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MECHANICAL ENGINEERING

Engineering Mechanics

By-Ravendar SIR

- Theory
- Explanation
- Derivation
- Example
- Shortcuts
- Previous Years Question With Solution

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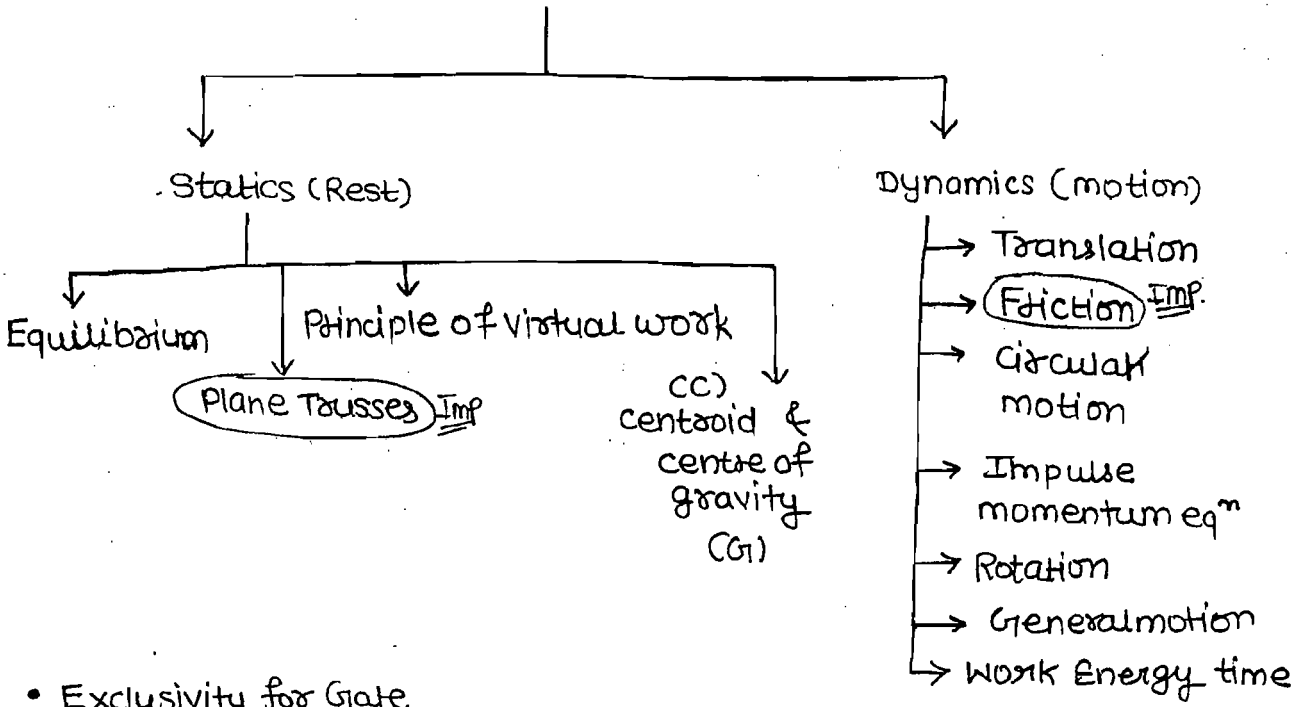
Engg. Mechanics

"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
  - * Langage's Equation

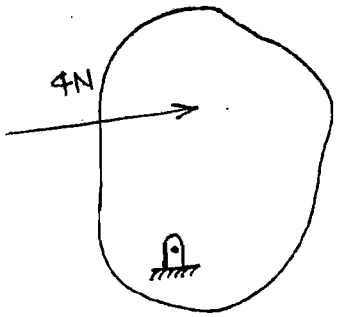
• **Actual Force :→**

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 has Not been applied by any other body.

