_s = K(\Delta x)$$

Spring Constant elongation or compression from Natural Length

• Newton's First Law (NFL): →

For a Particle → at the same
if $\sum \vec{F} = 0$ then $\vec{a} = 0$ Instant

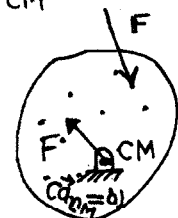


For a Rigid body

If $\sum \vec{F}_{\text{ext}} = 0$

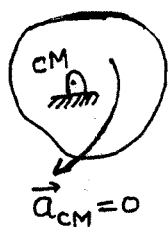
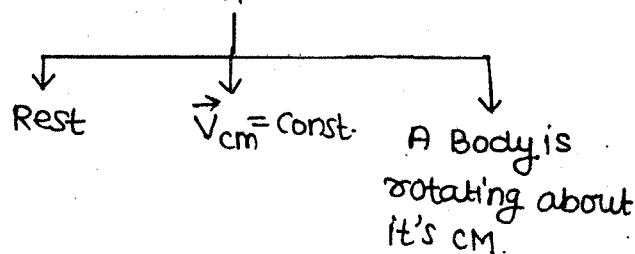
then $\vec{a}_{\text{cm}} = 0$

Particle

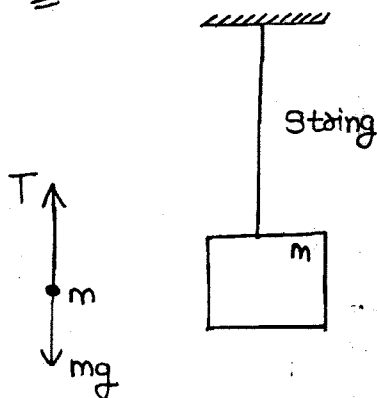


Rigid Body

$\vec{a}_{\text{cm}} = 0$



Eg:-1



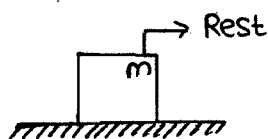
(m) → Rest $\Rightarrow \vec{a}_{\text{cm}} = 0$

$\sum \vec{F}_{\text{ext}} = 0$
↳ Newton's 1st Law

$T - mg = 0$ [Newton's First Law]

$T = mg$ [NFL]

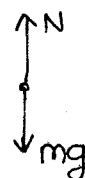
Eg:2



(m) → Rest

$\vec{a}_{\text{cm}} = 0$

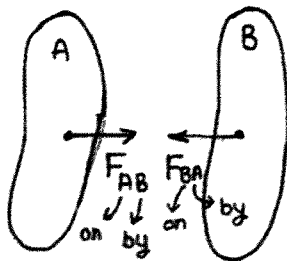
$\sum \vec{F}_{\text{ext}} = 0$
↳ (NFL)



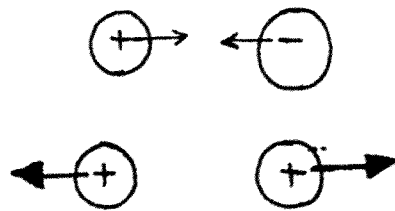
$N - mg = 0$

$N = mg$ [NFL]

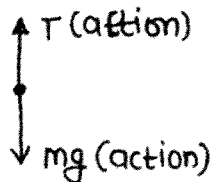
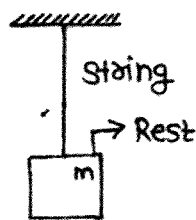
• Newton's Third Law (NTL) →



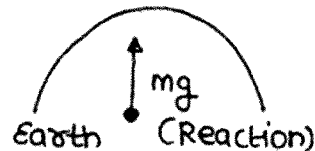
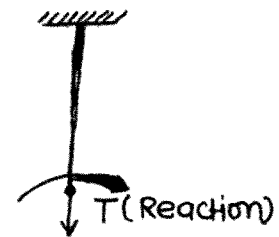
$$\vec{F}_{AB} = -\vec{F}_{BA}$$



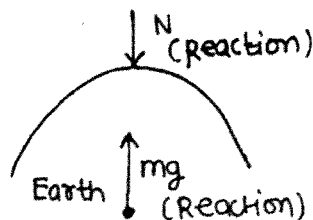
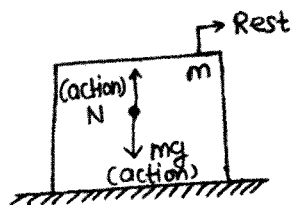
Ex: 1



$$g = \frac{G M_E}{R_E^2}$$



Ex: 2

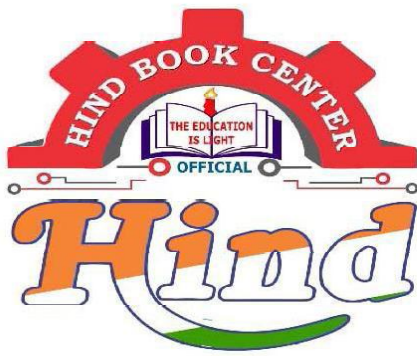


Reading of weighing

"If a Body A exerts ~~an~~ Force on Body B. then ~~a~~ certainly Body B will exert force on Body A, they will equal in magnitude and opposite in direction, colinear in action and same in Nature."

Imp
• F.B.D. ⇒ It is Representation of all the forces acting on the system by the surrounding

NOTE: → In FBD surrounding should not be shown.



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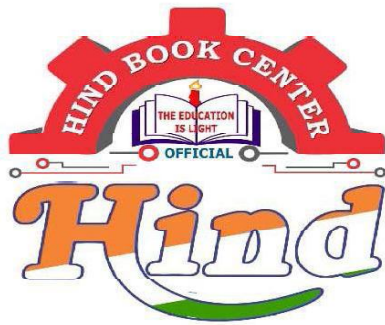
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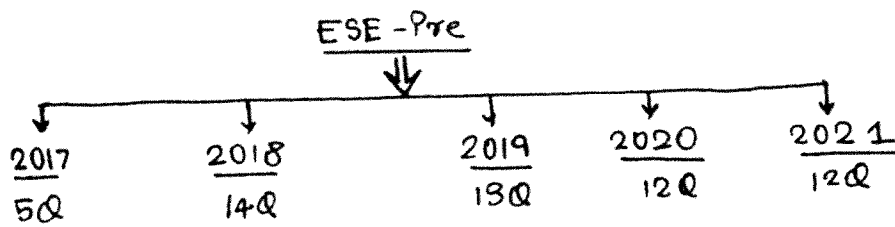
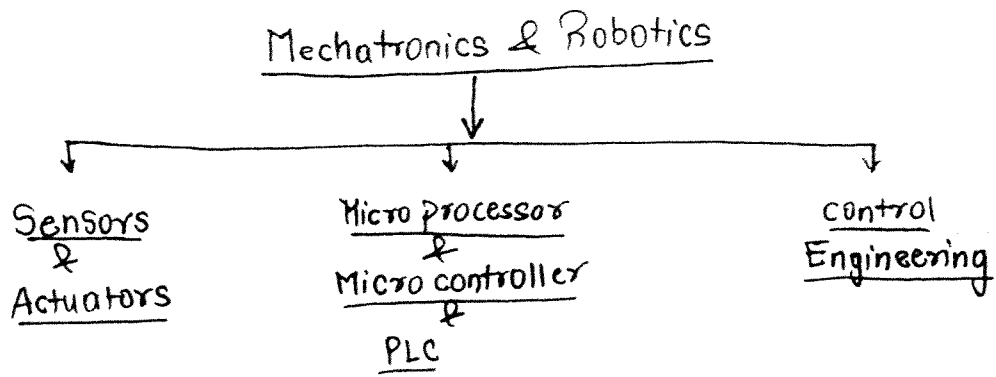
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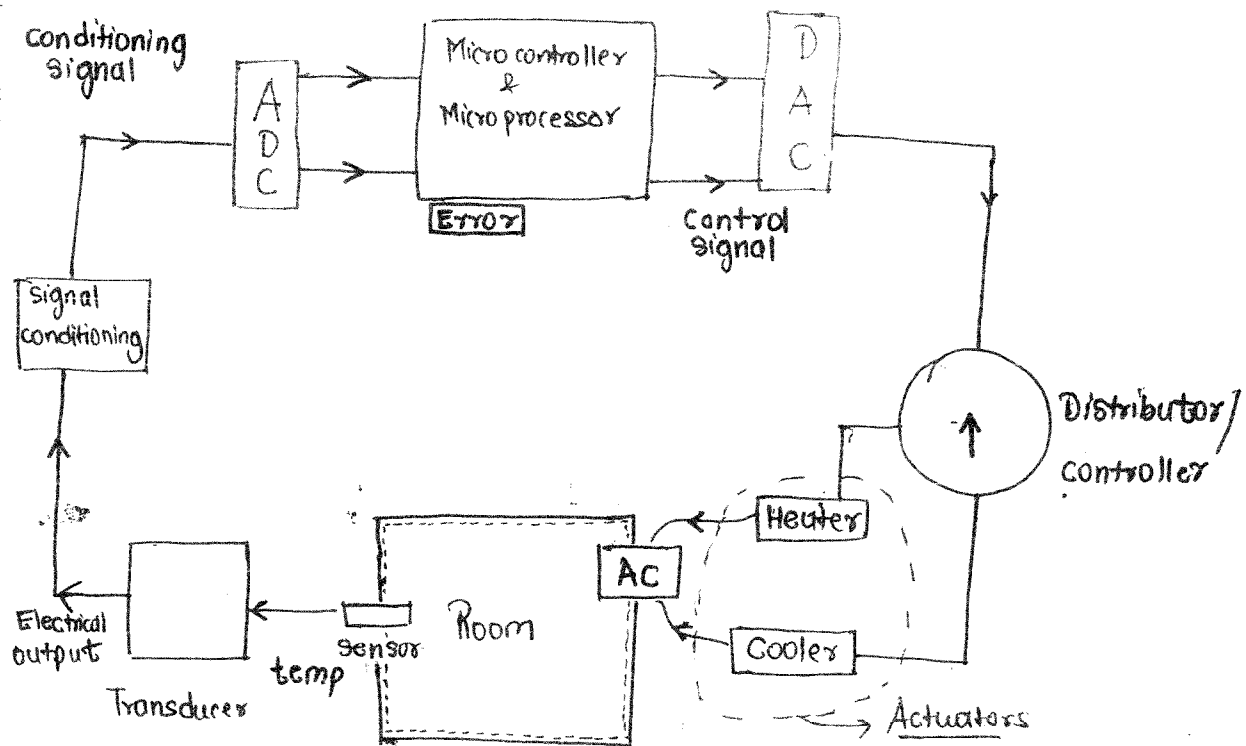
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State AE → 6 to 9Q

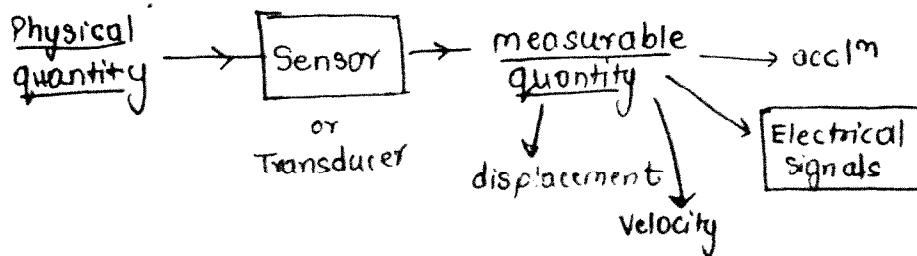
↳ (ESE PYQ / Sample paper of ESE)

Conventional AC :



Sensors :

Sensor is a device which is used to convert or measure or convert physical quantities into other measurable quantities

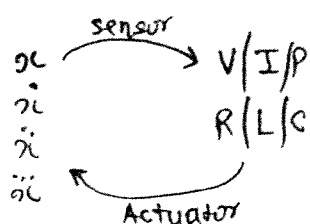


our main aim is to convert physical quantities into electrical signals only

<u>Physical quantities</u>	<u>Derived quantities</u>	<u>Passive quantities</u>	<u>Active quantities</u>	<u>Digital quantities</u>
T	α	R Resistance	V	0
P	$\dot{\alpha}$	C capacitance	I	1
Vol	$\ddot{\alpha}$	L inductance	P	↓
Sound	$\ddot{\alpha}$	eg Strain gauge	Analog signal	Digital signal
Vibration			eg 1 Potentiometer	eg optical encoder
etc			2. Hall Effect sensor	

Need
↓
Thermometer

* Our main aim is to convert physical quantities into V/I/P



R/L/C are steady component में आगे Flow नहीं करते. Thus to measure them or manipulate them we convert into V/I/P which has ability to flow and can be measurable also

Active Sensors

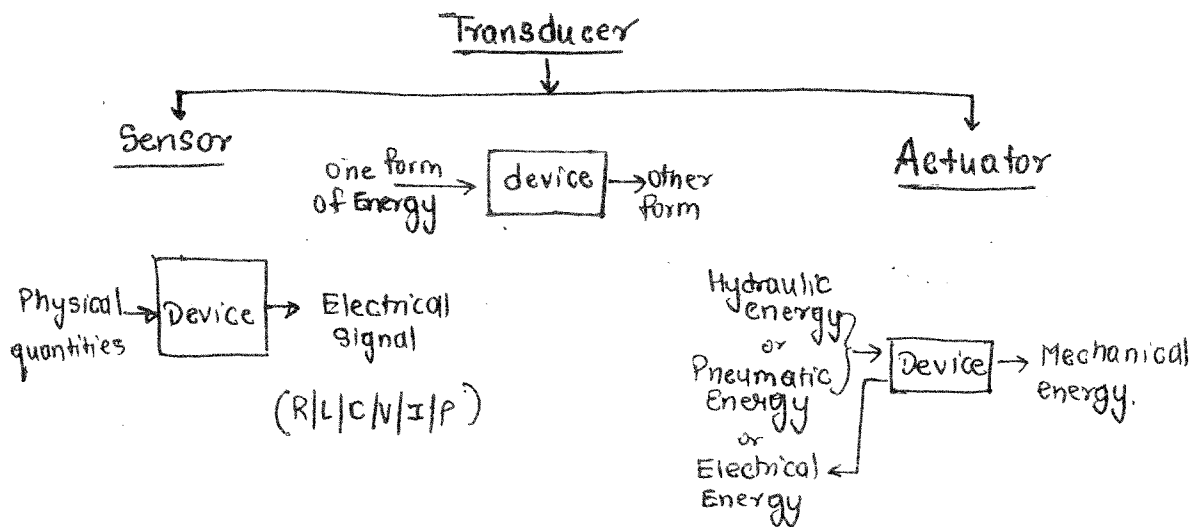
These sensor produces output which can be given directly to the computers

Passive Sensors

These sensors are generally static as their output can't be transfered or used directly

Whenever we try to convert

Transducer



A transducer is a device which converts one form of energy into another form. A Transducer can be divided into two parts

1. Sensor
2. Actuator

Actuator

It is a device which converts one form of energy into Mechanical Energy

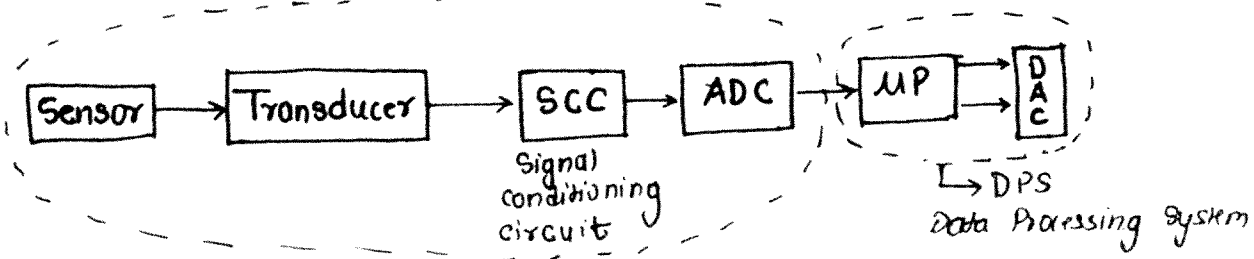
Hydraulic $\rightarrow$ Mechanical

Pneumatic $\rightleftharpoons$ Mechanical
Pneumatic Actuator

Electrical $\rightleftharpoons$ Mechanical

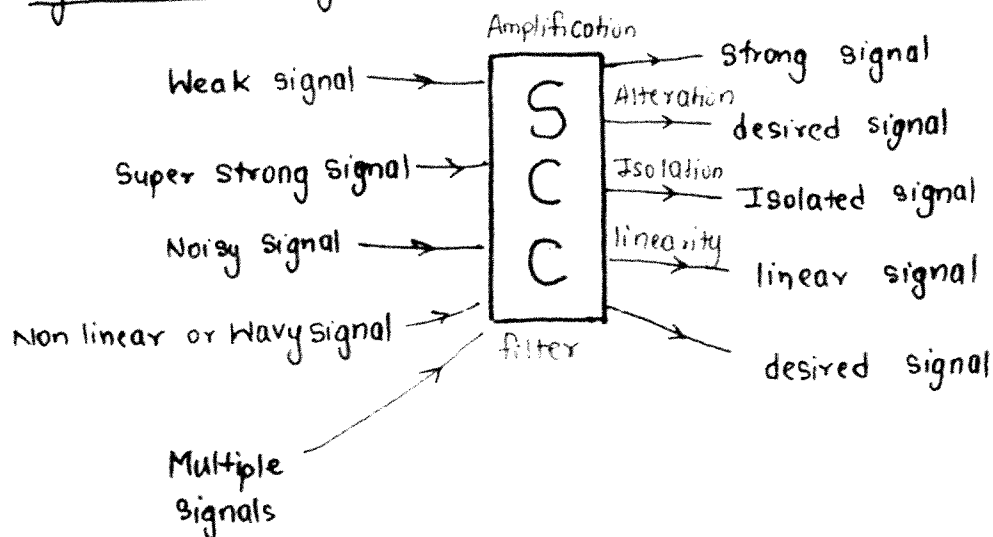
DAS Data Acquisition system

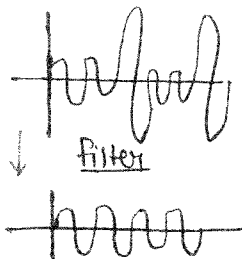
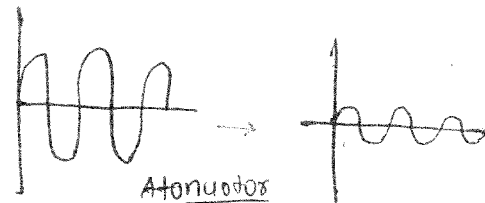
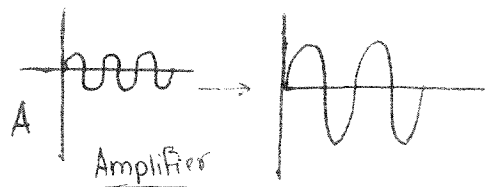
DAS/DAQ



It is a procedure by which data of physical quantities is provided to microprocessor/computer for further processing

Signal conditioning circuit





A signal conditioning circuitry is used to manipulate the signal into desired form by using different devices

NOTE If sensor generates O/P in form of R/L/C then we will use an electronic device which converts R/L/C into V/I/P. V/I/P are the desirable O/P

Amplifier: It is a device which is used to increase the amplitude of a signal (or) Use to increase a signal strength

Attenuator: It is a device which is used to decrease the amplitude of a signal (or) Used to Reduce the strength of signal

Filter: It is a device which is used to select a particular signal with desired frequency from multiple signals

Low pass filter

High pass filter

It is used to filter out the desired frequency from a signal

Statement - I: To use a sensor, we generally need to add a signal conditioning circuitry, such as circuits which amplify and convert analog signal to digital, to get the sensor signal in the right form, taking account of any non linearities and to calibrate it

Statement II: A smart sensor is a sensor integrated with the required buffering and conditioning circuitry in a single element and provides function beyond that of a sensor

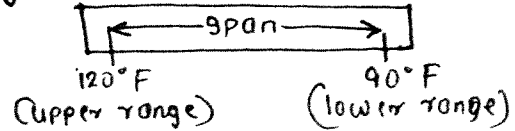
Ans : b

Q135
P-626

Q127

Sensor Specification

eg Thermometer



Range : The range of a sensor indicates the limit between which the input can vary

Span : The span is the difference between the maximum and minimum value of input

Error :

$$\text{Error} = \left| \frac{V_a - V_e}{V_e} \right| \times 100$$

$\uparrow$ appeared value $\rightarrow$ expected value

Error is defined as the difference between true value and measured value

OR

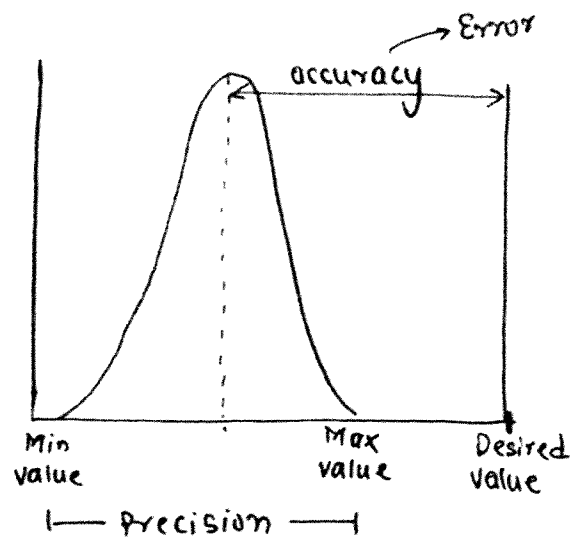
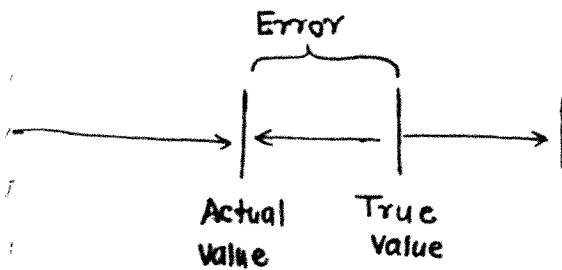
$$\text{Error} = \left| \text{True value} - \text{Measured value} \right|$$

Error = $|V_a - V_e|$

(Absolute value is obtained of error)

$$\text{Error} = \left| \frac{T.V - M.V}{T.V} \right| \times 100$$

Accuracy & Precision



Accuracy

It is the closeness of the agreement of between the results of measured value and desired value

OR Proximity to the measured Result to the true value

Precision

It is the ability of a sensor to Replicate the same output 'n' number of times, it is also known as repeatability



NOTE

1. Accuracy is generally dependent on error.
2. Precision has no Relation with the desired value

$$\text{Repeatability} = \left| \frac{\text{Max value} - \text{Min value}}{\text{Range}} \right| \times 100$$

Diagram illustrating the formula: A box contains the formula. Above the box, two arrows labeled 'actual' point to the 'Max value' and 'Min value' in the numerator. Below the box, an arrow labeled 'Full sensor Range' points to the 'Range' in the denominator.

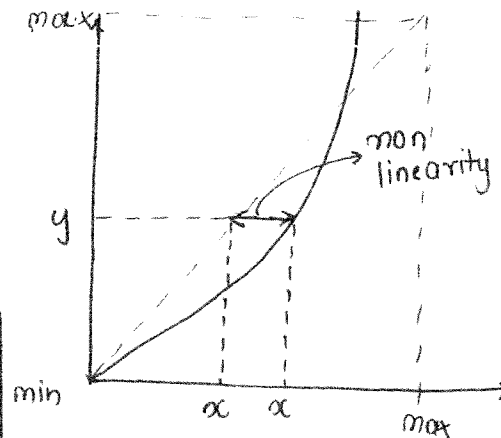
Accuracy ka matlab hain apne desired result ke kitne karib hai

eg 80/100 is more accurate than 70/100

Repeatable matlab ek hi result apne kitni bar dohra sakte hai

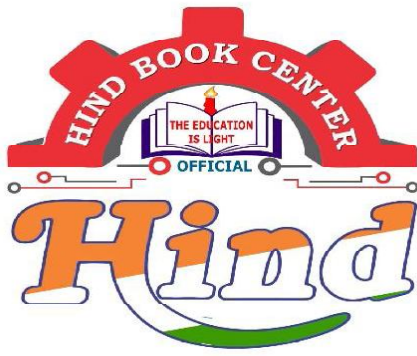
Nonlinearity

It indicates the maximum deviation of the actual measured curve of sensor with the ideal curve



$$\text{Non linearity} = \left| \frac{\text{max error in input}}{\text{Full scale Range of input}} \right| \times 100$$

%



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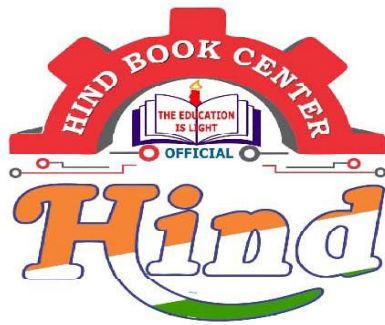
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MECHATRONICS And ROBOTICS :-

Mechatronics :-

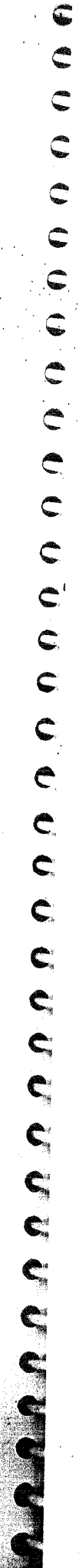
- Microprocessor & Microcontrollers,
- Architecture, programming, I/O, computer interfacing,
- Programmable logic controller
- Piezoelectric accelerometer.
- Hall effect sensor
- Optical Encoder.
- Resolver,
- Inductosyn,
- Pneumatic and Hydraulic actuators,
- Stepper motor

Control Systems :-

- Mathematical modeling of physical systems,
- Control signals.
- Controllability and observability.

Robotics :-

- Robot classification
- Robot specification, notation,
- Direct & inverse kinematics
- Homogeneous coordinates &
- Arm equation of four axis SCARA Robot



* Robotics *

* Introduction :-

- Origin of the word 'robot' can be traced in the Czech word 'robota', which means "forced or compulsory labour".
- The "official" definition of an industrial robot is provided by the Robotics Industries Association (RIA), formerly the Robotics Institute of America (RIA):-

multifunctional. "An industrial robot is a reprogrammable, multifunctional, manipulator designed to move materials, parts, tools, or special devices through variable programmed motions for the performance of a variety of tasks".

Manipulator → Robot arm.

• IS CRANE a ROBOT?

→ although crane also has a manipulator but it is always controlled by human operator.

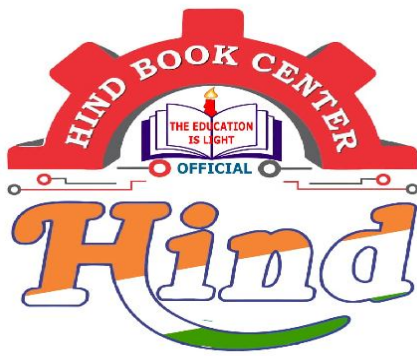
crane → Manual handling system.

End effector → Gripper → attached to the last joint of robotic arm used for holding or grasping an object.

* Indian Scenario :-

1> NETRA → (flying) Surveillance Robot, UAV → Unmanned aerial vehicle.
Network Traffic analysis Developed by DRDO
↳ "CAIR" (Lab)
Centre for Artificial Intelligence & Robotics.

NETRA Robot can intercept voice traffic signals and identify the device using words such as bomb, blast etc in real time response.



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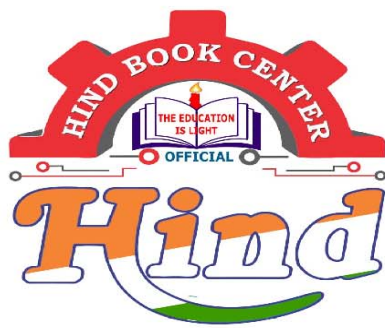
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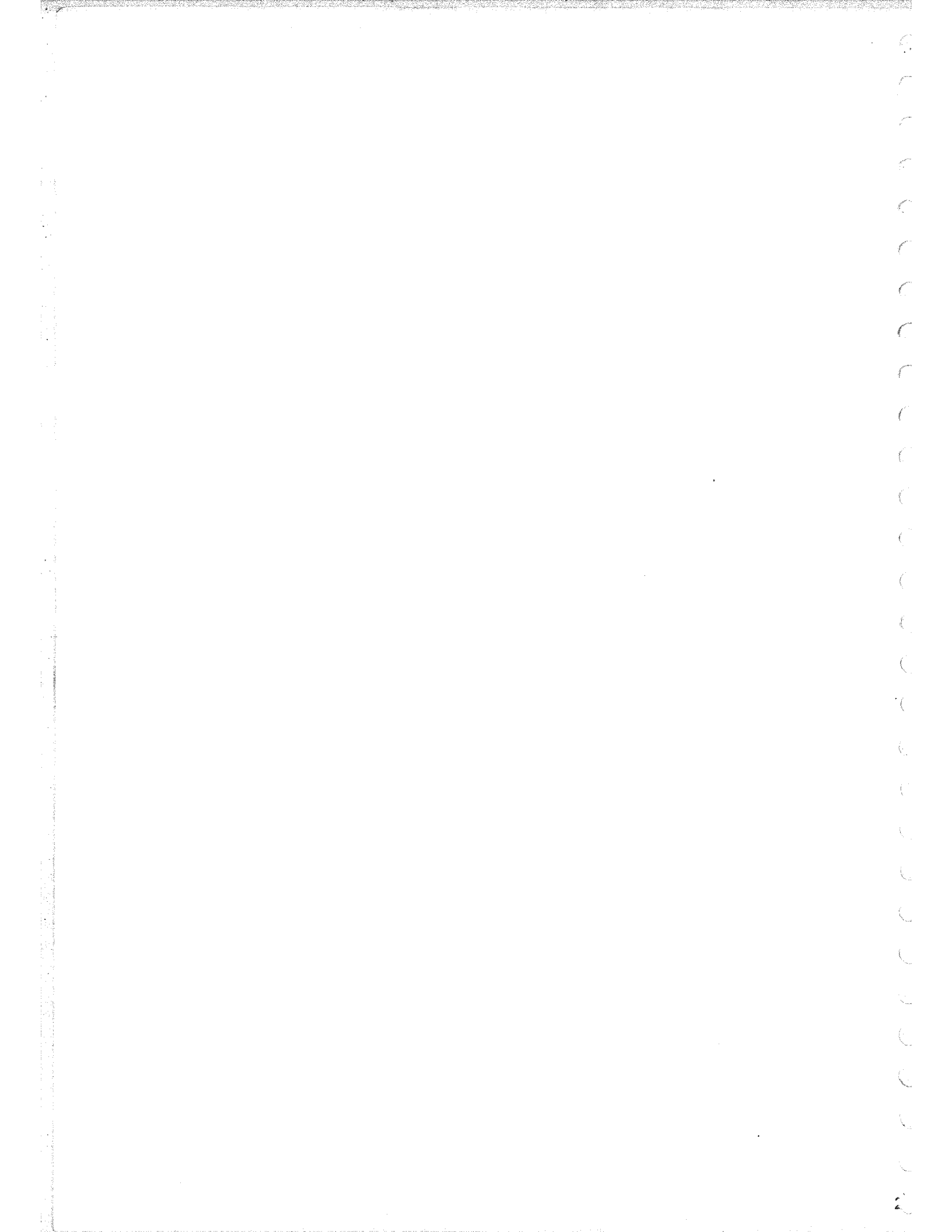
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RSE

BY RAHUL SIR

Reference book

-BH Khan.



BASIC

ENERGY: It is capacity to produce an effect.

Energy can be:

- (i) Stored within a system
- (ii) Can be transferred from one system to another (By Heat, work, mass)

Oil Crisis of 1973:

This year brought an end to the era of secure and cheap oil. In October of that year, OPEC (Organisation of petroleum Exporting countries) put ban on oil production and started oil-pricing control strategy. The year "1973" is called as year of oil shock.

Government of all countries took this matter very seriously and for the first time, a need for developing source of energy was felt.

Classification of energy Resources:

1. Based on Usability of Energy:

a) Primary energy resource:

These are resources already present in nature prior to undergone any human made transformations. E.g., Coal, crude oil, sunlight, wind, vegetation, uranium.

These are located, explored, extracted, processed and are converted to a form as required by the consumer. These resources are generally available in raw form (i.e., cannot be used as such) and are, therefore known as raw energy resource.

b) Secondary energy resource:

The form of energy which is finally supplied to a consumer for utilization is called as secondary energy resource.

E.g., Electrical energy, thermal energy (in the form of steam or hot water), chemical energy (in the form of hydrogen), oil

2. Based on traditional use:

a) Conventional energy resource:

Energy resources which are being traditionally used for many decades and were in common use around the oil crisis, are called as conventional energy resource.

E.g., Fossil fuel, Nuclear and hydro resources.

coal petroleum

b) Non-conventional energy:

Energy resources which are considered for large scale use after oil crisis. E.g., Solar, wind, biomass, etc.

3. Based on long-term availability:

a) Non-renewable energy resource:

Resources which are finite and do not get replenished (fill up again) after their consumption are called as non-renewable energy resource. E.g., Fossil fuel, uranium. These are also called as brown energy, because produces pollution.

b) Renewable energy resource:

Resources which are renewed by nature again and again and their supply is not affected by the rate of their consumption are called as renewable energy resource.

These are also called as green energy as produces very less or no pollution.

E.g., Solar, wind, Geothermal, Ocean (tide, wave, thermal), biomass, Hydro

Hydro → conventional as well as Renewable Energy Resource

Difficulties in harnessing renewable energy:

- It is present in dilute form (useful energy is very less).
- It is highly fluctuating type of energy. It depends on weather conditions. Hence, continuous supply of such energy can't be ensured always.
- Large area of land is required to produce energy for commercial applications.

Aim of subject:

To find replacement of fossil fuel.

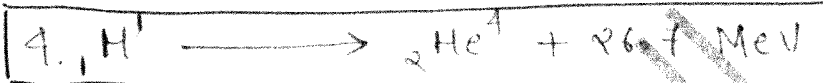
Syllabus:

1. SOLAR RADIATION
2. SOLAR COLLECTOR
3. SOLAR APPLICATION
4. ENERGY STORAGE
5. BIOMASS ENERGY
6. WIND ENERGY
7. TIDAL ENERGY
8. PHOTO-VOLTAIC CONVERTORS
9. FUEL CELL

SOLAR RADIATION

SUN (As a Source of energy)

- It is a large sphere of intensely hot gaseous matter.
- Surface temperature of Sun is around 5800K (Effective blackbody temperature calculated by using Stefan-Boltzmann's law)
- Core of Sun:
Density is round 100 times of water
Pressure is around 10^9 atm.
Temperature (8×10^6 to 40×10^6)K
- Such a higher inner core temperature is maintained by huge energy released due to "continuous fusion reaction". Several fusion reactions have been suggested to be source of energy radiated by the sun. The most important of them is



$$1 \text{ eV} = 1.6 \times 10^{-19} \text{ Joule.}$$

In above equation, 4 hydrogen atoms combine together to form one helium atom. The mass of helium is less than that of four hydrogens, the difference of mass is been converted to energy in a fusion reaction.

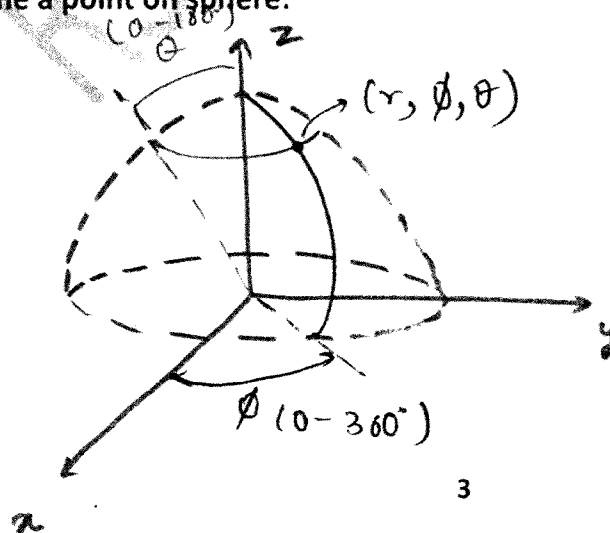
- Solar energy can be used by three technological processes.
 - (i) Helio-chemical: Solar $\rightarrow$ Food + oxygen (Photosynthesis)
 - (ii) Helio-electrical: Solar $\rightarrow$ Electricity (PV cell)
 - (iii) Helio-thermal: Solar $\rightarrow$ Thermal energy (water heater)
Pool - Top

Helio $\rightarrow$ SUN

SUN AND EARTH GEOMETRY

Position on earth: Position on earth is specified by latitudes and longitudes.

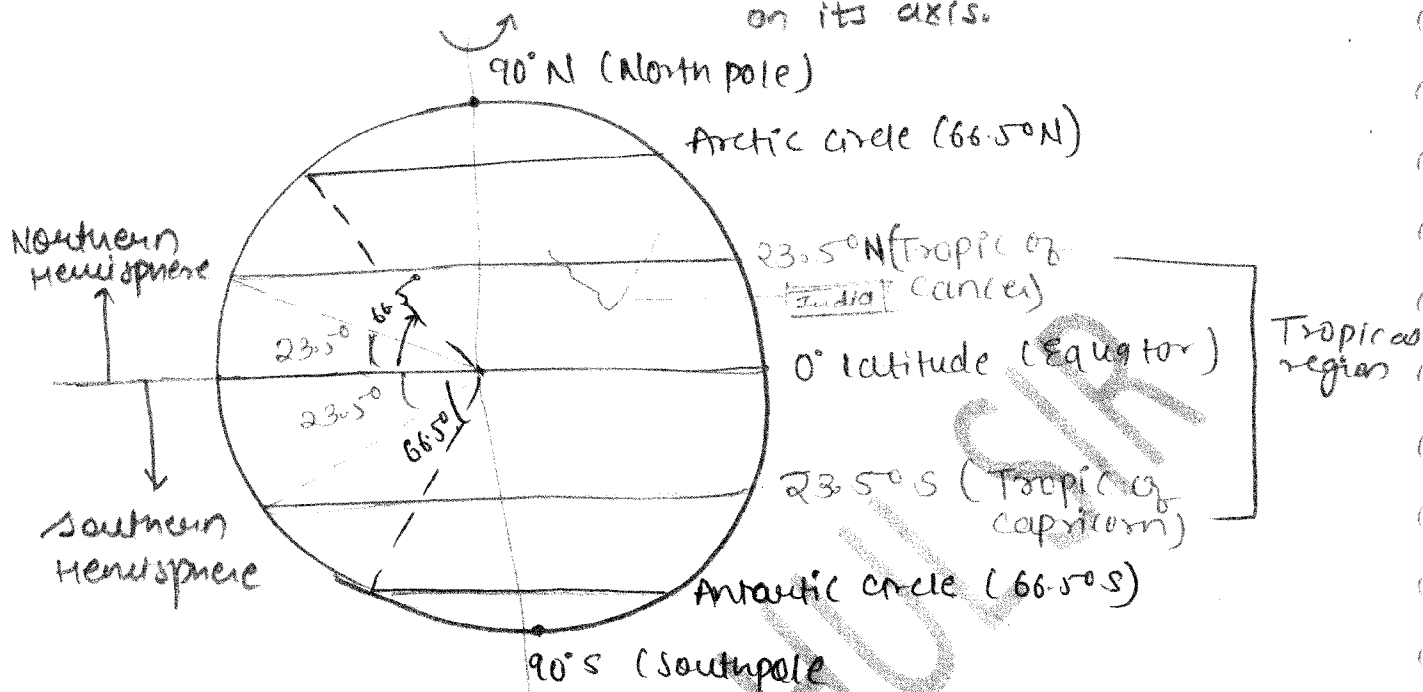
Define a point on sphere:



θ, ϕ - symbols
for Heat
Transfer.

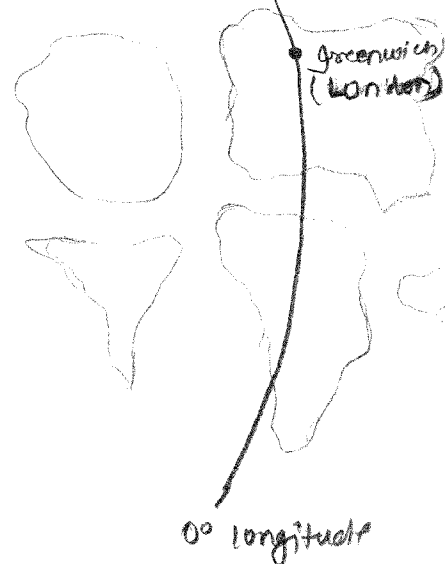
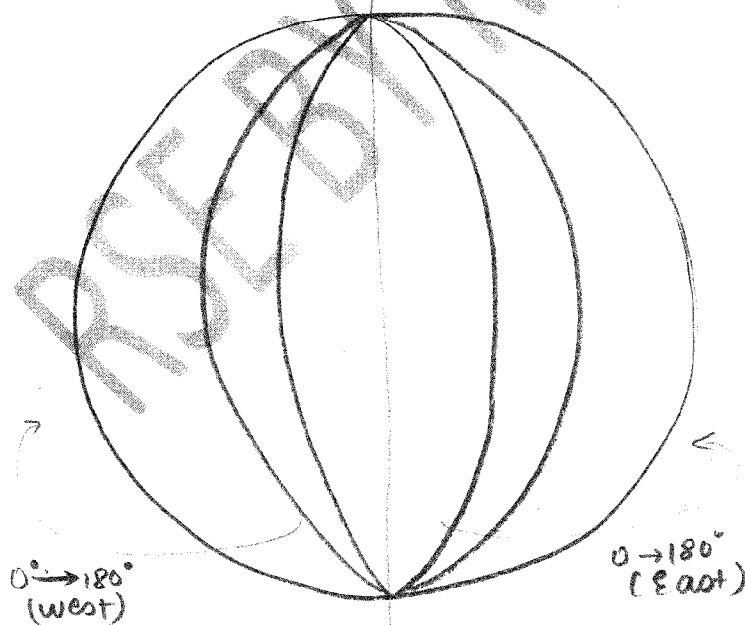
Latitudes:

Earth rotates from West to East on its axis.



Longitudes

- Earth completes 1 rotation (i.e. 360°) in around 24 hrs. So, it rotates 1° in around 4 mins ($\frac{24 \times 60}{360} = \frac{4 \text{ min}}{\text{deg}}$)



PRIME MERIDIAN

(or) 4

Greenwich Meridian

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Apparent motion of sun:

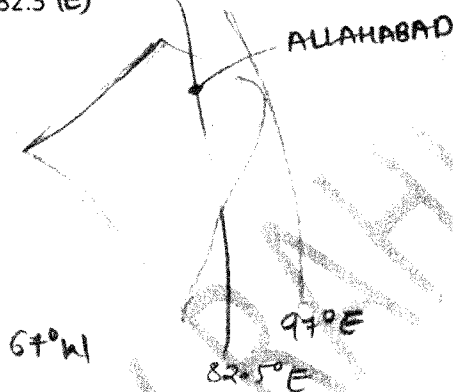
Although sun is stationary in our solar system but due to rotation of earth on its own axis (from west to east) sun appears to be moving from east to west relative to earth at any location on earth.

It appears to rising in east and setting in west to an observer on earth.

Scaling of time on earth:

It is done on the basis of sun rising and setting. It can be observed that different places in a country will see rising and setting of sun at different moment. So, for that purpose standard longitude is decided in any particular country to define standard time of that country.