To define a force →
- Magnitude (Intensity)
- direction (orientation)
- Point of application



• **Types of Forces**

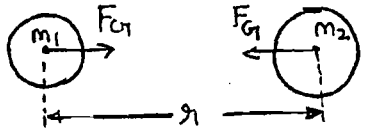
1. Gravity (W)

2. Contact Force (R) →
   - Normal Reaction (N)
   - friction (f)

3. Tension (T)

4. Spring Force (F_s)

• Gravity →



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

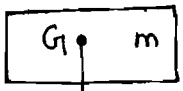
$G = 6.67 \times 10^{-11}$

$$g = \frac{G M_e}{R_e^2} \quad \star$$

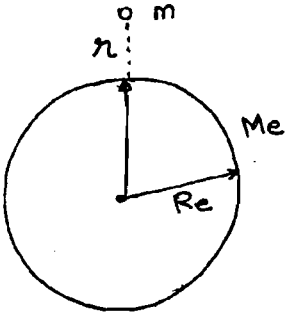
M_e = Mass of Earth

R_e = Radius of Earth

$$W = mg \quad \text{(Pulling)} \quad \star$$



mg ⇒ on mass m by Earth



$F_{G1} = \frac{G M_e m}{R_e^2}$

$F_{G1} = mg$

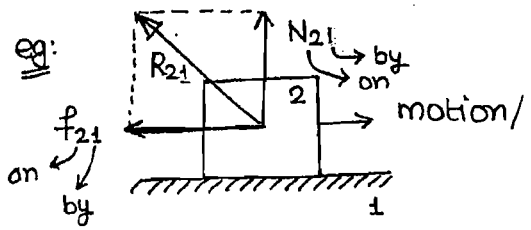
$(R_e + r \simeq R_e)$

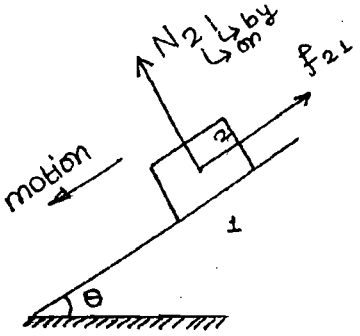
• contact Force →

→ Normal Reaction (Pushing)

→ Friction

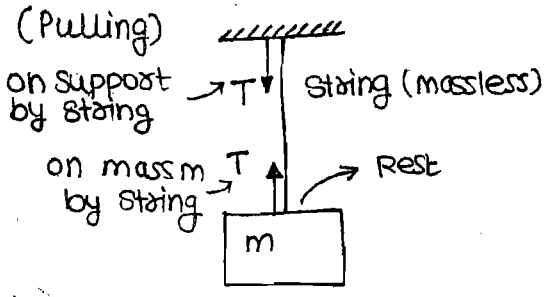
eg:



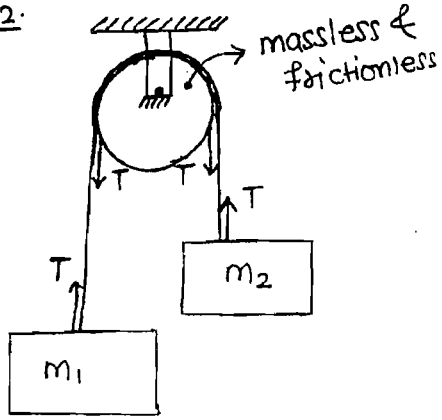


• Tension →

ex→1. (Pulling)



ex→2.



• Spring Force (F_S) ⇒

(Can be Pulling or Pushing)