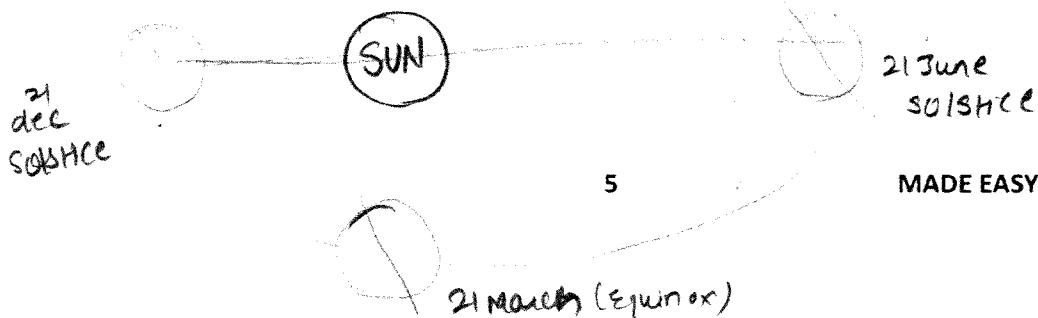
E.g., For India it is 82.5°E



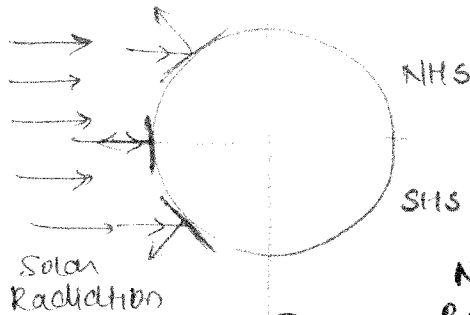
Revolution of Earth around Sun:

- Earth revolves around sun on elliptical path and takes around one year for complete revolution.
- The distance between Sun and Earth keep on varying all around year.
- The earth is tilted on its axis of rotation. As The axis of earth is tilted, both hemisphere northern (NHS) and southern (SHS) receives different amount of solar radiation at different time of year and so have different temperatures.
- **Solstice:** At solstice sun rays are normal on either Tropic of Cancer (21 June) or on Tropic of Capricorn (21 December).
- **Equinox:** At equinox sun rays are normal on Equator (21 march and 21 September).
- **Aphelion:** It is point when distance between earth and sun is maximum (4th July)
- **Perihelion:** It is point when distance between earth and sun is minimum (4th Jan).

21 sept (Equinox)

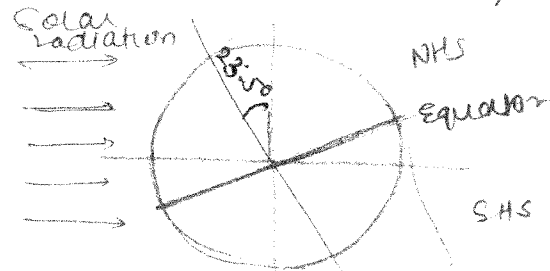


If Axis of Rotation is not tilted



NHS & SHS would receive same amount of solar radiation and would have same season

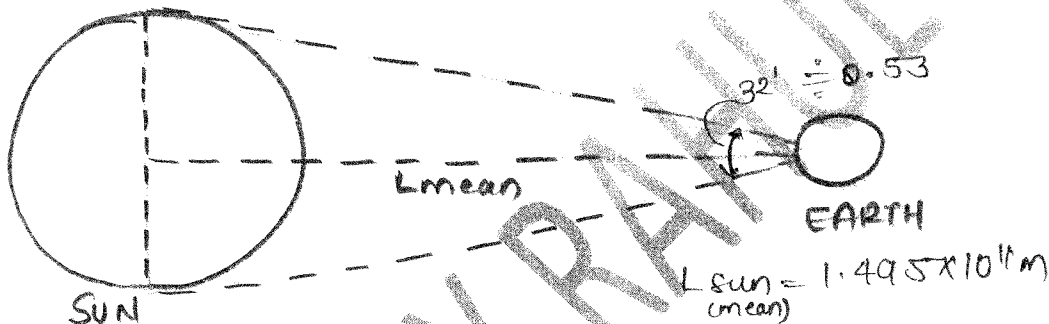
But in actual Axis is Tilted



Both Hemispheres receive different amount of solar radiation during entire year. So, both Hemispheres have different temp throughout year.

ONE ASTRONOMICAL UNIT

It is average distance between Sun's centre to earth's surface.



Spectral Energy Distribution of Sun:

It is given by Planck's distribution, treating sun as black body. 99% of extra-terrestrial radiation emitted by sun lies in the range of 0.2 to $4 \mu\text{m}$.

In which,

Around 6.4% $\rightarrow$ Contains UV ($\lambda < 0.38 \mu\text{m}$)

Around 48% $\rightarrow$ Contains visible region ($0.38 \mu\text{m} < \lambda < 0.78 \mu\text{m}$)

Around 45.6% $\rightarrow$ Infrared region ($\lambda > 0.78 \mu\text{m}$)

Note: Extra-terrestrial radiation peaks in visible range.

Solar radiation and earth's atmosphere:

The radiation available on the earth's surface is less than what it is received outside the earth's atmosphere and this reduction depends upon:

1. Effect of atmospheric gases:

The earth's atmosphere contains various gaseous constituents, suspended dust and other minute solid and liquid particulate matter. These are air molecules, ozone, oxygen, nitrogen, carbon dioxide, water vapor, dust, etc.

Atmospheric gases deplete solar radiation by

(i) **Absorption:** Absorption of various wavelength occurs by different molecules. The absorbed radiation increases the energy of the absorbing molecules thus raising their temperature. Such as ozone absorbs significant amount of UV radiation.

(ii) **Scattering:** Some scattering of incoming radiation takes place by dust particles and air molecules. A part of scattered radiation is reflected back to space and remaining is directed downward to earth's surface from different directions as "diffuse radiation".

Cloudy atmosphere:

- A major part of incoming solar radiation is reflected back into space by clouds.
- Another part is absorbed by the clouds.
- Rest is transmitted downward to the earth surface as diffuse radiation.

Albedo:

Total solar radiation reflected back to space by earth is called as albedo of earth-atmosphere system. It has a value of 30% of incoming solar radiation.

Terrestrial Radiation: It is a region near to earth's surface.

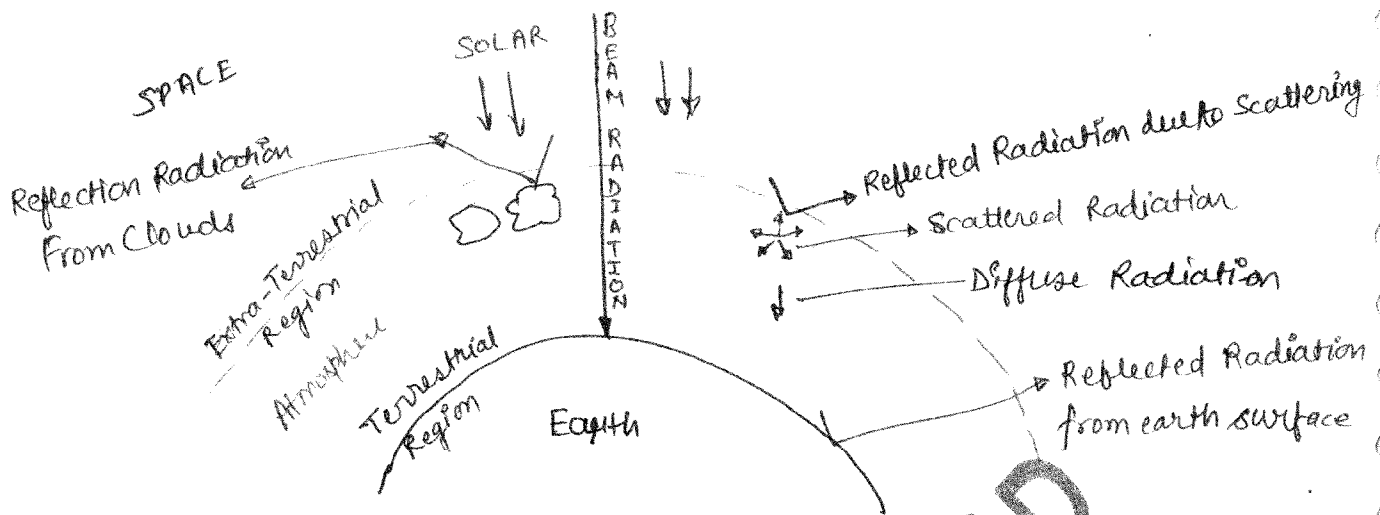
Extra-terrestrial Radiation: It is region on outer most part of atmosphere.

On the surface of the earth, we have two components of Solar radiation:

(a) **Beam Radiation:** Solar radiation propagating in a straight line and received at the earth's surface without change of direction is called as beam or direct radiation.

(b) **Diffuse Radiation:** Solar radiation scattered by dust and gaseous molecules is known as diffuse radiation. It does not have unique direction.

(c) **Global Radiation:** It is sum of beam radiation and diffuse radiation.



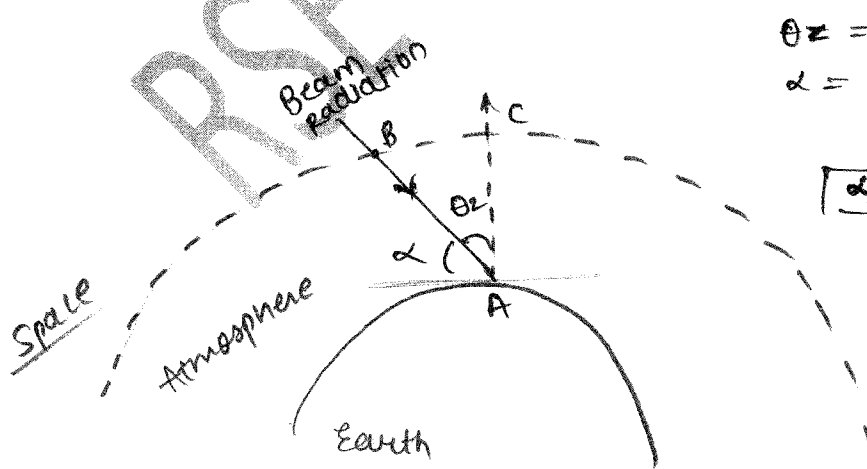
2. Distance travelled through atmosphere:

The second reason for depletion of solar radiation passing through atmosphere is the distance travelled by beam radiation through the atmosphere before it reaches a location on earth's surface.

The path length of a solar beam through the atmosphere is accounted for in the terms of air mass.

Air Mass (m):

It is defined as the ratio of the path length through the atmosphere, which the solar beam actually passes up to ground (BA) to the vertical path length which is minimum through the atmosphere (CA).



θ_z = zenith angle

α = Incination Angle

$$\alpha + \theta_z = 90^\circ$$

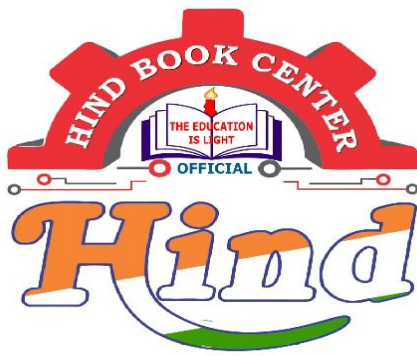
$$m = \frac{BA}{CA} = \sec \theta_z$$

$$m = \sec \theta_z = \csc \alpha = \csc \theta_z$$

$m=0$:- on extra-Terrestrial Region

$m=1$:- It means sun is overhead.

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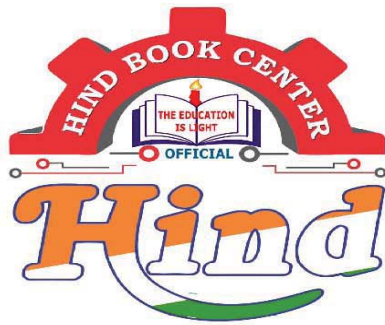
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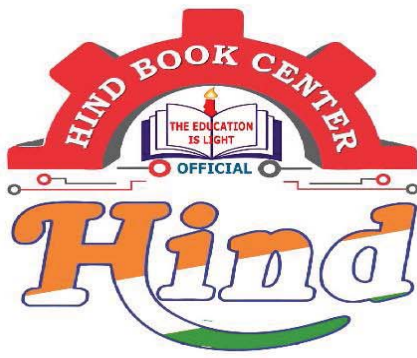
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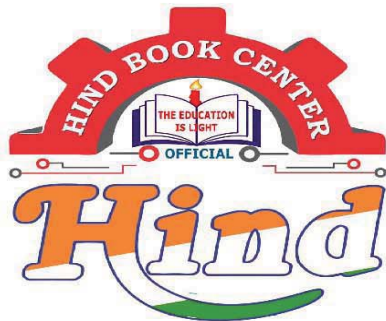
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→ Books Author - 1

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→ Presidential Election 2022.

Imp't Ases ↓

- (President/VP election)
- (Azadi Ka Amrit Mahotsav)
- (^{Corona} Russia - UK raine War).
- (Sports - FIFA) / Olympics.
w. cup.
- (State elections).
- (Energy crisis in world).
- (Nuclear power plant).
- (Financial Condⁿ of India & the world)
- (India, china, Pak, Sri Lanka),

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- Books and authors.
- World Heritage sites.
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- Important personalities.
- Centenary / Anniversary of imp. events.

14-15 quesⁿ

Economics - 4-5.

Books/Author - 01

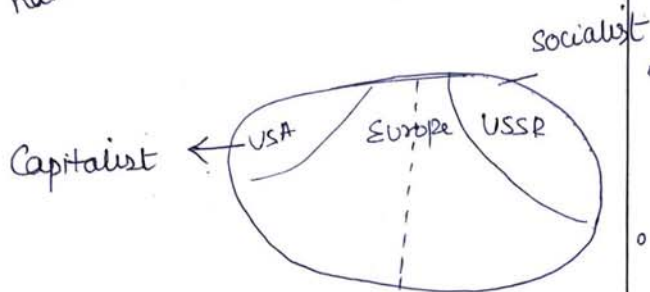
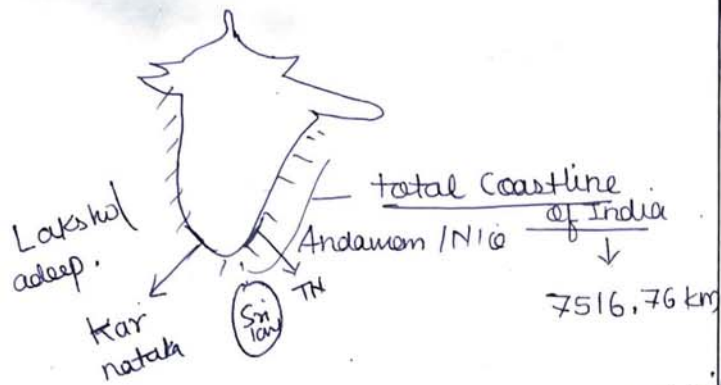
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Sci tech / Env / Def - 4/5.

Awards / Honours - 1.

Rare events - 1/2.

Imp development in Nat / Intⁿ - 2/3.



(Non-alignment movement - NAM)

~~Theore~~

There are 3 types of economies in world:-

1. Capitalist Economy:

- Factors of production lie in the hands of private sector.
- Govt has min role in factors of production.
- USA, UK, etc
- Concept was given by : Adam Smith

↓
Book: Wealth of Nations.
Concept: Laissez faire
↓
(Min interference by govt)
↓
Capitalist economy.

2) Socialist Economy:

Means of production lies in the hands of state / govt.

- No private production.
- Concept of Socialist economy - Karl Marx (Germany).
- USSR → Revolution (1917)
↓
Bolshevik Revolution.
↓
lead to formⁿ of Socialist govt.

- USSR adopted socialism.
- China adopted Communism.

USSR

Glasnot (Openness).

Perestroika (Restructuring)

Mikhail Gorbachev (Russian President)

- In 1985, China adopted open door policy for improvement in Chinese economy.

(iii) Mixed Economy.

- Factors of production lies in the hands of state and private sector both.
- Concept given by John Maynard Keynes
↓
Keynesian economy.

eg: India.

Sectors of Economy

3 sectors of economy:-

(1) Primary sector:-

It uses Natural resources as the direct product.

Agriculture, Horticulture, Sawing,
Bee Keeping, Mining.

(2) Secondary sector:

It uses the product from primary sector as raw material,

eg: Manufacturing, processing of food, etc.

(3) Tertiary Sector:

It involves ~~service~~ service sector.

eg. Banking, Finance, Tutions, etc.

(4). Quaternary Sector:-

It is related to knowledge economy. It involves R&D, training, skill development, etc.

Important terms

1. Repo rate:-

• RBI is also called as Bankers Bank. RBI is responsible for controlling monetary policy, (money supply) in the market.

• RBI is responsible for controlling all the retail banks in India.

• The rate at which RBI gives loan to retail Banks is called as Repo rate.

2. Reverse Repo rate:-

Rate at which Banks gives loan to RBI.

Bank rate:— Rate at which Bank gives loan to public.

Inflation:— Rate of increase of Cost and prices.

- If market has more money, inflation increases.
- If market has limited money, inflation decreases.
- If Repo rate is decreased by RBI then inflation increases (Repo rate $\downarrow$; Inflation $\uparrow$).
- (Reverse repo rate ~~###~~ = Repo rate + 1%)
- VVP for this year
Presidential Election 2022

India is a republic country which means that Head of the state is elected ~~###~~. Since in India, Head of the state is president and therefore the president is elected while in Britain it is not a republic but monarchy state and therefore the head of state is not elected but it is hereditary.

India Conducted presidential election on 18th July '22 to elect its 15th president in 16th presidential election *

- The first president of India, Dr. Rajendra prasad was elected for two consecutive terms.
- According to Indian Constitution, Article no 52nd there will be a president of India. Election for the next president must be completed before the expiry of the term of current president. It means that post of President of India will never remain vacant.

• The president of India is only the nominal head but still the powers of president include

- President is the Head of the executive, legislature & Judiciary.
- President is the Supreme Commander of all the armed forces (Army, Airforce, Navy).

Therefore the presidential election in India follows a Nominal process only while the election of Prime minister follows an elaborate process.

Details of Presidential Election.

Presidential elecⁿ is diff^t than the election of PM since common public don't vote directly for the presidential election while the president of India is indirectly elected by the electoral college and electoral college consists of ¹⁾ elected members from ^{parliament} Lok Sabha and Rajya Sabha.

2) elected members from state legislative assembly.

3) elected members of union territory where legislative assembly is present (these two union territory of Delhi and Puducherry)

• who can't participate in the Presidential election?

(i) Nominated members of LS and RS.

(ii) Nominated members of state legislative assembly.

(iii) Members of Legislative Council (Vidhan Parishad).

How presidential election takes place?

The process of presidential elecⁿ is such that there is equal representation of state through legislative assembly and the Centre through the members of parliament. The value of votes assigned to the members of legislative assembly, and MP are different. The approximate value of each vote of MP is approx. 700 while the value of vote of legislative assembly member depends upon the state. The value of vote of MLA is calculated according to the formula given as:

$$\frac{\text{total popⁿ of state}}{\text{total members of legislative assembly} \times 1000}$$

Note: The total value of votes of MP and MLA is approximately 5 lakh each.

(Only 4 Candidates)

- The presidential election is conducted through Ballot paper and not through EVM.
- The presidential election takes place through Ballot paper only and EVM's are not used.
- There is no option for NOTA in the Ballot paper.
- In this counting of election takes place for the first preference of the candidate. Each member cast their vote in order of their preference and the member getting highest no. of first preference is declared as winner. But at the same time the winner must also cross the majority mark. The majority mark means the winning candidate must secure 50% of the total quota of votes + 1 vote.
- The presidential election takes place according to the system of proportional representation through Single transferable vote

where single transferable votes means the votes of candidate having lowest preference is transferred to the candidate having their second highest preference.

In 2022 election candidate from the ruling party was Draupadi Murmu, she was acting as the governor of Jharkhand and she came from a tribal community and she belongs to Orissa while opposition party candidate was Yashwanth Sinha who was a former finance minister in Atal Bihari Vajpayee government. There were incidents of cross voting also. In presidential and Vice presidential elections cross voting is also allowed.

Cross voting means the members can vote for their choice and without suffering from the cancellation of their membership.

Eligibility criteria to become the
— President of India —

- The person must be the citizen of India and must've attained a min. age of 35 years

- At least 50 proposers and 50 seconders should propose / second the name of the candidate.

- The proposal and Secunder must must come from the electoral college. An elector can't propose and second multiple candidates.

- The concept of proposal and Secunder was introduced in 1974. So that non-secular candidate can't participate in the presidential election. Also the limit of the no of candidate was restricted to 4 candidates only.

- The candidate must have the qualifications to become the member of parliament.

• Qualifications to become the member of parliament are:—

1. must be citizen of India

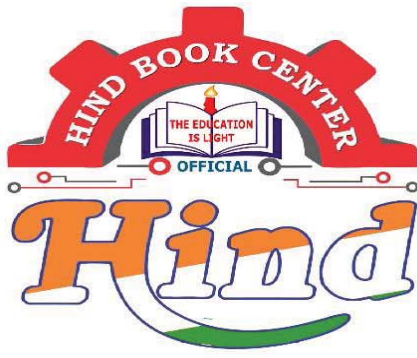
2. Must've attained the min. age of 25 years.

3. Must be a voter for any ^{parliamentary} constituency in India.

4. Member of parliament candidate also require proposer and Secunder. if the candidate is coming from a political party then only one proposal and one seconder is req. and If the candidate is coming from Independent Background then atleast 10 proposers and 10 seconders are required.

5. The candidate must submit a security deposit of atleast ₹2500.

6. The candidate must not hold any office of profit in the central or state government.



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Energy and Environment

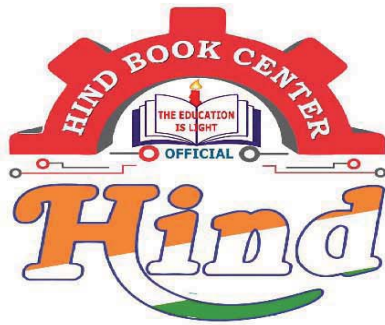
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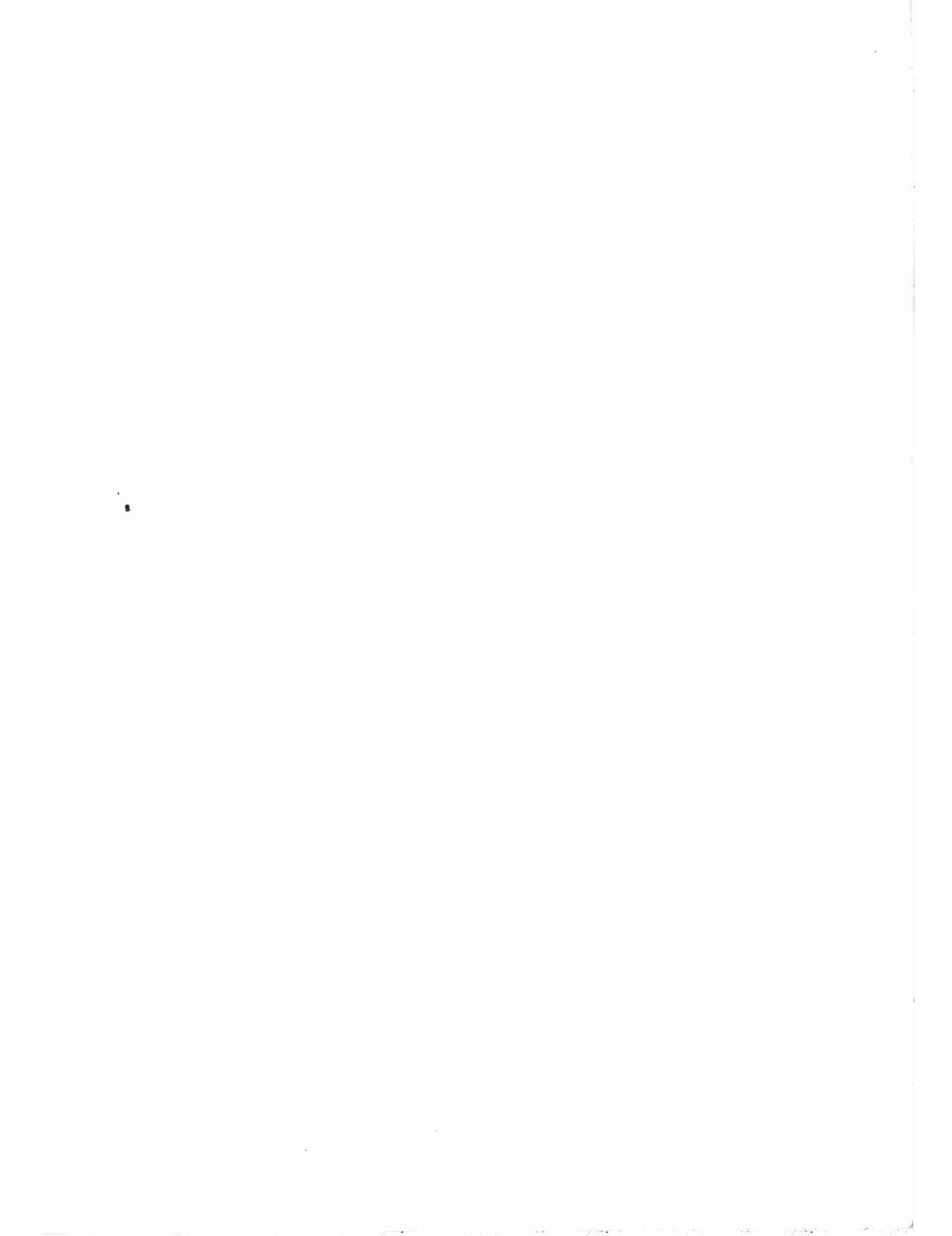
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ENVIRONMENT & ENERGY

Syllabus :

- (i) Basics of environment
- (ii) Biodiversity
- * (iii) Environmental Pollution (EP) and Environmental Degradation (ED)
- (iv) Climate change & Global warming
- (v) Environmental Protocol, convention & Treaties
- (vi) Ozone Hole & Related issues
- (vii) Energy
- (viii) E.I.A.

• MARKS = 20% Questions of paper - I

(12-15) QUESTIONS

→ 7-8 = conceptual
→ 6-7 = Concept + current

• Current Affairs → Made easy magazine Annual

• Study Materials

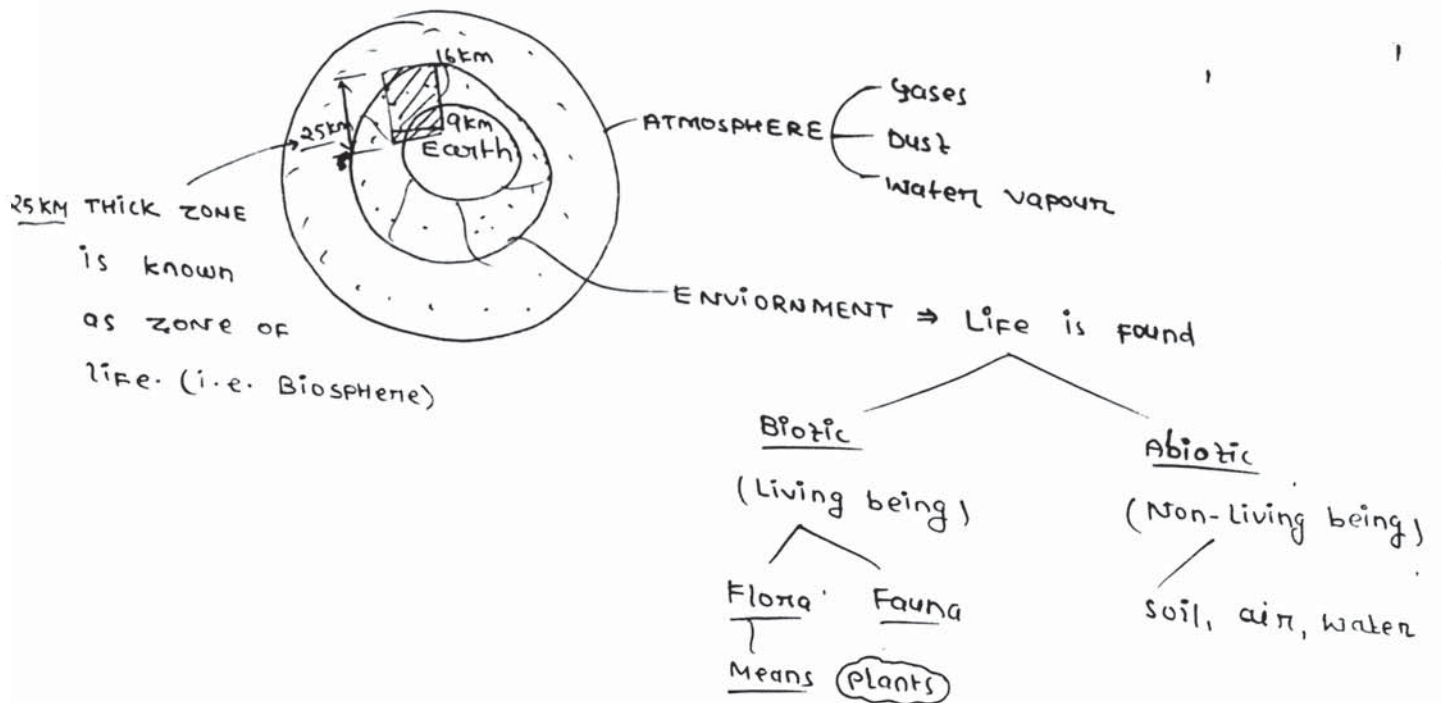
- class Notes
- PYQ
- Theorybook
- current magazine

(Made easy C.A.) → Annually.

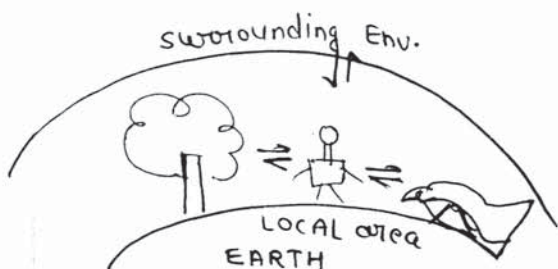
ENVIRONMENT?

DEFⁿ: Environment has been derived from French word "Environnement" / "Environ" which means to surround something.

Therefore Environment refers that surrounding of earth where life is found bcoz of favourable Biotic & Abiotic components / Fact.



ECOLOGY = ECO + LOGY
 Environment Science



⇒ Interaction
 |
 Exchange of energy and matter

- THE word Ecology is Greek Term.
- Ecology is made from "Oikos" & "Logos" where Oikos means Habitat / Abode place and Logos means to study or describe.
- THE term "Ecology" was first time coined ^{and defined} by ERNST HAECKEL (German scholar) in 1869 A.D.

DEFN: Ecology is a science under which we use to study Interaction of Flora & Fauna among themselves & their combined Interaction with surrounding Environment.

APPROACHES TO STUDY ECOLOGY :

1. AUTECOLOGY

[Population Ecology]

- Under it Interaction is studied among individuals of same species.

2. SYNECOLOGY

[Community Ecology]

- Under it Interaction is studied among individuals of different species.

ECOSYSTEM → concept given by A.G. Tansley in 1935.

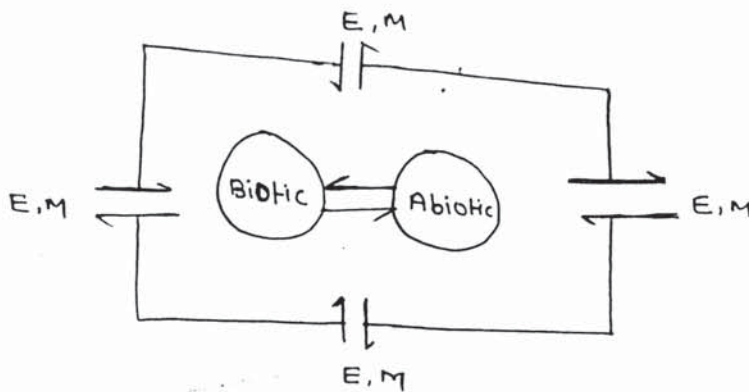
However it was elaborated in detail by "E.P. ODUM".

"E.P. ODUM" is known as Father of Ecosystem, Ecology

Ecosystem = Eco + System
 | Environment

is an Entity which is made from more than one elements where all elements are interconnected with each other in such a ~~system~~ way that if functioning of one element get affected then others are also affected

DEF^N: Ecosystem is a type of system which is mainly made from Biotic & Abiotic components where they are related in such a way that they behave as one entity and interact with their surrounding for exchange of E & M. Therefore ecosystem is an example of ~~Ecosystem~~ OPEN system.



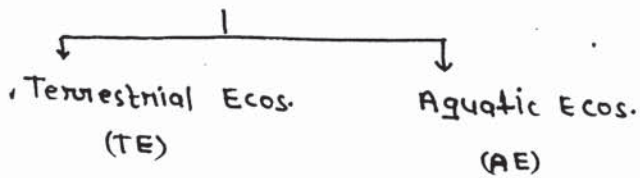
E, M → Energy, Matter

NOTE: TYPES OF SYSTEM

	<u>CIRCULATION OF</u>	<u>EXIST GN</u>
eg. — OPEN SYSTEM (Ecosystem)	E, M	Nature
CLOSE SYSTEM	E, M (STOP)	Lab
Isolated system	E, M Both stop	Mental Map or Imagination

TYPES OF ECOSYSTEM

1. Natural Ecosystem



ex: Forest, Grassland, Desert etc.

ex: Ocean (Marine Ecos.), Seas, River, Lakes, Ponds etc.

2. Artificial Ecosystem



ex: Zoo, Garden etc.

ex: Aquarium

STRUCTURE OF ECOSYSTEM

1. Biotic Component (Living being)



- They make their food themselves

e.g. - Flora (Trees, plants)

- They can not make their food by themselves i.e. they are dependent on the others for food intake.

TROPHS - MEANS FOOD

2. Abiotic Component (Non-living being)

DETAILS OF PRODUCER / AUTOTROPHS →

PHOTOTROPH

Are the living being who make their food in presence of sunlight
i.e. Their source of energy is sunlight
e.g. - plant.

CHEMOTROPH

Are those producers who make their food, their chemosynthesis & chemical rxn is main source of energy.

e.g. cyanobacteria / Blue green Algae
Blue green Algae
↓
single celled Algae

DETAILS OF HETROTROPHS / CONSUMERS →

Macro consumer

(bcoz of large body size)

• Primary Consumers / Herbivores

e.g. Rabbit, cow, deer, grasshopper, Goat, etc.

Micro consumer

(small size)

- Locomotion Capacity

- Food Intake Habit

Generalist → can eat all

Specialist → choosy

• Secondary consumer / Carnivores :

Since more variety of organism found in this category that's why they are further subdivided into →

1st order ——— 2nd order ——— 3rd order

Grasshopper (Herbivore) → FROG → SNAKE → Eagle

• Tertiary Consumer / Omnivores :

They can eat all types food.

e.g. Human being, Ant, Rat, Duck, pigs, cranes, etc.
crow,

Micro-Consumers (Saprotroph):

Saprot means Decayed / Rotten

DETRI-VORES

THEY eat Dead Residue or Remnants of Flora & Fauna and they also convert DETRITUS into Nutrient.

ex: Earthworm, termite, Maggot etc.

DECOMPOSER

THOSE micro-organism which decompose Dead food into Nutrients.

ex: Bacteria, Fungus

DETRITUS = Dead Remnant

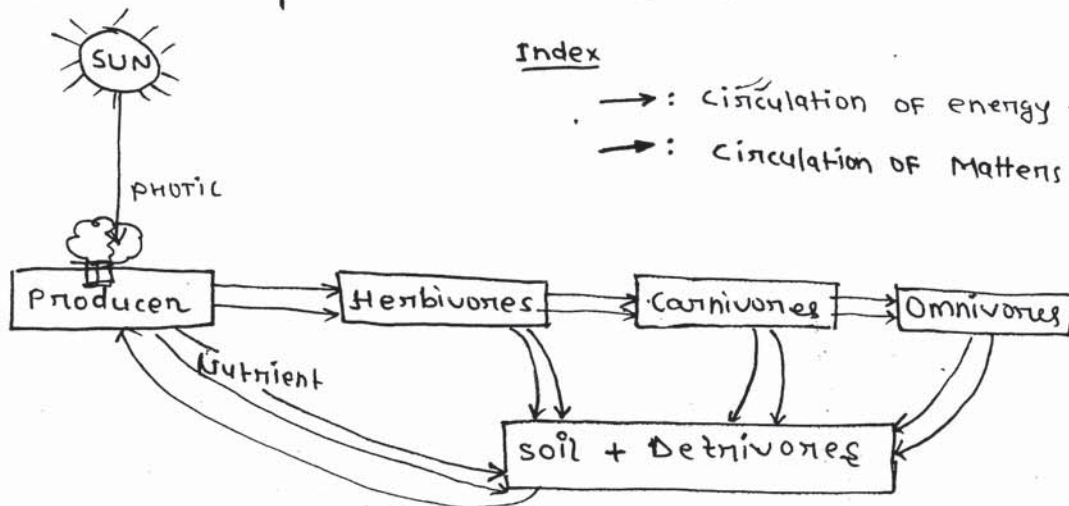
2. Abiotic Components (Non-living)

(a) Physical Elements: Soil, air, water, sunlight, temp etc.

(b) ENERGY

- (i) Inorganic Energy ex: Nutrients like Manganese, N_2 , Potash, phosphorus, sulphur etc.
- (ii) Organic Energy
 - Fat, Carbohydrate, protein
 - 1 gm - 9 calorie; 4.5 calorie, 4.5 calorie

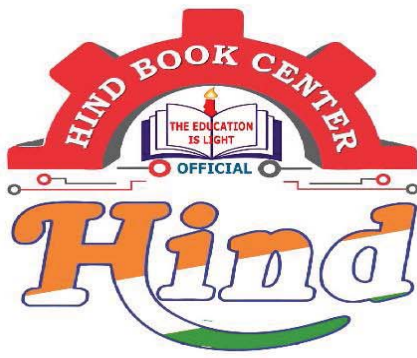
FUNCTIONING PROCESS OF ECOSYSTEM



Index

→ : Circulation of energy = Non-cyclic

→ : Circulation of Matter = cyclic



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ENGINEERING DRAWING

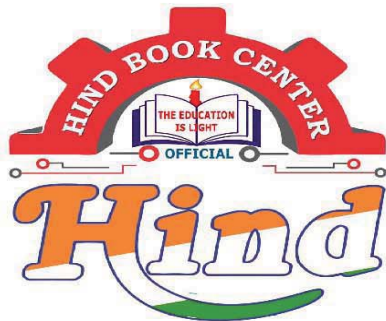
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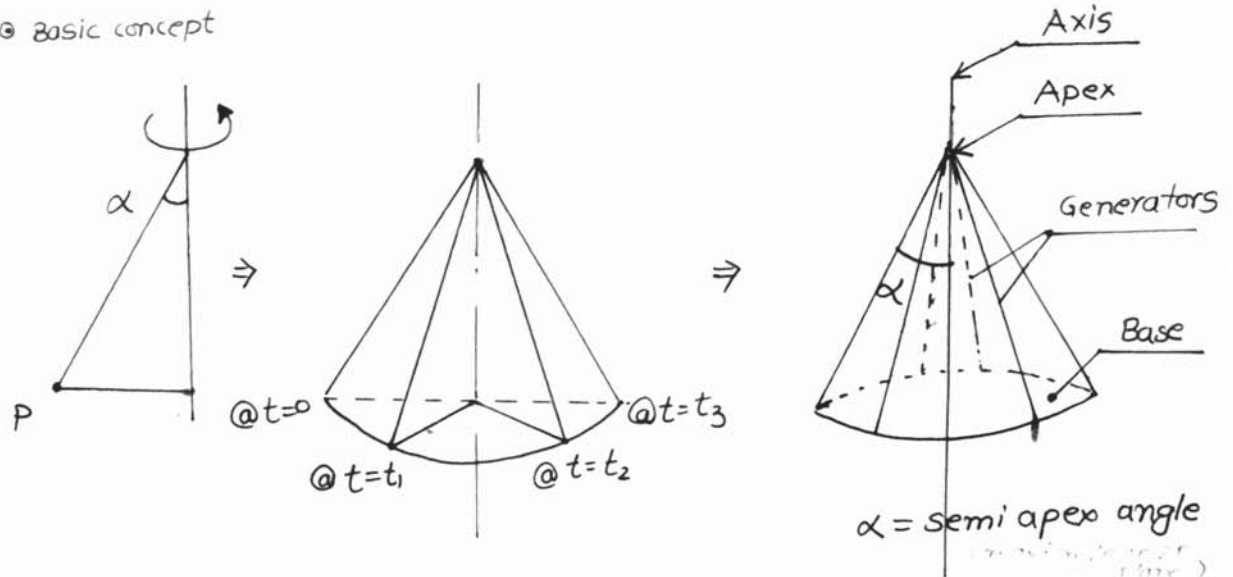
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CONIC SECTIONS

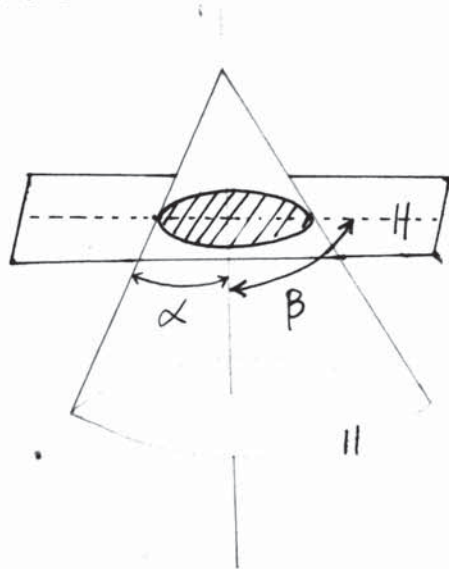
I] Conic section defined as section of cone.

• Basic concept



- when a right circular cone is cut by a section plane, the section thereof formed is called as conic section.

(a) CIRCLE



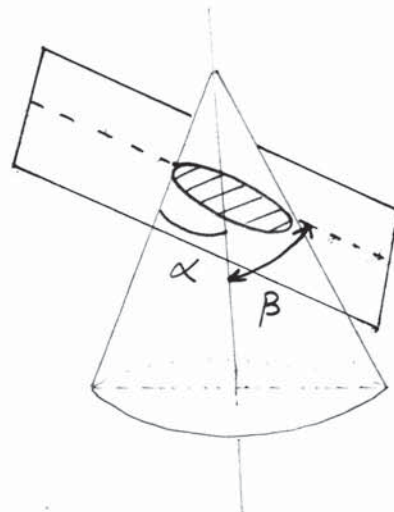
condition:

If $\beta = 90^\circ$, i.e. the section plane is parallel to the base of cone then a circle is formed.

(b) ELLIPSE

Condition :-

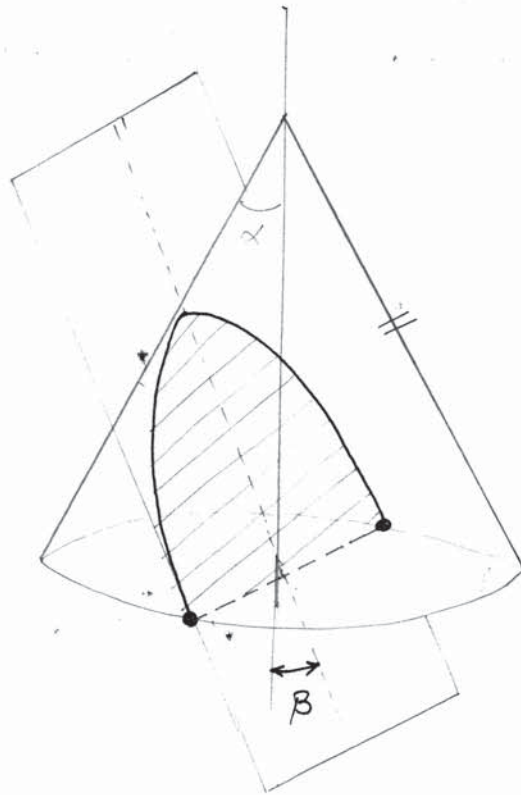
$$\alpha < \beta < 90^\circ$$



(C) PARABOLA

Condition:

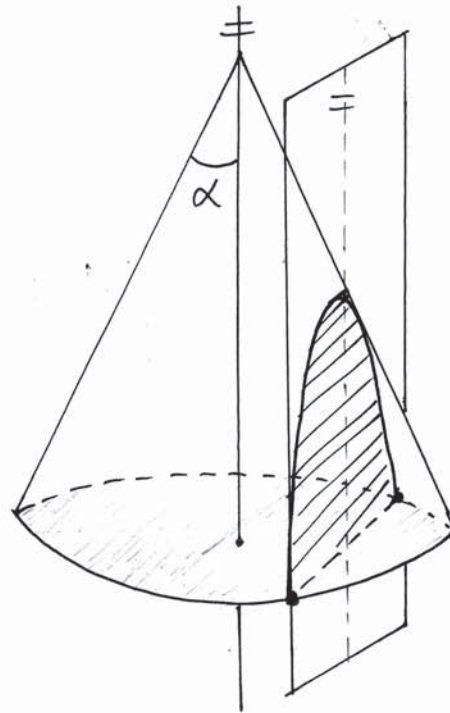
If $\beta = \alpha$ the section plane is parallel to one of the end generator then a parabola is traced



(d) HYPERBOLA

condition:

$$0 \leq \beta < \alpha$$

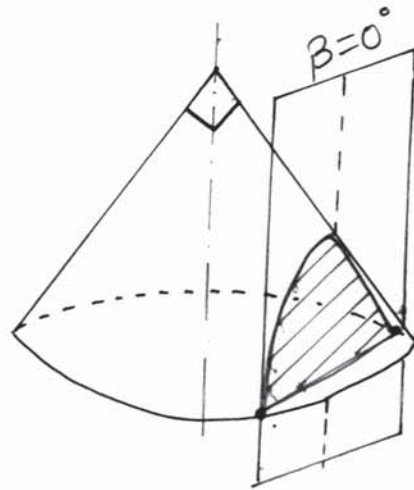


Note 1: only circle and ellipse cut all the generator of cones

Note 2: a Hyperbola becomes a rectangular hyperbola when:-

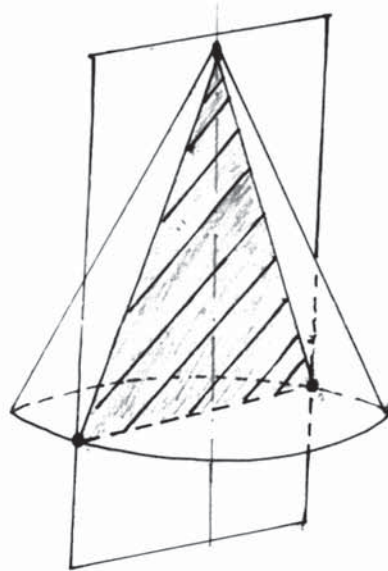
- i) $\beta = 0$ ie section plane is parallel to the axis of the cone.
- ii) Apex angle, $2\alpha = 90^\circ$
- iii) section plane must not pass through the axis of cone

Example:-



Rectangular Hyperbola
 $B=0^\circ$

Note 3: if section plane passes through the apex of cone, then either isosceles or equilateral or in general a triangle is formed.