$F_S = K(\Delta x)$ → elongation or Compression from Natural Length

↓ Spring Constant

- **Newton's First Law (NFL):→**

For a Particle → at the same Instant

if $\Sigma \vec{F} = 0$ then $\vec{a} = 0$

$\vec{a} = 0$

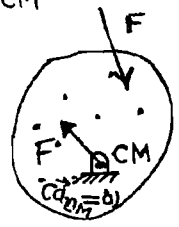
- Rest
- Uniform Linear Velocity

For a Rigid body

If $\Sigma \vec{F}_{ext} = 0$

then $\vec{a}_{CM} = 0$

Particle

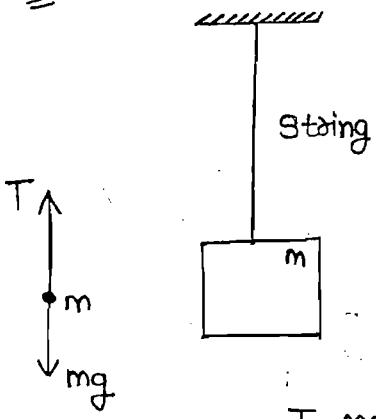


Rigid Body

$\vec{a}_{CM} = 0$

- Rest
- $\vec{V}_{cm}$ = Const.
- A Body is rotating about it's CM.

Eg:-1



(m) → Rest ⇒ $\vec{a}_{CM} = 0$

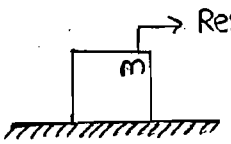
$\Sigma \vec{F}_{ext} = 0$

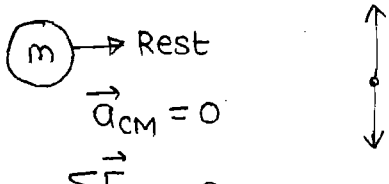
↳ Newton's 1st Law

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

$\boxed{T = mg}$ [NFL]

Eg:2





$\vec{a}_{CM} = 0$

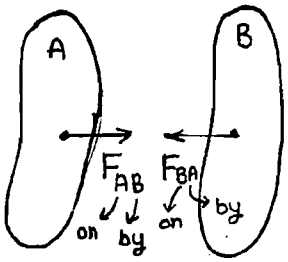
$\Sigma \vec{F}_{ext} = 0$

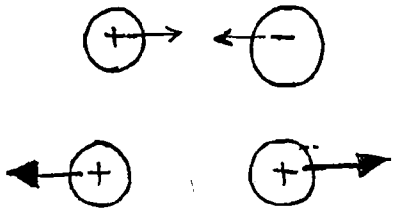
↳(NFL)

$N - mg = 0$

$\boxed{N = mg}$ [NFL]

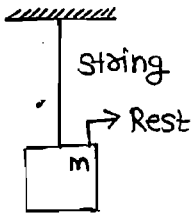
• Newton's Third Law (NTL) →

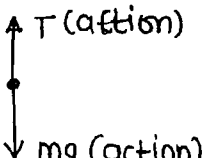




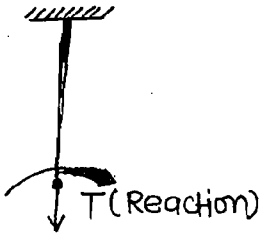
$$\vec{F}_{AB} = -\vec{F}_{BA}$$

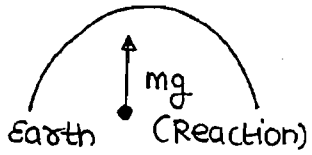
Ex: 1



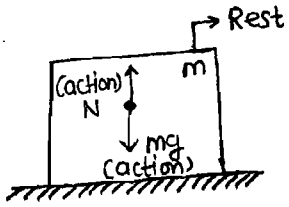


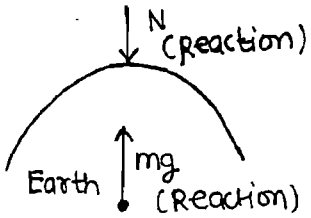
$$\downarrow g = \frac{GM_e}{R_e^2}$$





Ex: 2





Reading of weighting

"If a Body A exerts ~~one~~ Force on Body B. then 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

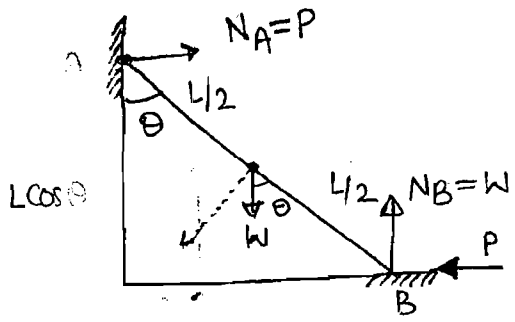
NOTE: → In FBD Surroundi. should not be shown.