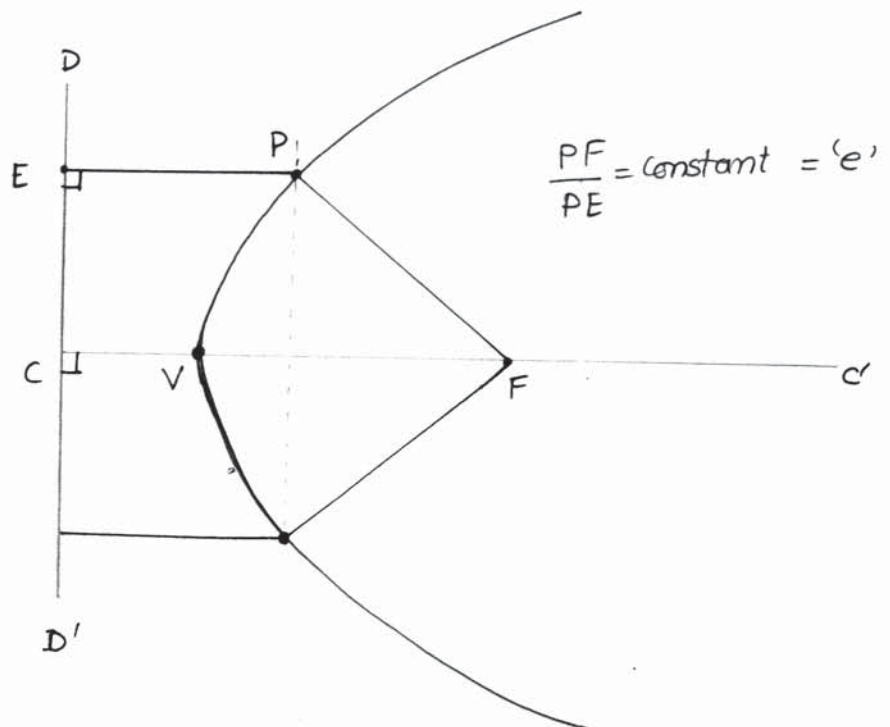
II] Conic section defined as locus of point

DD' = directrix

CC' = Axis

F = Focus

V = Vertex



- A conic section is defined as the locus of point which moves in a plane such that the ratio of the distance of the point from focus and that from directrix is always constant is known as eccentricity (e)

Mathematically; Eccentricity

$$e = \frac{PF}{PE} = \frac{\text{distance of point from focus}}{\text{distance of point from directrix}}$$

CASE (i) $PF > PE$

@ $PF > PE$; $e = \frac{PF}{PE} > 1$

→ Curve $\equiv$ Hyperbola

→ Application

- cooling
- Flower vases

→ Math eqn

$$\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$$

$$b^2 = (e^2 - 1)a^2$$

CASE (ii) $PF = PE$

@ $PF = PE$, $e = \frac{PF}{PE} = 1$

→ Curve $\equiv$ Parabola

→ Application

- Parabolic mirrors
- Head lamps
- Dish antenna
- Trajectory of Particles

→ Math eqn

$$y^2 = 4ax$$

CASE (iii) $PF < PE$

@ $PF < PE$; $e = \frac{PF}{PE} < 1$

→ Curve $\equiv$ Ellipse

→ Application

- Bridges Arches
- Elliptical gears
 - ↳ profile of teeth = Involute

→ Math eqn

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$$

$$b^2 = (1 - e^2)a^2$$

NOTE @ $e = 0$ { $e < 1$ }

$$b^2 = a^2$$

$$\therefore x^2 + y^2 = a^2 ; \text{ circle}$$

→ Application

- wheels
- Discs
- Speakers

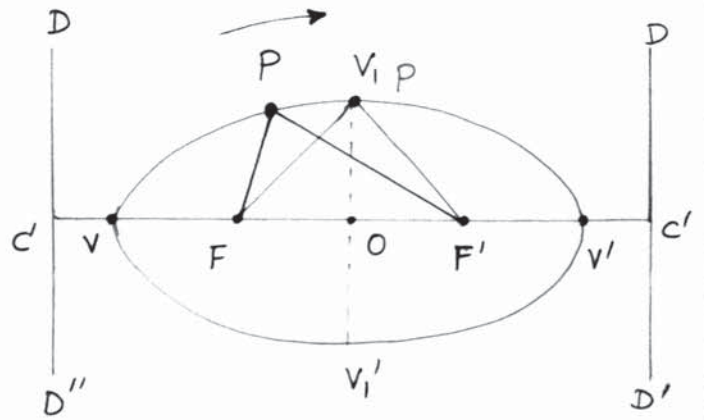
Some Noteworthy Points

① ELLIPSE

$VV' = \text{major axis}$

$V_1V_1' = \text{Minor axis}$

$O = \text{centre of ellipse}$



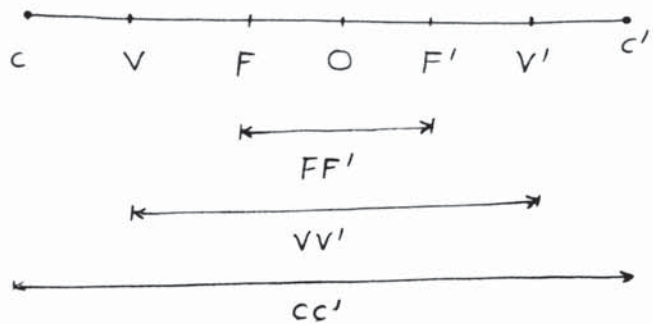
→ a) The sum of the distance of a point on the ellipse from two foci is always equal to its major axis. ie $PF + PF' = VV'$

→ b) The distance of any end of the minor axis from focus is half of major axis ie. $PF = \frac{1}{2} VV' (= PF')$

→ c) Eccentricity

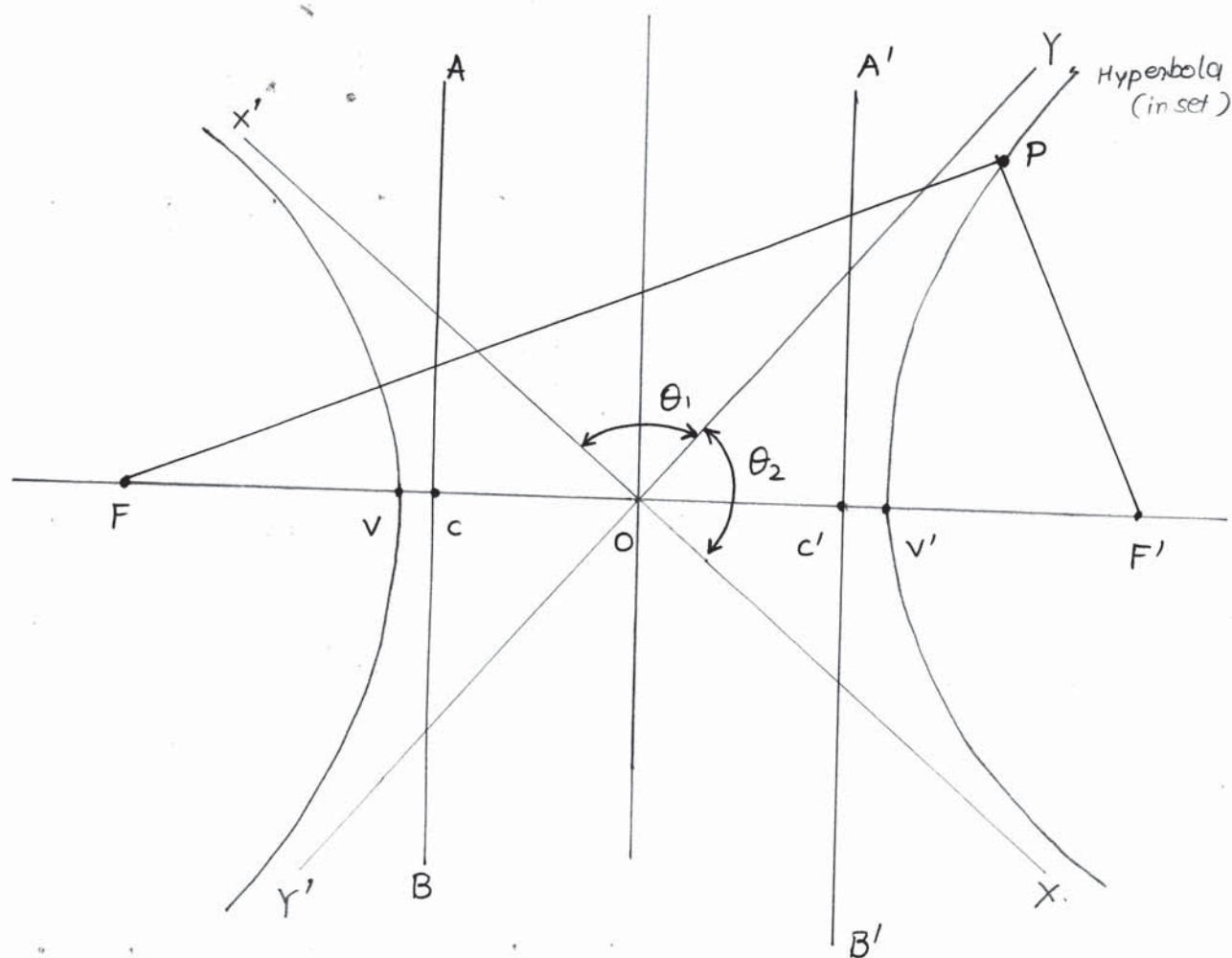
$$e = \frac{PF}{PE} (< 1)$$

$$e = \frac{VV'}{CC'} = \frac{FF'}{VV'}$$



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② HYPERBOLA



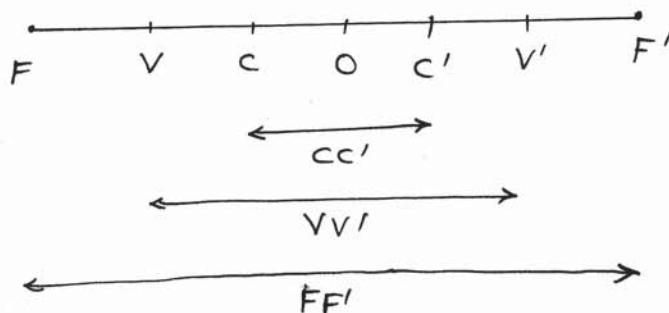
- $AB, A'B' \equiv$ Directrix
- $XX', YY' \equiv$ Asymptotes
- $VV' \equiv$ Transverse axis
- $O \equiv$ Centre of hyperbola.

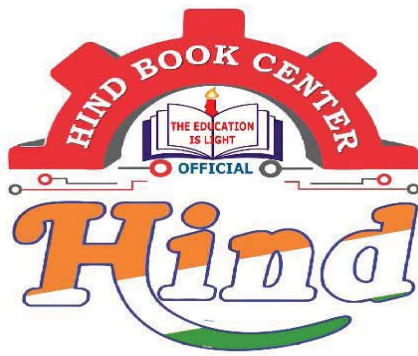
1) — The difference of the distance of the point from two foci is always equal to transverse axis. i.e. $PF - PF' = VV'$

2) — Eccentricity

$$e = \frac{PF}{PE} (>1)$$

$$e = \frac{FF'}{VV'} = \frac{CC'}{VV'}$$





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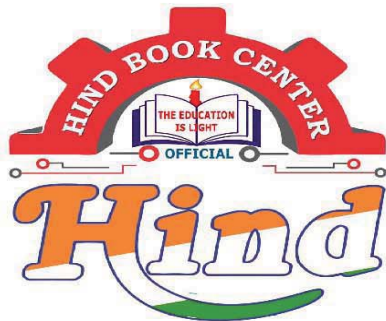
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3. Crystallography
4. Electrical Properties of Materials
5. Magnetic Properties of Materials
6. Mechanical Properties of Materials
- 7.*Ceramics
- 8.*Polymers
- 9.*Composites
- 10.*Phase Diagram and alloys. → Theory Book.

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Introduction

Material Science

- It involves investigating the relationship that exist b/w the structures and properties of material.
- Material science does not deal with the behaviour of engineering components such as machines, buildings and vehicle facilities etc., instead it deals with the study of properties of materials with which these components are made.

Material

- Material can be defined as something that consists of matter.
- It is the stuff with the help of which something can be made.
- Engineering materials are mainly classified as:-
 - (1) Metals and Alloys
 - (2) Ceramics and glasses
 - (3) Organic Polymers
 - (4) Composites.

Structure of Materials

- It relates to the arrangement of it's internal components.
- Structure can be classified as :-

(1) Nuclear Structure

- It tells us about the no of neutrons and protons into the nucleus of an atom.

- Nuclear structure is studied with the help of nuclear spectroscopic techniques such as Nuclear Magnetic Resonance (NMR) OR Mossbauer studies.

(2) Electronic Structure

- It deals with the arrangement of electrons in the various orbits of atom.

(3) Crystal Structure

- It tells us about the arrangement of atoms in the crystal.
- In a crystal atoms are arranged in regular and periodic manner.
- The smallest group of atoms by repeating which in all the crystallographic directions, the crystal structure can be developed, this smallest group of atoms is k/a unit cell.

(4) Microstructure

- It is observed under the optical microscope which can magnify a structure upto 1500 times without loss of resolution.
- Structures obtained by using a microscope with a much higher resolution such as electron microscope, which can magnify a structure upto 10^6 times are k/a Substructure.

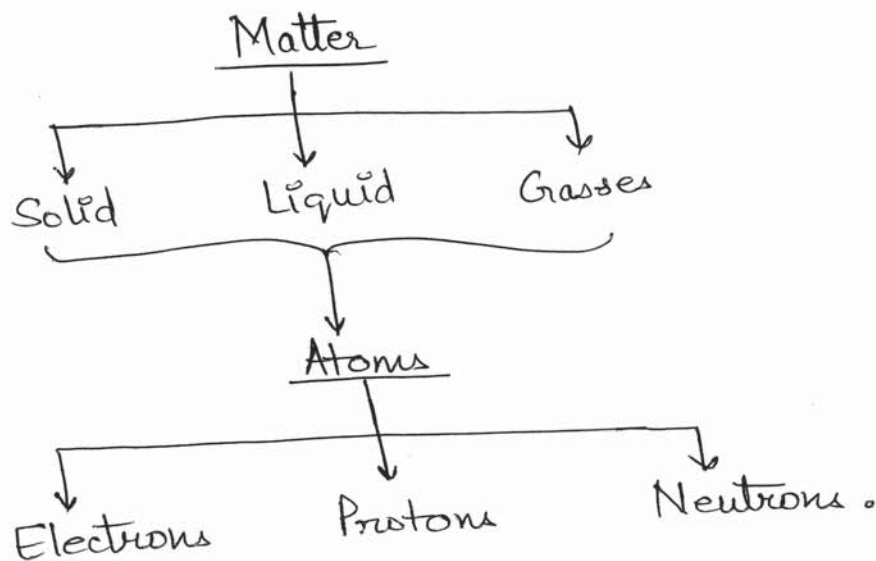
(5) Macrostructure

- It can be observed with naked eye.
- The internal symmetry of crystalline material may reflect in a external form of a crystal.

→ Property of a Material

- A property is a material character / attribute in terms of kind and magnitude of response to a specific imposed excitation.
- Properties of solid materials can be classified as:-
 - (1) Mechanical Property
 - (2) Electrical Property
 - (3) Magnetic Property
 - (4) Optical Property
 - (5) Thermal Property
 - (6) Deteriorating Property of Material.

Ch-02 Atomic Structure & Chemical Bonding



- Matter is made up of very tiny and indivisible structures k/a Atoms.
- Atoms can neither be created nor be destroyed.

Electrons

- -vely charged particles
- charge = -1.6×10^{-19} Coulomb = $-e$
- Mass = 9.1×10^{-31} kg
- $-e$

Protons

- +vely charged particles.
- charge = $+1.6 \times 10^{-19}$ C = $+e$
- Mass = 1.67×10^{-27} kg
- $+e$

Neutrons

- Electrically neutral particles
- charge = 0
- Mass = 1.67×10^{-27} kg

Magnitude of Electron charge = e
 $= 1.6 \times 10^{-19}$ C

→ Atomic Number (Z)

- It is no. of protons or no. of electrons in an atom.

→ Atomic Mass Number (A)

- The no. of protons and neutrons in the nucleus of an atom is k/a Atomic Mass Number.

→ Atomic Mass Unit (amu)

- It is defined as $1/12$ of mass of a carbon atom.

$$C = 6p + 6n + 6e^- = 12 \text{ amu}$$

$$1p = 1$$

$$1p = x$$

$$6x + 6x + \overset{\text{Neglect}}{\frac{6x}{1850}} = 12 \text{ amu}$$

$$x \simeq 1 \text{ amu} \simeq \text{mass of a proton}$$

$$1 \text{ amu} \simeq 1.67 \times 10^{-27} \text{ kg}$$

→ Mole

- It is an SI unit.
- 1 mole is the amount of substance that contains as many particles or entities as there are atoms in 12g of carbon.-12.

$$1 \text{ mole} = 6.023 \times 10^{23} \text{ atoms}$$

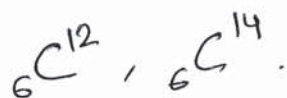
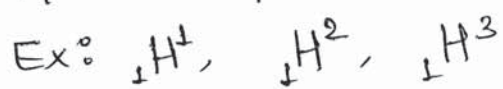
→ Avagadro Number (N_A)

- Avagadro proposed that equal volumes of gasses at the same temperature and pressure should contain equal no. of molecules.
- The no. of atoms / molecules in a mole is termed as Avagadro Number.

$$N_A = 6.023 \times 10^{23} \text{ atoms/mol}$$

→ Isotopes

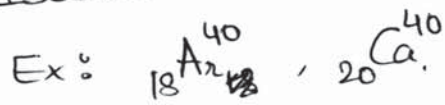
- Atoms having same atomic number but different atomic mass number (A) are k/a Isotopes.



$$\text{Stability} \propto \frac{1}{\text{Energy}}$$

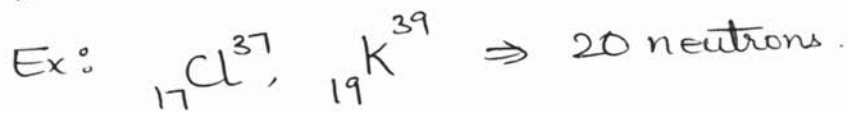
→ Isobars

- Atoms having same Atomic Mass No. (A) but different Atomic No. (Z) are k/a Isobars.



→ Isotones

- Atoms having same no. of neutrons but different Atomic No. and different Atomic Mass no.



→ Comparison of α , β and γ rays

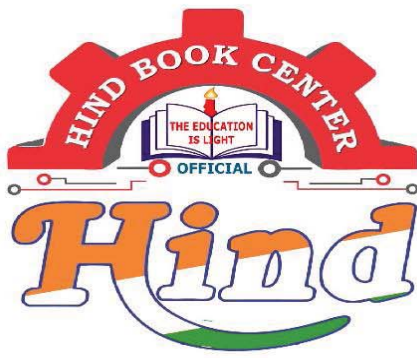
(1) Alpha (α) rays:

- α -particle consist of 2 protons + 2 neutrons.
(It is an active He nucleus).

- Emitters of α -particle are heavy element.
- α -particle has mass equal to 4 amu.
- It is +vely charged particle.

(Charge = +2e)

- α -particles have highest ionization power.
- α -particles / rays travel with very slow speed.
- They have least penetration power, they cannot penetrate even the outer layer of human skin.



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Project Management

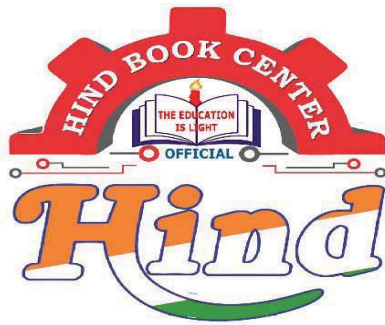
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PROJECT MANAGEMENT

- (1) Project Planning + Schedule
- (2) Project Crashing
- (3) Project Life Cycle
- (4) Capital Budgeting Technique OR Project Financing technique
- (5) Tender and contract
- (6) Project Organizational Structure
- (7) Deviations in Orders.

8882873075

Gunjan Chowdhary

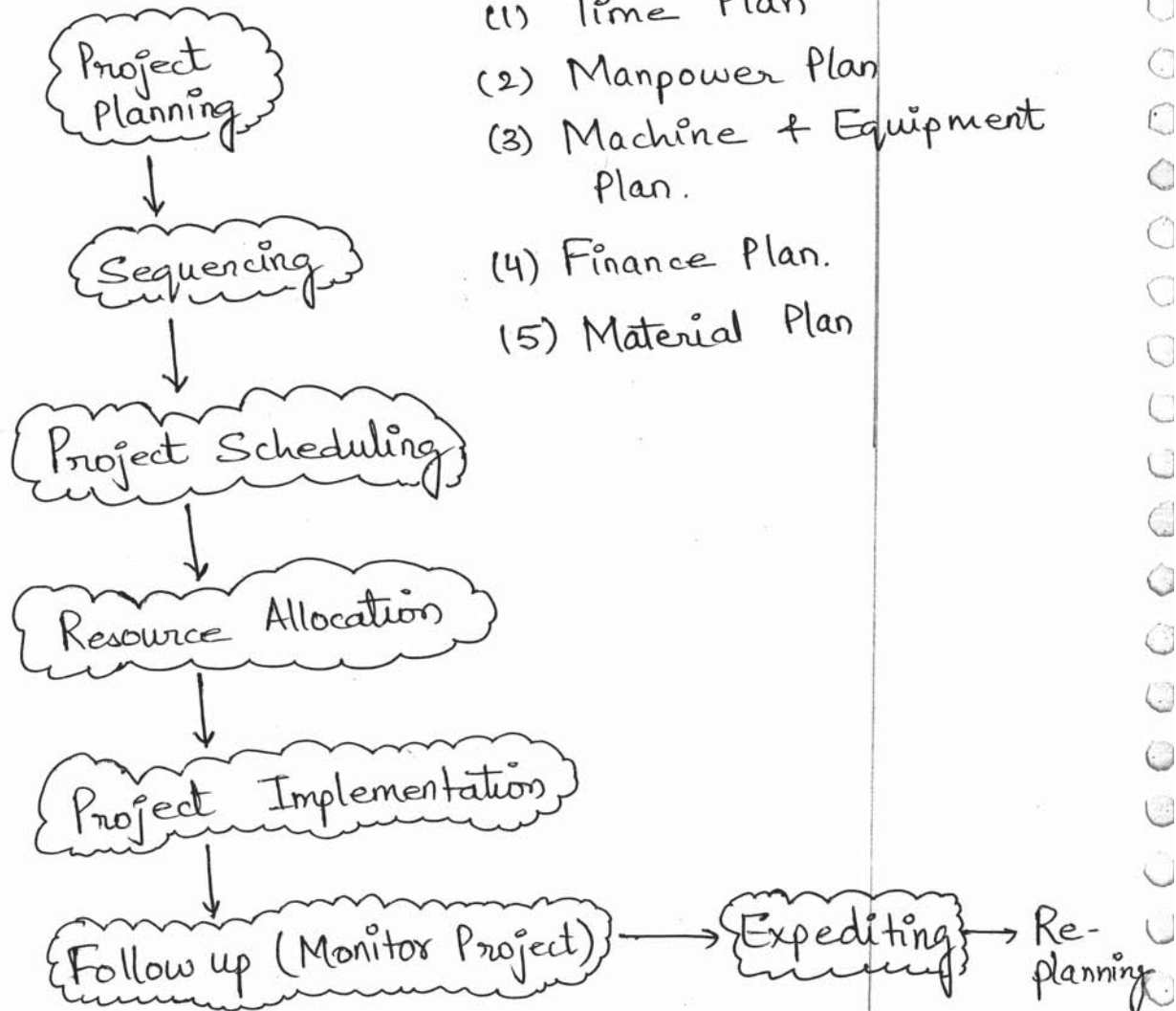
• Define a Project

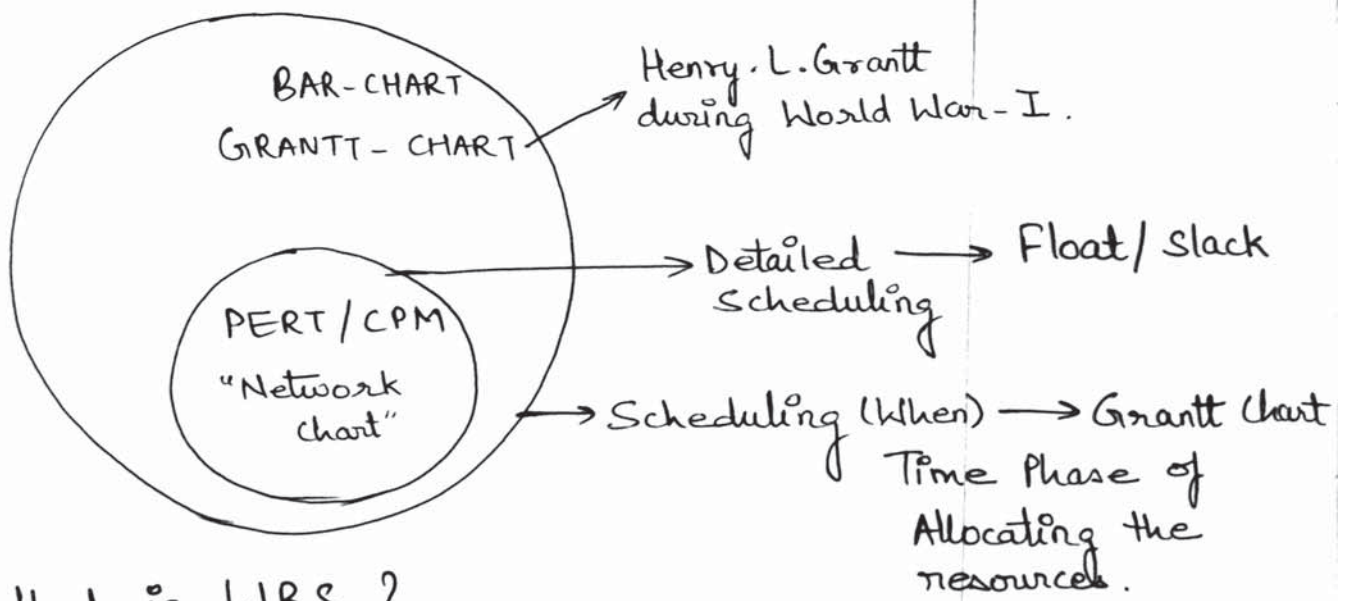
- Project Management Body of Knowledge (PMBok) defines project to be a unique and temporary endeavor.

↓
Every project has a beginning and it ends.

- Project Planning
- Project scheduling
- Tenders + Contracts
- Financial Analysis
- Company Hierarchy
- Project Implementation
- Project cycle.

• What are different Project Plans ?



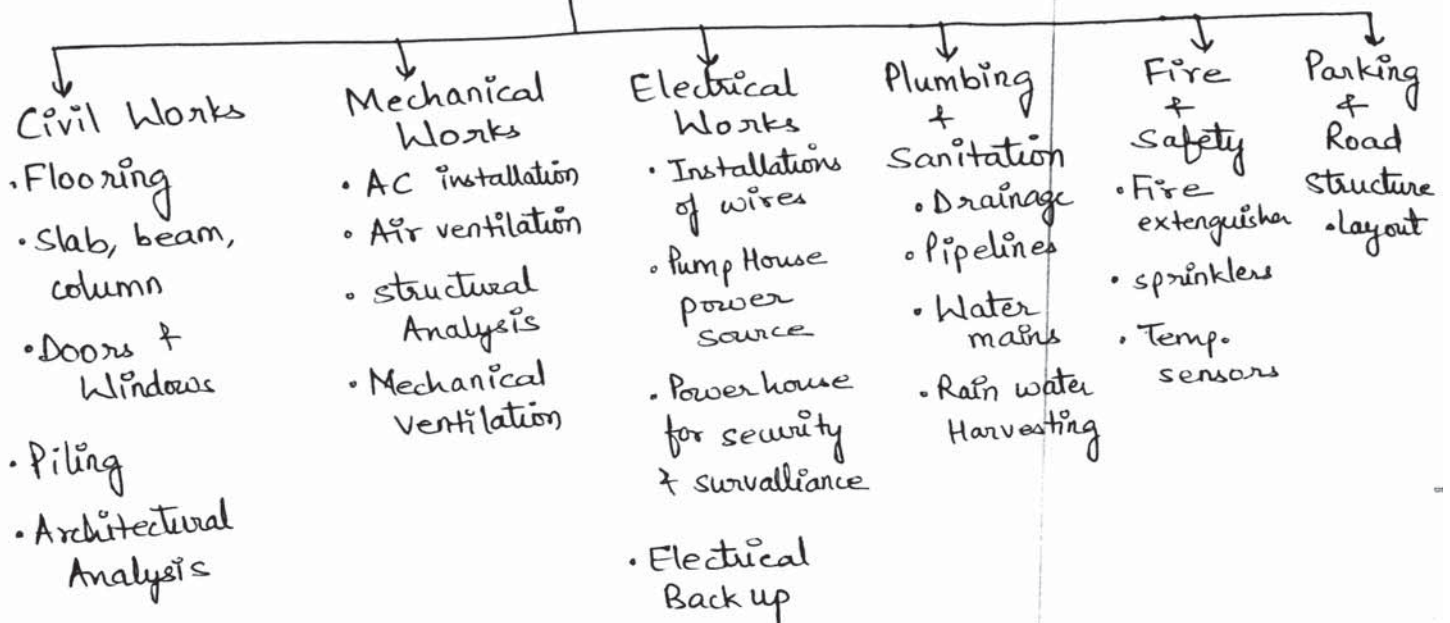


• What is WBS ?

Work Breakdown Structure (WBS)

- It is a technique in project management in which a project is broken into manageable chunks.
- It is task oriented family tree which is organized, defined and represented graphically from top to bottom.

• Ex: Construction of a tower in IT Park.



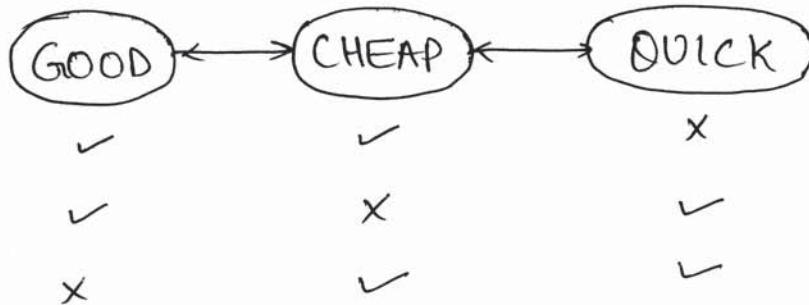
Limitations of WBS

No information about :-

- (1) Task or Activity time.
- (2) Dependencies of an activity over another.
- (3) Project cost
- (4) Resource allocation
- (5) Cannot identify priorities.

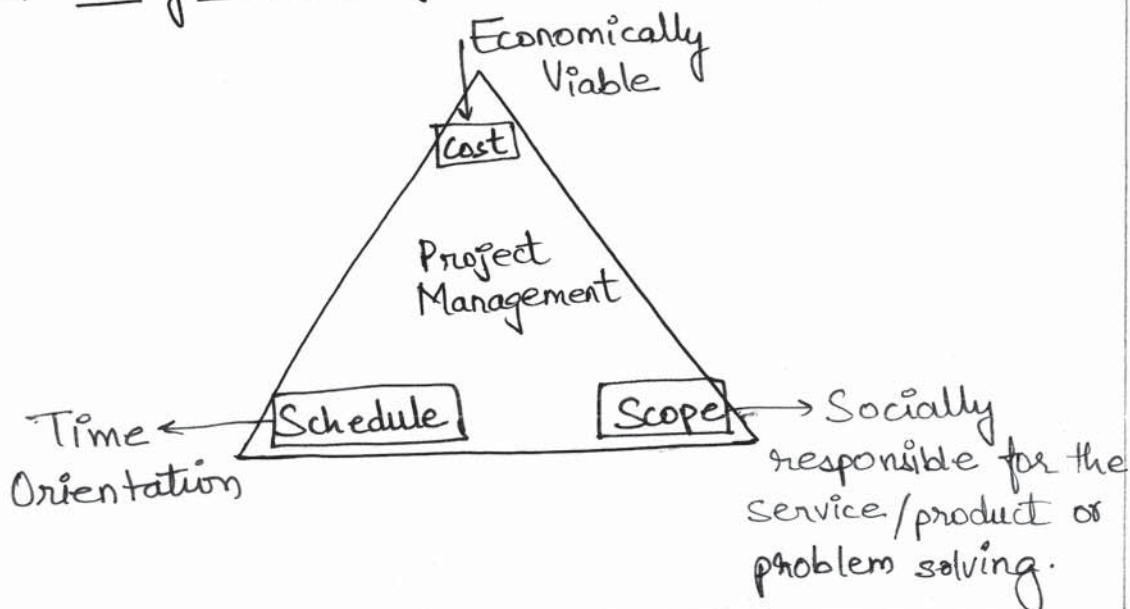
Philosophy for a Good Manager

Philosophy for a Project Manager



- Good and Cheap work cannot be Quick.
- Cheap and Quick work cannot be good.
- Good and Quick work cannot be cheap.

Key Matrix of Project Management



- 1 → Feasibility ☒
- 2 → Profitability ☒
- 3 → Scalability ☒

FPS - Rule

BAR-CHART

S.No.	Activities	Time in Months.											
		1	2	3	4	5	6	7	8	9	10	11	12
1	Excavation	■	■	■									
2	RCC-Floor			■	■	■							
3	RCC-Walls					■	■						
4	Plastering							■	■	■			
5	Painting									■	■	■	■
6	Fencing								■	■	■		

Excavation → upto 3 months (Jan to Mar)

RCC-Floor → 3 months (March to May)

RCC-Walls → 2 months (May to June)

Plastering → 3 months (July - Aug - Sept)

Painting → 4 months (Sept - Oct - Nov - Dec)

Fencing → 3 months (Aug - Sept - Oct).

Project duration = 12 months.

No info about the task dependencies.

- Horizontal bars represented on horizontal time scale.
- Simple visualization of tasks, their duration and hence project duration can be calculated
- Henry Gantt during World War-I.

PERT - Chart

- Free flow network diagram.
- For large projects.
- Time dependencies among various interrelated activities can be determined.
- Min. time required for the project completion can be determined.
- It is used for Research + Development.

GRANTT - Chart

- Horizontal bar chart.
- For small projects.
- Time dependencies are not represented among the involved activities.
- Task completion time can be easily known.
- Used for simple construction of project.

Note : Resource Levelling and Resource Allocation is Common in Both Charts.

~~Q1~~ Which of the above techniques are used for scheduling?

(1) Bar chart

(3) Milestone Chart

(2) Network method → PERT

a) 1 only

c) 1 and 3

b) 1 and 2

d) 1, 2 and 3.

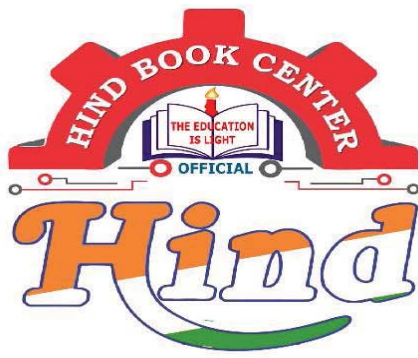
Q2) Bar charts were introduced by?

a) William Ford

b) Ramanujan

c) Russel Jennifer

d) Henry Grantt



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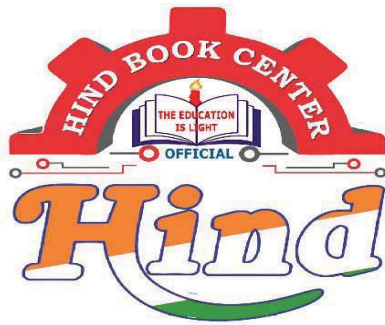
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-: Information and Communication Technology -:

Syllabus:

Application of ICT tools in the field of networking,
e-Governance & e-education

- ① ICT tools
- ② Networking & its application
- ③ ICT application in e-Governance
- ④ ICT application in e-Education
- ⑤ current development in ICT

Marking: 9-10 questions

Saurabh Pandey sir: 9646269236

Topic-1 Applications of ICT in e-Governance

- Governance is the procedure followed by the Govt.
- e-Governance means using ICT based technology to run the governance processes.
- In 2000, IT Act was passed. under this Act a new ministry MoICT was formed
MoICT → min. of Information & communication Tech.
3 department were under this ministry.
 - (i) Department of post
 - (ii) Deptt. of Information Tech.
 - (iii) Deptt. of communication

2015: MoICT → meITY: min. of electronics and Information tech.
→ MOCB: min. of communication & Broadcasting

IT Act, 2000



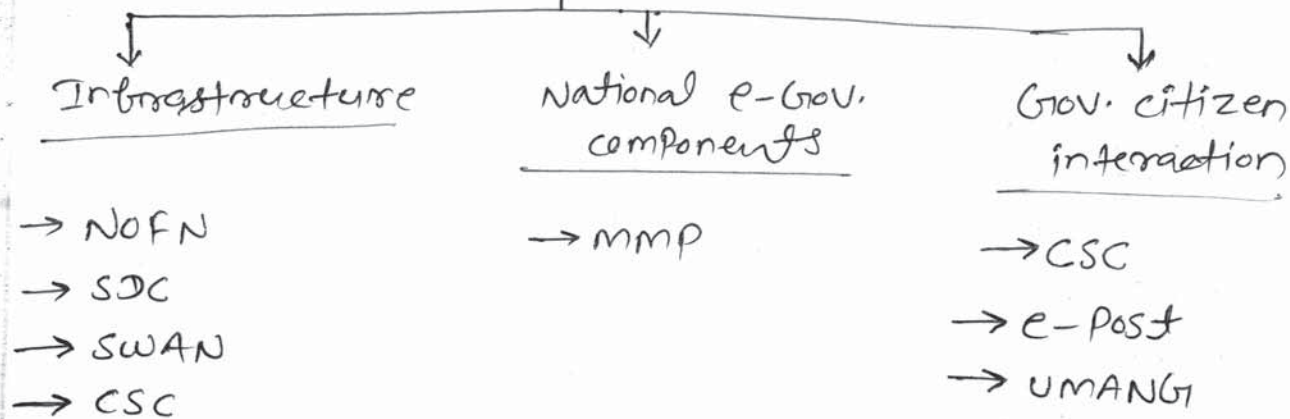
Information Technology Act, 2000:

IT Act that was introduced in parliament in year 2000 was a basic Act only and it did not have any punishment provision for those who violated IT Act. It also did not talk about the things like cyber crime, cyber fraud, e-commerce etc. since then not much changes have taken place in the IT Act but it requires update rapidly in the changing world.

IT ACT Amendment, 2008:

- 66(A) was added in IT Act 2000.
- In year 2008, an amendment was introduced in IT act 2000. According to this amendment there will be consideration of criminal offence for any person who sends by means of digital media or communication device that is abusive or has menacing character, danger, insult, injury, hatred, trying to disturb the communal harmony or posting of images or videos related to child pornography and causing harm to the dignity of human is considered as a criminal offence.
- In 2017, The supreme court amended IT act and abolished clause A from section 66, saying that it is violation of our right to freedom of speech and expression which is our fundamental right.
- In 2005, RTI was introduced as fundamental right.
- In 2006: NeGP (National e-Governance Program) was introduced.
- NeGP was introduced in year 2006 that consisted of 27 mission mode projects (27 mmPs) 4 mmPs were added later on, making a total of 31 mmPs.
- NeGP also included large infrastructure dev^t. national e-Governance components and changes in the framework for Government and citizen interaction.

NEGP 2006



Infrastructure:

① NOFN: National optical fibre Network

- Under NOFN, target was to connect more than 20,000 Gram Panchayats were connected with optical fibre network to convert it into e-panchayat.
- Kerala became the 1st state where all Gram Panchayat were converted into e-panchayat

② SDC: State Data centre

- The SDC is a part of core infrastructure to support NEGP.
- The SDC is utilised for collecting & storing all the data & electronic delivery of services.

③ SWAN: State wide Area Network

- SWAN is a broadband network through which the data centers are connected upto district and block level with speed upto 100 mbps.
- The network is established using optical fibre network.

④ CSC: Common service center

- CSC are the Govt. citizen interaction point in the form of a kiosk (shop).

- These CSC can make available services to citizen through online medium
- There is min. charge for services. Each Gram Panchayat must have at least one CSC. while larger Gram Panchayat can have more than one CSC also.
- The CSC are operated in public private partnership mode.

National e-Governance components:

mmp: mission mode project:

- mmps are those projects under NERP that focuses on one aspect of electronic Governance.
- In this case mission mode means that the project will be launched in a fixed timeline and it will be on a priority basis.
- Initially 27 mmps were launched and in 2011 4 more were added making a total of 31 mmps.

mmps are divided into three parts:

- | | | |
|----------------|--------------------|-------------------|
| ① central mmp | ② state mmp | ③ Integrated mmp |
| eg. Income Tax | eg. commercial Tax | eg. Education csc |

Govt.-citizen Interaction:

① e-Post:

- post offices have large no. of centers across India. These post offices were connected with internet connectivity to convert it into e-post.
- The benefit of e-post office is to act as a nodal agency to provide govt services to the

citizen in an online mode.

→ e-post offices are brought under pillar No. 3 of Digital India programme to act as a Nodal agency and to provide services under "public internet Access ~~process~~ programme".

→ under e-banking IPPB (India Post Payment Bank) was initiated at post offices.

→ IPPB was developed by RBI & AIB (Association of Indian banks)

→ In IPPB, the postman collects the payment by door to door visit and transfer the payment through e-post and from there also a postman visits door to door to deliver the money.

→ IPPB provides an alternate banking system to post offices.

Payment Banks:

— Payment banks are specialized banks that are used for retail transactions and the payment banks can have a deposit upto max 1 Lakh rupees. (Now 2 Lakh/-)

— Payment banks can be directly used for retail transactions without using any UPI

— Payment banks are not allowed to give loans, they can only take deposits.