- **Equilibrium** → Rest
  → uniform Linear velocity

(I) $\Sigma \vec{F} = 0$ $[\Sigma F_x = \Sigma F_y = \Sigma F_z = 0]$

(II) $\Sigma \vec{\tau} = 0$
(about any Point 'or' Line)

Que :



A uniform Ladder AB of Length L and weight W is held in equilibrium by Horizontal force P at B as shown in figure: Assume all the surfaces to be Smooth

find P

~~W X L = P tan~~

$\Sigma M_B = 0$

$W \sin\theta \times \frac{L}{2} = P L \cos\theta$

$$\boxed{P = \frac{W}{2}\tan\theta}$$

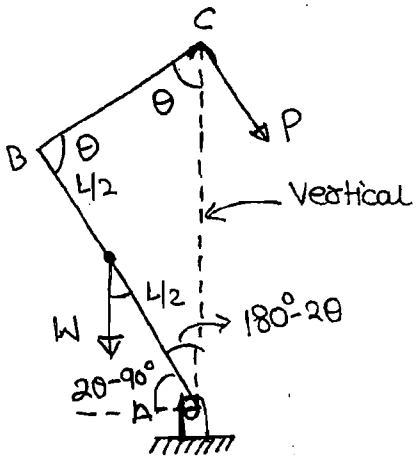
Que A uniform Rod of weight W and Length L is movable in vertical Plane about hinge at A but it is held in equilibrium by a ~~string~~ force P which is attached to a string BC Passing over a Smooth Peg C. If AB = AC then the force P is

(a) $W \cos\theta$

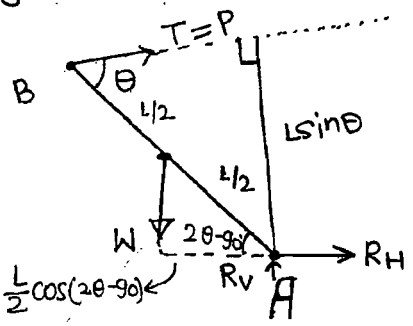
(b) $\frac{W}{\cos\theta}$

(c) $W \tan\theta$

(d) $W \sin\theta$



Considering equilibrium of Rod 'AB'



$\Sigma \vec{T}_A = 0$

$W \times \frac{L}{2}\cos(2\theta - 90) = P L \sin\theta$

$W = 2W \sin\theta\cos\theta = P\sin\theta$

$\boxed{P = W\cos\theta}$

- **Moment of a force 'or' Torque :→**

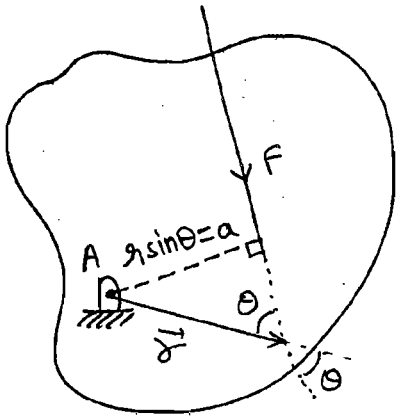
$(\vec{M}$ 'or' $\vec{T})$

$\vec{T}_A = \vec{r} \times \vec{F}$

$|\vec{T}_A| = rF\sin\theta$

$\boxed{|\vec{T}_A| = Fa}$

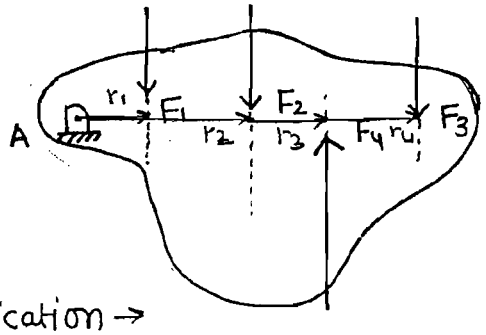
direction → $\perp_{A}^{r}$ inward through