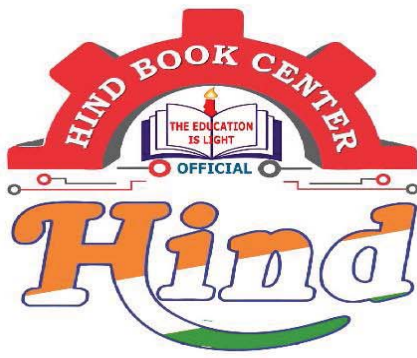
— The Idea of Payment Banks were started with the aim of reaching deeper into backward areas.

eg Paytm Payment Bank

Airtel —" —"

India post —" —"

finco —" —" etc



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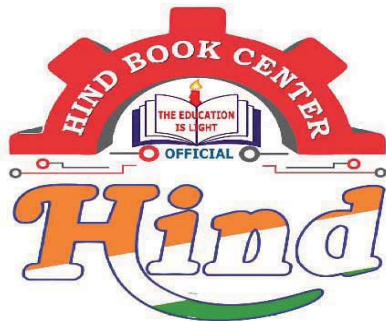
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- Maintenance
- sampling
- Quality
- Quality control tool
- process capability
- quality in service sector
- TQM
- ISO
- six sigma
- quality in construction
- Inventory
- Line balancing
- L.P.P. (Linear Programming problem)

Reliability: The Reliability of a product or system can be defined as the probability that the product will perform its required function under specific condition for a certain period of time.

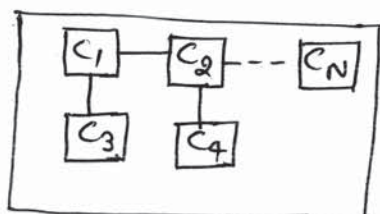
$$R = f(\text{time})$$

$t=0$, Reliability = 100% time $\uparrow$ = Reliability $\downarrow$

Note: $\Rightarrow$ Reliability is the measure of quality of the product over long run.

$\Rightarrow$ It is a concept of quality of performance.

$\Rightarrow$ No product is guaranteed 100% to function properly. However company know that high reliability is an imp. part of customer oriented quality & tries to build it into the product design.



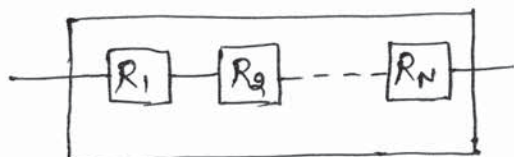
$c = \text{component}$

system/product

$\Rightarrow$ Reliability of the product/system depends upon reliability of individual component.

for series connection:

system/product



$$R_s = R_1 \times R_2 \times \dots \times R_N$$

R_s = Reliability of system

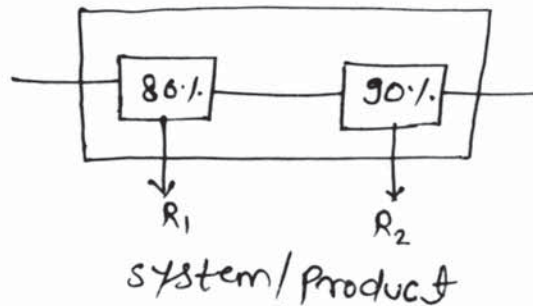
R_1 = Reliability of component ①

R_2 = " " " " " ②

R_N = " " " " " ③

→ Efficiency / performance / Reliability calculated in the same way.

- Q.) Assume that a product has 2-components both of which must work for the product to function properly. component ① has Reliability of 80% and component ② has Reliability of 90%. compute the Reliability of the system.



$$\begin{aligned} R_s &= R_1 \times R_2 \\ &= 0.8 \times 0.9 \\ &= 0.72 \\ &= 72\% \end{aligned}$$

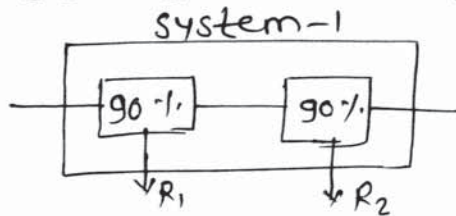
statement-1: The Reliability of the system is always less than or equal to the Reliability of individual component when they are connected in series.

$$R_s \leq \{R_1, R_2, \dots, R_n\}$$

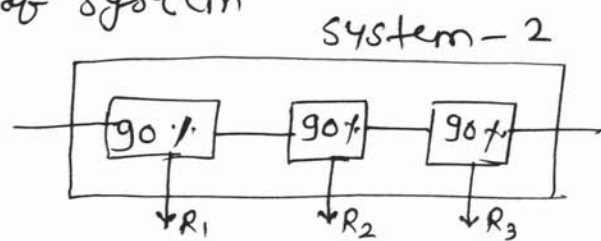
for equal Reliability:

- i) when all components are 100% reliable.
- ii) when there is a single component.

Q.) calculate Reliability of system



$$\begin{aligned} R_s &= R_1 \times R_2 \\ &= 0.9 \times 0.9 \\ &= 0.81 \\ &= 81\% \end{aligned}$$



$$\begin{aligned} R_s &= R_1 \times R_2 \times R_3 \\ &= 0.9 \times 0.9 \times 0.9 \\ &= 0.729 \\ &= 72.9\% \end{aligned}$$

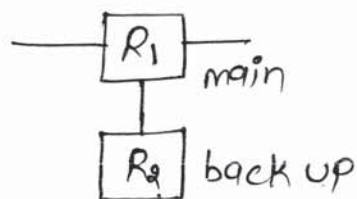
Statement-2: As the no. of component in series increases, the reliability of system decreases.

☞ How to increase the reliability of the system??

→ one way to increase the product reliability is to build redundancy into the product design in the form of back up plan.

→ Redundancy is build into the system by placing components in parallel so that one components fails, other component takes over.

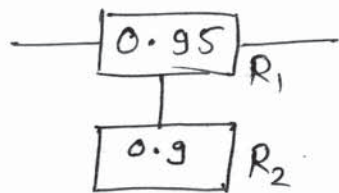
For Parallel connection:



$$R_s = R_1 + R_2(1 - R_1)$$

$$R_s = R_1 + R_2 - R_1 R_2$$

Q.] Two power Generator provide electricity to a facility i.e. main & back up Generator. The main generator has reliability of 0.95 and the back up has reliability of 0.9. compute the reliability of the system.



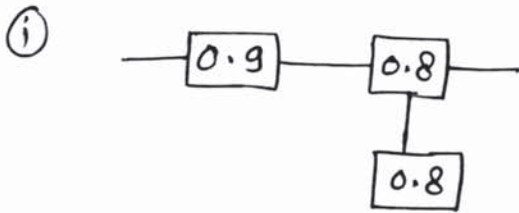
$$\begin{aligned} R_s &= R_1 + R_2(1 - R_1) \\ &= 0.95 + 0.9(1 - 0.95) \\ &= 0.995 \\ &= 99.5\% \end{aligned}$$

Statement-3: The reliability of the system is always greater than or equal to the reliability of individual component if they are connected in parallel.

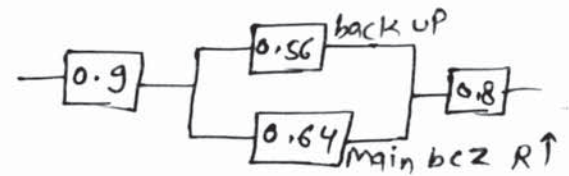
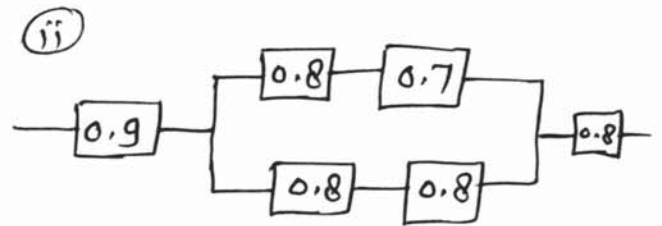
$$R_s \geq \{R_1, R_2, \dots, R_n\}$$

Statement-4: As the no. of component in parallel or (backup) increases, the overall reliability of the system increases.

Q.) compute the Reliability of the system

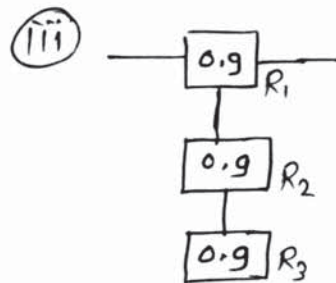


$$\begin{aligned}
 R_s &= 0.9 \times [0.8 + 0.8(1-0.8)] \\
 &= 0.9 \times [0.8 + 0.16] \\
 &= 0.9 \times 0.96
 \end{aligned}$$



$$\begin{aligned}
 &0.56 + 0.56(1-0.56) \\
 &= 0.8416 \quad \times
 \end{aligned}$$

$$\begin{aligned}
 &0.64 + 0.56(1-0.64) \\
 &= 0.8416
 \end{aligned}$$



$$\begin{aligned}
 R_s &= R_1 + R_2(1-R_1) + R_3(1-R_1)(1-R_2) \\
 &= 0.9 + 0.9(1-0.9) + 0.9(1-0.9)(1-0.9) \\
 &= 0.999 = 99.9\%
 \end{aligned}$$

$$\begin{aligned}
 R_s &= 0.9 \times 0.8416 \times 0.8 \\
 &= 0.6059 = 60.59\%
 \end{aligned}$$

Reliability prediction using exponential distribution:

It is one of the most commonly used distribution in the reliability prediction and it is used to predict the probability of survival upto a particular time.

- Normal distribution
- lognormal
- Gamma
- weibull

- exponential ———— } most commonly used

Exponential Distribution:

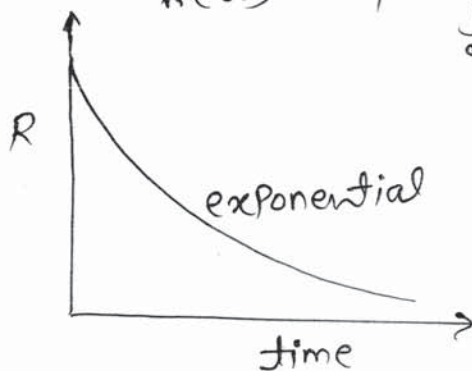
$$R = f(t) \quad \text{pdf: } f(t) = \lambda e^{-\lambda t}$$

$$\text{cdf: } F(t) = \int_0^t \lambda e^{-\lambda t} dt$$

$$R(t) = 1 - F(t)$$

$$R(t) = 1 - \int_0^t \lambda e^{-\lambda t} dt$$

$$\Rightarrow R(t) = e^{-\lambda t}$$



R - Reliability

t - time

λ - failure rate

at $t=0$, $R(t) = 100\%$

Note: Exponential $\Rightarrow$ when failure rate is constant w.r.t. time.

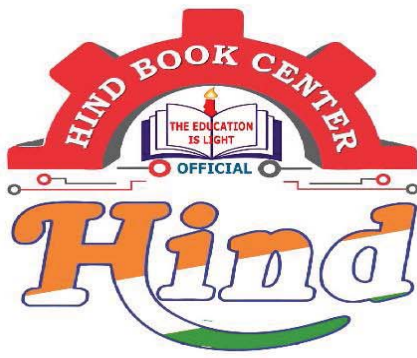
Weibull $\Rightarrow$ when failure rate increases/decreases w.r.t. time

To find λ :

MTTF: mean time to failure

$\rightarrow$ It is referred as avg. time, an item may be expected to function before the failure.

$\rightarrow$ It is used for non repairable items



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ETHICS & Values

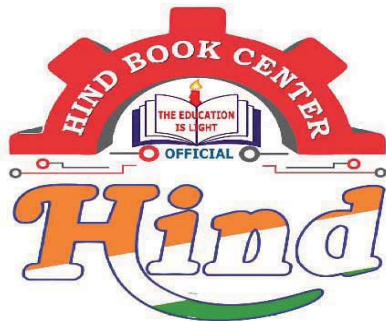
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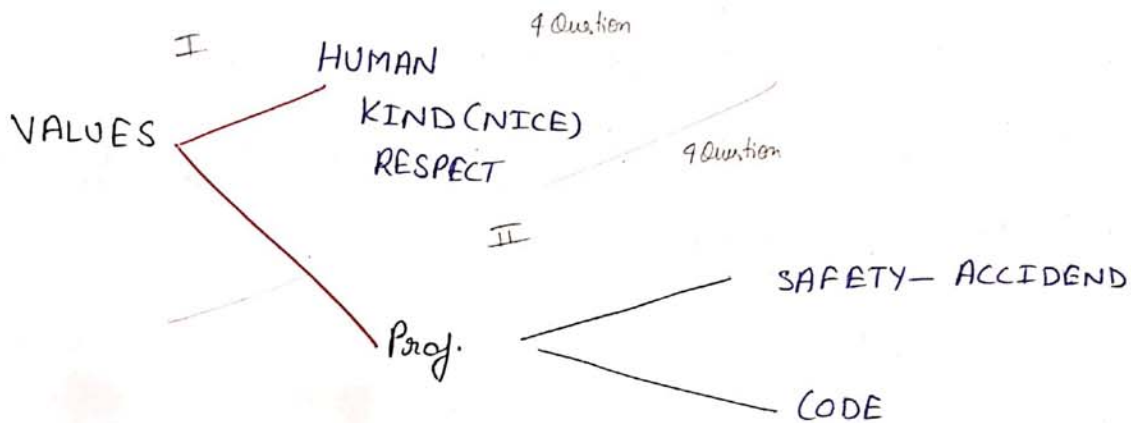
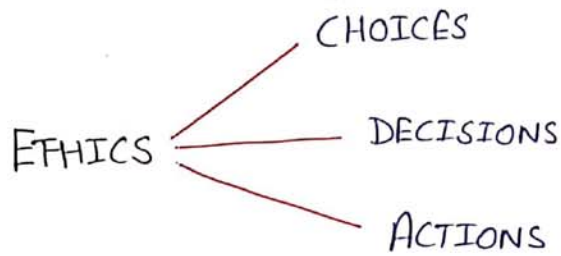
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DEFINATION OF ETHICS :-
/ MORAL

- "a body of ^{"Allowed"} prescription & prohibitions, do's & don't's"
- "Ethics -- may be styled as art of self government, self control, self + Discipline (regulation)".
- "the standards of conduct (minimum standards) derived from the philosophical & religious traditions of society"
- "Ethics is concerned about what is right, fair, just or good, about what we ~~each~~ ought to do" (DYNAMIC & SITUATIONAL)
- Branch of philosophy which seeks to address issues related to concepts of right and wrong.

- Branch of philosophy that is concerned with human conduct/
Right Behaviour.

- Examination of the our moral judgments.

- ~~• examination of our moral~~

- An attempt to help human in leading good life by applying moral principles

* Ethics enquires into

- human actions, motives, intentions voluntary actions and so on.

- questions such as- what is virtue (character), law, duty? what obligations are common to all?

* Source of Ethics

- God & religion.

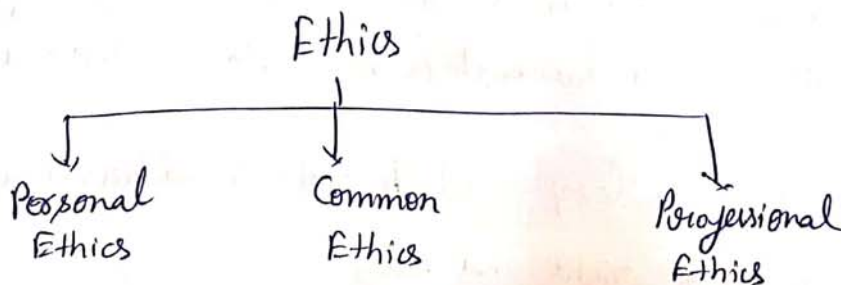
- Human conscience

- A rational Moral cost-benefit analysis of actions and their effects

- The example of good human beings (role models)

Political Power (Law/Rules)

PROFESSIONAL ETHICS



- A distinguished as common morality & personal ethics.
- Common morality set of moral beliefs shared by almost everyone
- Personal ethics or morality is a set of moral beliefs that a person holds
- Professional ethics is the set of standards adopted by professionals.

What is a profession?

Features :-

- Advance expertise :- skill, knowledge, continuous learning
- Self Regulation :- standards of conduct
- Public good :- Serving public good
- Way of making a living.
- Enter voluntarily & leave voluntarily.

* Characteristics of Professional Ethics

- Professional ethics is stated in formal code.
- Focuses on issues that are important for & in that profession.
- Regulates professional relationship.
- Moral Obligations of Professional (Safety & Quality) (Engineers)

Being Ethical in values



Being ethically ~~ist~~ literate



Being ethically competent / skills

Ethical Literacy :-

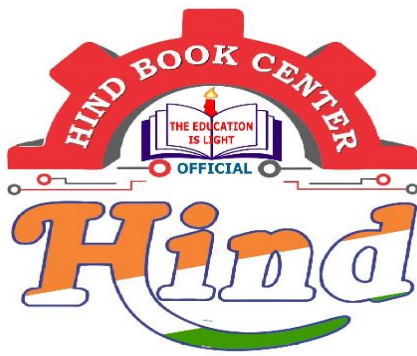
- Comprehending complex ethical issues.
- Ability to comprehend the **consequences of one's Actions**.

Assertion / Reasons

- Every member of all-India service shall maintain "**HIGH ETHICAL STANDARDS**".
- **Ethical Literacy = Ethical standards.**

Ethical skills / competencies :-

- Be **knowledgeable of Ethical Principles**
- Recognize and promote **constitutional principles** of equality, fairness etc.
- **Respect** the law, **Serve** the public law.
- Respect and protect **privileged information**, ^{→ (Confidentiality)}
(^(Fiduciary) **SECRET**)
- Embrace and **Promote** ethical behaviour.



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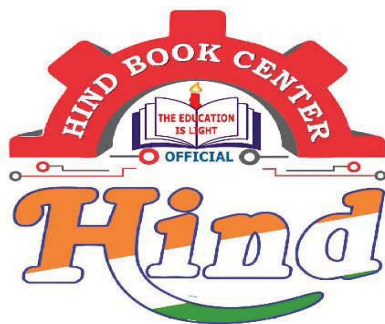
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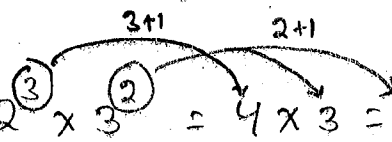
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NUMBER SYSTEM

Factors:-

Factors are the set of numbers which divide a given no. completely.

Ex:-1 $72 = 2^3 \times 3^2 = 4 \times 3 = 12$



1, 2, 3, 4, 6, 8, 9, 12, 18, 24, 36, 72

Ex:-2

$$120 = 2^3 \times 3^1 \times 5^1 = 4 \times 2 \times 2 = 16$$

1, 2, 3, 4, 5, 6, 8, 10, 12, 15, 20, 24, 30, 40, 60, 120

Total Factors/Divisors:-

$$N = a^p \times b^q \times c^r \dots \dots \dots$$

$$T_f = (p+1)(q+1)(r+1) \dots \dots \dots$$

where, a, b, c are distinct prime numbers and
 p, q, r are natural numbers.

Ex:-3 9000

find the T_f , odd factor, even factor?

$$N = 2^3 \times 3^2 \times 5^3$$

i) $T_f = 4 \times 3 \times 4 = 48$

ii) odd f : $\rightarrow$

To Remove the 2 from the system and use same procedure.

$$\text{Odd factor} = 2^3 \times [3^2 \times 5^3]$$

$$= 3 \times 4 = 12$$

$$\text{Even factor} = 48 - 12 = 36$$

Q1. How many Factors of number 72 are multiple of 6.

$$72 = 2^3 \times 3^2$$

$$2 \overline{) 72}$$

$$= \frac{2^1 \times 3^1}{6} \left[\frac{2^2 \times 3^1}{12} \right]$$

$$= 6 [1, 2, 3, 4, 6, 12]$$

$$T_f = 3 \times 2 = 6$$

Q2. How many Factors of number 120 are multiple of 12.

$$120 = 2^3 \times 3^1 \times 5^1$$

$$= 2^3 \times 3^1 \left[\frac{2^1 \times 5^1}{10} \right]$$

$$= 12 [1, 2, 5, 10]$$

$$T_f = 2 \times 2 = 4$$

Q3. How many Factors of number 9000 are multiple of 30.

$$9000 = 2^1 \times 3^1 \times 5^1 [2^2 \times 3^1 \times 5^2]$$

$$T_f = 3 \times 2 \times 3 = 18$$

Prime and composite factors:-

$$72 = 2^3 \times 3^2$$

$$T_f = 4 \times 3 = 12$$

$$P_f \rightarrow 2 \text{ for } [2, 3]$$

$$C_f \rightarrow 9$$

$$NPNC \rightarrow 1$$

$$\text{Total} = 12$$

Ex:-2

$$120$$

$$2^3 \times 3^1 \times 5^1$$

$$= 4 \times 2 \times 2 = 16$$

$$P_f \rightarrow 3 \text{ for } [2, 3, 5]$$

$$C_f \rightarrow 12$$

$$NPNC \rightarrow 1$$

$$\text{Total} \rightarrow 16$$

$$T_f = P_f + C_f + 1$$

Sum of Factors

$$N = a^p \times b^q$$

$$\text{Sum of factor} = \left(\frac{a^{p+1} - 1}{a - 1} \right) \left(\frac{b^{q+1} - 1}{b - 1} \right) \dots$$

$$N = 72 = 2^3 \times 3^2$$

$$\begin{aligned}\text{Sum of Factors} &= \left(\frac{2^4 - 1}{2 - 1} \right) \left(\frac{3^3 - 1}{(3 - 1)} \right) \\ &= 15 \times 13 \\ &= 195\end{aligned}$$

Product of Factor

$$P.F = [N]^{\frac{\gamma}{2}}$$

Ex: -72

$$4 = 2^{\textcircled{3}} \times 3^{\textcircled{2}}$$

$$= 4 \times 3 = 12$$

$$\text{So, PF} = (72)^{\frac{12}{2}} \\ = (72)^6$$

Ex: 2 $N=36$

$$= 2^2 \times 3^2 = 3 \times 3 = 9$$

$$\therefore \text{PF} = (36)^{9/2}$$

Factorials

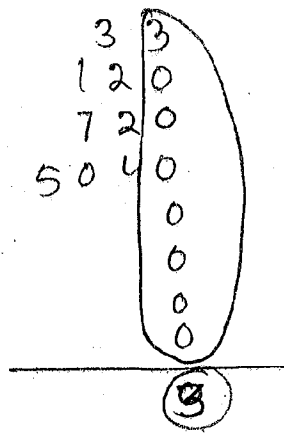
1! + 2! + 3! + + 99! then what would be the unit place/digit/last digit/last place of the number (u)?

$$5! = 5 \times 4 \times 3 \times 2 \times 1 = 120$$

$$6! = 6 \times 5! = 720$$

$$7! = 7 \times 6 \times 5! = 5040$$

$$1! + 2! + 3! + 4! + (5! + 6! + 7! + 8! + \dots + 99!) \\ \downarrow \quad \downarrow \quad \downarrow \quad \downarrow \quad \downarrow \quad \downarrow \quad \downarrow \quad \downarrow \quad \downarrow \\ 1 + 2 + 6 + 24 + 0 + 0 + 0 + \dots + 0 \\ = 3(3)$$



Ex: 2

100! Factorial contains how many zero.

$$100! = 1 \times \textcircled{2} \times 3 \times 4 \times \textcircled{5} \times 6 \times 7 \times \dots \times 100$$

$$\frac{100}{5} = 20 \quad [5, 10, 15, 20, \dots, 100] \approx 5^1$$

$$\frac{20}{5} = 4 \quad [25, 50, 75, 100] \approx 5^2$$

$$\text{Total} = 20 + 4 = 24 \rightarrow \text{no. of zero.}$$

Ex: 3

or

How many power of 3.

$$100! = 1 \times 2 \times \check{3} \times 4 \times 5 \times \check{6} \times 7 \times 8 \times \check{9} \times 10 \times \dots \times 99 \times 100$$

$$\frac{100}{3} = 33 \quad [3, 6, 9, 12, \dots, 99] \approx 3^1$$

$$\frac{33}{3} = 11 \quad [9, 18, 27, \dots, 99] \approx 3^2$$

$$\frac{11}{3} = 3 \quad [27, 54, 81] \approx 3^3$$

$$\frac{3}{3} = 1 \quad [81] \approx 3^4$$

48

or

$$\frac{100}{3} + \frac{33}{3} + \frac{11}{3} + \frac{3}{3} = 33 + 11 + 3 + 1 = 48$$

Ex:- $\frac{100}{7} = 14$
 $\frac{14}{7} = 2$

So $14 + 2 = 16$ nos.

Ex:- $\frac{100}{15} = 6$ $\frac{100!}{(15)^n}$
 $= [15, 30, 45, 60, 75, 90]$
Bullshit

$$\frac{100!}{(10)^n} = \frac{100!}{(2 \times 5)^n}$$

$$100! = 1 \times 2 \times \textcircled{3} \times 4 \times \textcircled{5}$$

$$\frac{100!}{(15)^n} = \frac{100!}{(3 \times 5)^n}$$

$$\begin{aligned} 100! &= 3^{48} \times 5^{24} \\ &= 3^{24} \times 3^{24} \times 5^{24} \\ &= (3 \times 5)^{24} \times 3^{24} \\ &= (15)^{24} \times \textcircled{3^{24}} \end{aligned}$$

Ex:- $\frac{100!}{2^n} = \frac{100}{2} + \frac{50}{2} + \frac{25}{2} + \frac{12}{2} + \frac{6}{2} + \frac{3}{2} = 97$

$$100! = 2^{97} \times 3^{48} \times 5^{24} \times 7^{16} \times 11^9 \times 13^7 \times 17^5 \times 19^5$$

$$\begin{aligned} \frac{100!}{(91)^n} &= \frac{100}{13 \times 7} \rightarrow \text{power of 13} \Rightarrow \text{Ans} = 7 \\ \frac{100!}{(85)^n} &= \frac{100}{17 \times 5} \rightarrow \text{power of 17} = 5 \Rightarrow \text{Ans} = 5 \end{aligned}$$

$$\begin{aligned} \frac{100!}{(77)^n} &= \frac{100!}{11 \times 7} \Rightarrow \text{Ans} = 9 \\ \frac{100!}{(65)^n} &= \frac{100!}{13 \times 5} \end{aligned}$$

Q1. First 9 multiples of 5 are multiplied then the no. of trailing zero at the ends.

$$5 \times 10 \times 15 \dots \times 45$$

Cyclicity:-

	<u>For-2</u>	<u>For-3</u>	<u>For-7</u>	<u>For-8</u>
$4n+1 \rightarrow \text{Remindor } 1 \rightarrow 2$		3	3	8
$4n+2 \rightarrow \text{Rem } 2 \rightarrow 4$		9	9	4
$4n+3 \rightarrow \text{Rem } 3 \rightarrow 8$		7	3	2
$4n \rightarrow \text{Rem } 0 \rightarrow 6$		1	1	6

$$(732)^{227} \rightarrow 2 \left(\frac{27}{4} \right) \rightarrow \text{Re} \rightarrow 3$$

$4 \rightarrow \text{no. of operation}$

So unit place = 8

$$(453)^{222} \rightarrow 2 \left(\frac{22}{4} \right) \rightarrow \text{Re} \rightarrow 2$$

So unit place = 9

<u>2 operation</u>	
<u>For 4</u>	<u>For 9</u>
4 $\rightarrow$ odd	9 $\rightarrow$ odd
6 $\rightarrow$ Even	1 $\rightarrow$ Even

Ex:- $(79)^{91} = \text{odd} \rightarrow 9$

$(79)^{92} = \text{Even} \rightarrow 1$

Any power
 $0, 1, 5, 6 \rightarrow 1 \text{ operation.}$

BODMAS

Ex: 1

Any power 94

Any power 297

4-operation

$$(76)^{94} \times (227)^{343 \text{ Red } 3} + (77)^{297}$$

$$\downarrow \quad \quad \downarrow \text{Red } 3 \quad \quad \downarrow$$

$$6 \quad \times \quad 3 \quad + \quad 1$$

$$= 19$$

$$= (9) \text{ unit place only.}$$

Work Book/Q-97/pg-106

GATE
 2016/EE

$$(2171)^7 + (2172)^9 + (2173)^{11} + (2174)^{13 \rightarrow \text{odd}}$$

$$\downarrow$$

$$1 + 2 + 7 + 4$$

$$= 14 = (4)$$

$$(211)^{570} + (146)^{127} \times 3^{424 \text{ Rem } 20}$$

$$\downarrow \quad \quad \downarrow$$

$$1 + 6 \times 1$$

$$= 7$$

Base system :-

$$(25)_{10} = (11001)_2$$

$\begin{matrix} & 2^4 & 2^3 & 2^2 & 2^1 & 2^0 \\ & 16 & 8 & 4 & 2 & 1 \end{matrix}$
 $\begin{matrix} & 1 & 1 & 0 & 0 & 1 \end{matrix}$

2	25	Rem.
2	12	4
2	6	0
2	3	0
	1	1

$$(16 + 8 + 0 + 0 + 1) = (25)_{10}$$

$$\begin{array}{r} \textcircled{1} \textcircled{1} \\ 3 : 24 : 36 \\ 2 : 45 : 32 \\ \hline 6 : 10 : 8 \end{array}$$

$$\begin{array}{r} \textcircled{1} \textcircled{1} \textcircled{1} \\ 873 \\ + 127 \\ \hline 1006 \end{array}$$

$(b=8)$ NB/pg-96/Q-2
 $7+6=6+5$

$$\begin{array}{r} \textcircled{1} \textcircled{1} \\ 137 \\ + 276 \\ \hline 435 \end{array} \quad b=8$$

$$\begin{array}{r} \textcircled{1} \textcircled{1} \\ 731 \\ + 672 \\ \hline 1623 \end{array} \quad b=8$$

$$\begin{array}{r} \textcircled{2} \quad \text{BORROW } \textcircled{8} \\ 76821 \\ - 672 \\ \hline 037 \end{array} \quad b=8$$

Ex 1

$$\begin{array}{r} \text{1st} \quad \textcircled{1} \quad \textcircled{1} \quad \textcircled{1} \\ 4 \quad 2 \quad 2 \quad 6 \\ + 2 \quad 4 \quad 4 \quad 2 \\ \hline 1 \quad 0 \quad 0 \quad 0 \quad 1 \end{array} \quad b=7$$

then

$$\begin{array}{r} \text{7} \quad \text{7} \quad \text{7} \\ \text{2}_1 \quad \text{3}_2 \quad \text{4}_3 \quad 2 \\ - 1 \quad 6 \quad 5 \quad 6 \\ \hline 0 \quad 3 \quad 5 \quad 3 \end{array} \quad b=7$$

Workbook / Q52 / pg-101

$$(7526)_8 - (Y)_8 = (4364)_8 \quad \text{Find } Y = ?$$

$$\begin{array}{r} \text{8} \\ 7 \cancel{5} 2 6 \\ - 4 3 6 4 \\ \hline 3 1 4 2 \end{array} \quad b=8$$

$$\begin{aligned} \text{Red (3 sec)} &\longrightarrow 3, 6, 9, \textcircled{12}, \dots, \textcircled{24} \\ \text{Green (4 sec)} &\longrightarrow 4, 8, \textcircled{12}, \dots, \textcircled{24} \end{aligned}$$

$$\begin{aligned} K \times L_{cm} & \quad (t_{R_1}, t_{G_1}) \\ K \times L_{cm} & \quad (3, 4) = 12K \end{aligned}$$

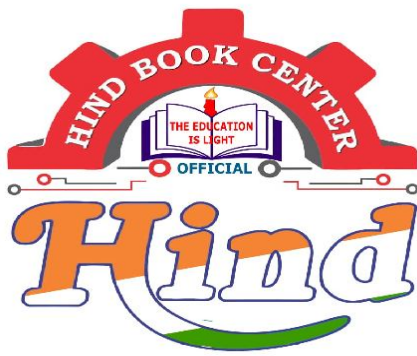
$$\begin{aligned} R (3t \longrightarrow 2 \text{ min}) & \xrightarrow{120 \text{ sec}} \frac{120}{3} = 40 \\ G (5t \longrightarrow 3 \text{ min}) & \xrightarrow{180 \text{ sec}} \frac{180}{5} = 36 \end{aligned}$$

$$K \times L_{cm} \left(\begin{array}{cc} R_1 & G_2 \\ 40 & 36 \end{array} \right)$$

$$\approx K \times 360$$

$$\approx 6 \text{ min.}$$

$$\text{1 hr} = \frac{60 \times 60}{360} = 10 \text{ times}$$



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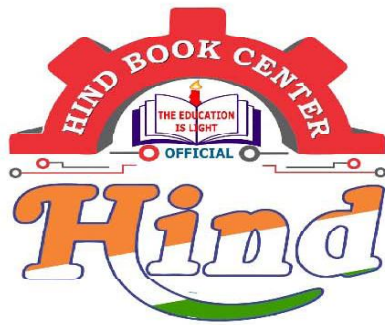
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⇒ Syllabus

- 1) Linear Algebra
 - 2) Probability
 - 3) Calculus
 - 4) Vector Calculus
 - 5) Differential Equation (Ordinary & Partial)
 - 6) Complex Variable
 - 7) Numerical Method
 - 8) Laplace Transform*
 - 9) Fourier Series*
-

LINEAR ALGEBRA

⇒ Study of system of linear equation.

Ex:

$$\begin{cases} x+2y=3 & \text{--- (1)} \\ 2x+3y=5 & \text{--- (2)} \end{cases}$$

Two Variable

$$\times (x=1, y=1)$$

Intersecting line

Unique soln

$$x+2y=3$$

$$2x+4y=6$$

Coincident Line

Infinite soln

$$x+2y=3$$

$$x+2y=5$$

$\Rightarrow \}$

No soln

⇒ MATRIX

Each row have some no. of elements and each column has some number of elements.

$A = [a_{ij}]_{m \times n}$
 A matrix of order $m \times n$
 element of Matrix
 No. of rows $\rightarrow$ horizontal
 No. of column $\rightarrow$ vertical
 a_{ij}
 $\rightarrow$ row
 $\rightarrow$ column

$$A = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{m1} & a_{m2} & \dots & a_{mn} \end{bmatrix}$$

$\rightarrow R_1$
 $\rightarrow R_2$
 $\rightarrow R_m$
 $\uparrow$
 C_1 C_2 C_n

$R \rightarrow$ Row

$C \rightarrow$ Column

- $m \neq n \rightarrow$ Rectangular Matrix
- $n = n \rightarrow$ Square Matrix

$$A = \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix} \quad 3 \times 3$$

- Primary Diagonal
- Leading Diagonal
- Principle Diagonal
- Main Diagonal
- Diagonal element

$$\text{Trace}(A) = \text{Sum of diagonal element}$$

$$\text{Trace}(A) = \sum a_{ij}$$

#

For Diagonal element $\rightarrow i = j \quad \forall i, j$

For lower Diagonal element $\rightarrow i > j \quad \forall i, j$

For upper Diagonal element $\rightarrow i < j \quad \forall i, j$

For other than Diagonal element
or $\rightarrow i \neq j \quad \forall i, j$
Off Diagonal element

~~For Diagonal~~

For Corresponding element $\rightarrow a_{ij} \text{ \& } a_{ji} \text{ (} a_{23} \text{ \& } a_{32} \text{)}$

Diagonal Matrix

All off diagonal elements must be zero
and at least one diagonal element must be Non-zero

$$\begin{bmatrix} a & 0 & 0 \\ 0 & b & 0 \\ 0 & 0 & c \end{bmatrix} \quad \begin{bmatrix} a & 0 & 0 \\ 0 & b & 0 \\ 0 & 0 & 0 \end{bmatrix} \quad \begin{bmatrix} a & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$$

Diagonal Matrix

$$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} \rightarrow \text{Null Matrix Square}$$

$$\begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} \rightarrow \text{Null Matrix Rectangle}$$

Q) Minimum number of zeros of Diagonal Matrix of order 'n' $\Rightarrow n^2 - n$

Maximum number of zeros of Diagonal Matrix of order 'n' $\Rightarrow n^2 - 1$

Identity Matrix (I)

$$I_2 = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

$$I_3 = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$I_4 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Scalar Matrix

$\begin{matrix} \text{K I} \\ \downarrow \\ \text{Scalar Value} \end{matrix}$

$$\begin{bmatrix} 7 & 0 & 0 \\ 0 & 7 & 0 \\ 0 & 0 & 7 \end{bmatrix} = 7 \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} = 7 I_3$$

$$\begin{bmatrix} 5 & 0 \\ 0 & 5 \end{bmatrix} \Rightarrow \text{Scalar as well as diagonal.}$$

$$\begin{bmatrix} 5 & 0 \\ 0 & 7 \end{bmatrix} \Rightarrow \text{only diagonal not scalar}$$

All scalar matrix are diagonal Matrix but all diagonal matrix are not scalar

Upper Triangular Matrix

$$A = \begin{bmatrix} 1 & 2 & 3 \\ 0 & 4 & 5 \\ 0 & 0 & 6 \end{bmatrix}$$

$$A = [a_{ij}]_{n \times n}$$

$$a_{ij} = 0 \quad \forall i > j$$

Lower Triangular Matrix

$$A = \begin{bmatrix} 1 & 0 & 0 \\ 2 & 3 & 0 \\ 4 & 5 & 6 \end{bmatrix}$$

$$A = [a_{ij}]_{m \times n}$$

$$a_{ij} = 0 \quad \forall i < j$$

Column Matrix

$$A = [a_{ij}]_{n \times 1}$$

↓
only one
column

Ex $A = \begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \end{bmatrix}_{4 \times 1}$

Row Matrix

$$A = [a_{ij}]_{1 \times n}$$

↓
only one
Row

Ex, $A = [1 \ 2 \ 3 \ 4]_{1 \times 4}$

Transpose of Matrix (A^T)

$$A = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix}$$

$$A^T = \begin{bmatrix} 1 & 4 & 7 \\ 2 & 5 & 8 \\ 3 & 6 & 9 \end{bmatrix}$$

Symmetric Matrix

i) $A^T = A$

ii) $a_{ij} = a_{ji}$

$$A = \begin{bmatrix} 1 & 2 & 3 \\ 2 & 4 & 5 \\ 3 & 5 & 6 \end{bmatrix}$$

$$A^T = \begin{bmatrix} 1 & 2 & 3 \\ 2 & 4 & 5 \\ 3 & 5 & 6 \end{bmatrix} = A$$

Skew-Symmetric Matrix

i) $A^T = -A$

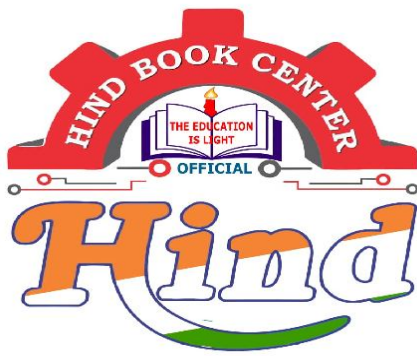
ii) $a_{ij} = -a_{ji}$

iii) All diagonal element must be zero

$$A = \begin{bmatrix} 0 & 2 & 3 \\ -2 & 0 & 5 \\ -3 & -5 & 0 \end{bmatrix}$$

$$A^T = \begin{bmatrix} 0 & -2 & -3 \\ 2 & 0 & -5 \\ 3 & 5 & 0 \end{bmatrix} = -A$$

Sum of all elements of a
Skew-Symmetric Matrix is always zero



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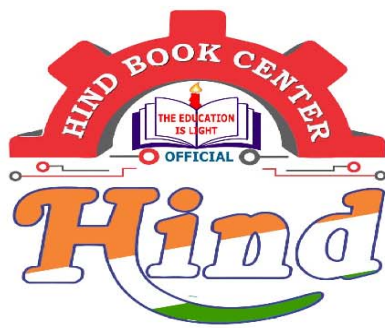
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ENGLISH

- * 1. Correction of sentences.
- * 2. Vocabulary
- 3. Critical Reasoning.
- 4. Analogy.

✓ 1. Question Tag

✓ 2. Usage of

a) As soon as

b) No sooner than

c) Hardly when

d) Scarcely when
before

•

✓ 3. Degree of comparison

✓ 4. Articles.

✓ 5. Tenses + If clause.

✓ 6. Reported speech.

✓ 7. Preposition

✓ 8. Parts of speech.

✓ 9. Concord and corrections.

Sentences: 4 kinds

- (i) Assertive
 $\left\{ \begin{array}{l} \rightarrow \text{Positive} \\ \rightarrow \text{Negative} \end{array} \right.$

 (ii) Interrogative
 (iii) Imperative
 (iv) Exclamatory

Special verb (24)

am, is, are, was, were

has, have, had, do, does, did

may, might, must, need, dare

used to, ought to

will, would, shall, should, can, could.

Negative:

To make a negative sentence, put not after the special verb.

Interrogative:

To make an interrogative sentence, put the special verb at that starting of the sentence.

Example: Dhoni is a perfect Gentleman (Positive)

Dhoni is not a perfect Gentleman (Negative)

Is Dhoni a perfect Gentleman (Interrogative)

Non special Verb:

borrow : do / does / did

do : present tense without 's'

does : present tense with 's'

did : Past tense.

NOTE: When we borrow do, does and did put the root verb in negative and interrogative.

Example: He goes to temple.
He does not go to temple.
Does he go to temple?

Example: He went to temple.
He did not go to temple.
Did he go to temple?

DO, Does, Did, these three always take root verb.

Question Tag

After giving a statement we sometimes confirm if the listener is accepting or not with out statement. This confirmation is called Question Tag.

NOTE: Question Tags are of mainly two kinds:

(i) To a positive statement, Negative Tag is added.

Only short forms are used.

In the place of nouns use pronouns.

Question tag should be ended with ~~special verb~~ pronoun.

Example: The clock is running fast, isn't it?

I am a teacher of English, aren't I?

We are the ilk of maddeasy, aren't we?

↓
meaning: family

My ~~drive~~ neighbour comes tomorrow, doesn't he?

If the gender is not specified give preference to male.

All the students went to picnic, did not they.

(ii) If the statement is negative, the question tag is ^{positive} ~~negative~~.

Example: I am not a teacher of English, am I?

My friend does not know the address, does he?

Formula: Special verb + pronoun.

Usage of:

Hardly, rarely, scarcely, barely, never, seldom

NOTE: These words always give negative sense. In the case of these words, the question tag is +ve.

Example: He hardly comes to my house, does he?

Barking dogs seldom bite, do they?

They never came to my house, did they?

Usage of:

have, has, had

These three act as two kinds:

(i) main verb (give the meaning of possessing)

(ii) Special verb (does not give any meaning)

Example:

He has a car, ~~does he?~~ doesn't he?
M.V.

He has purchased a car, hasn't he?
S.V.

He had solved the problem, hadn't he?
S.V.

He had a problem earlier, didn't he?
M.V.

Usage of

Everyone, Everybody, Someone, Somebody, Noone, nobody.

NOTE: These six verb words take singular verb at the time of statement but in question tag, these words take plural verb.

In the place of all these words we have to write they.

Singular verb	Plural verb
is	are
was	were
has	have
does	do

Example: Everyone is coming, ~~isn't everyone~~
aren't they?

Everyone likes music, don't they?

Every one has mobile, don't they?

Every one has given mobile, haven't they?

None is coming, aren't they?

No one supports corruption, do they?

10/10/2021

Usage of

a few = positive
few = Negative

a little = positive
little = negative

Example: He asked me a few books, didn't he?

He asked me few books, did he?

He wants a little, doesn't he?

He wants little, does he?

Usage of

making imperative in as question tags.

Imperative:

Rule:

1. Subject YOU is absent (But the meaning is implied in it)
2. Sentence begins with V₁
3. Expresses command or request

NOTE: Imperatives generally take will you in question tags.

Example: come here, will you?

A sentence that is satisfied with these three rules is called imperative.

Example: Go there, will you?

Don't come here, will you?

shut up, can't you? } ← Expresses command only.

Get lost, can't you?

Keep silence, can't you?

* If the statement begins with Let's or Let us, the question is always "shall we?"

Example: Let's start the work, shall we?

Let's not start the work, shall we?

* Let him go, will you?

* If the statement begins with so, a) to a positive statement Question tag is also positive.

b) to a negative statement, Question tag is also negative.

Example:

So, you are coming, are you?

So, you are not coming aren't you?

- Usage of
- a) as soon as
 - b) No sooner than
 - c) Hardly-when
 - d) Scarcely when
before

These four words are called Idiomatic Expression. These four words give the same meaning. i.e. "immediately".

Usage of No-sooner than:

No sooner connects with than.

Rules: 1. put no sooner in the place of as soon as.

2. change the as soon as into interrogative form.

3. Put than before the second sentence.

Example: As soon as I went home, I had rest.

No sooner did I go home than I had rest.

} same meaning

As soon as the baby sees the doctor, she will cry.

No sooner does the baby see the doctor than she will cry.

Usage of hardly when:

1. Put hardly in place of as soon as.

2. change the as soon as sentence into had + V₃ form. and then change into interrogative form.

3. Put when before the second sentence.