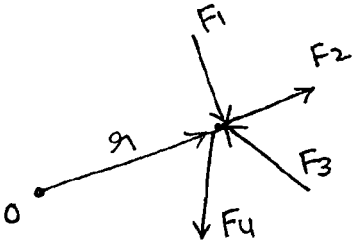


*** Imp: Property of Numericals (Vector algebra)

- **Varignon's Theorem**

For a concurrent force system Net Torque about a point will be Torque of resultant force about that point





$\Sigma \vec{T}_O = \vec{r}_1 \times \vec{F}_1 + \vec{r}_2 \times \vec{F}_2 + \vec{r}_3 \times \vec{F}_3 + \cdots$

$= \vec{r} \times \vec{F}_1 + \vec{r} \times \vec{F}_2 + \vec{r} \times \vec{F}_3 + \cdots$

$= \vec{r} \times (\vec{F}_1 + \vec{F}_2 + \vec{F}_3 + \cdots)$

$\boxed{\Sigma \vec{T}_O = \vec{r} \times \vec{F}_R}$

Application →

For a concurrent force system

if $\Sigma \vec{F} = 0$

$\Sigma \vec{T} = 0$

↳ at any point

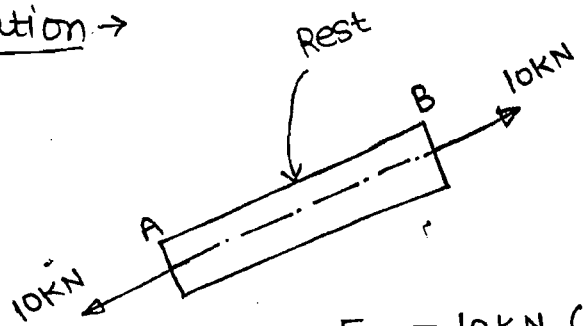
Ex. Joints in Truss

• Systems of Equilibrium: →

1. Two Force System →

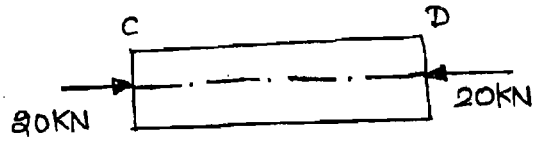
To keep a body in equilibrium under the action of two-force, they must be equal in magnitude and opposite in direction and colinear in action.

Application →



F_{AB} = 10KN (Tensile)

Intensity of Internal resisting force



F_{CD} = 20KN (Compressive)

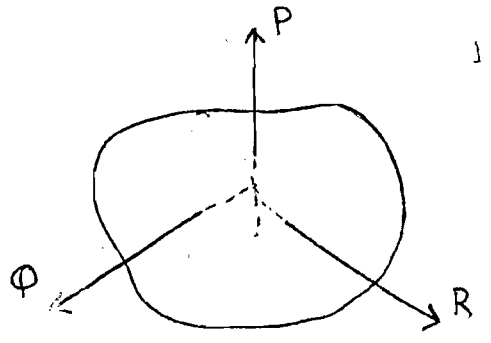
Intensity of internal resisting force in member CD

2. Three Force System →

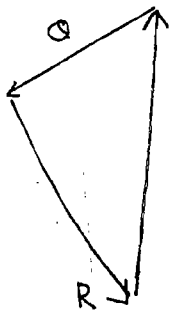
To keep a body in equilibrium under the action of 3 forces they must be coplaner and concurrent.

$\vec{P}, \vec{Q} \& \vec{R}$

(a) $\vec{P}+\vec{Q}+\vec{R}=0 \Rightarrow$ Coplaner



(b) $\Sigma\vec{T}=0$



(Force Triangle)

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FLUID MECHANICS

By: Varun Pathak Sir

Introduction

* A fluid is a substance that is having the ability to flow or deform continuosly under the action of shear force [Tangential force], No matter how much small the force is.

*→

*→ No slip condition or Maxwellian condition [Experimental]

*→ Free surface :

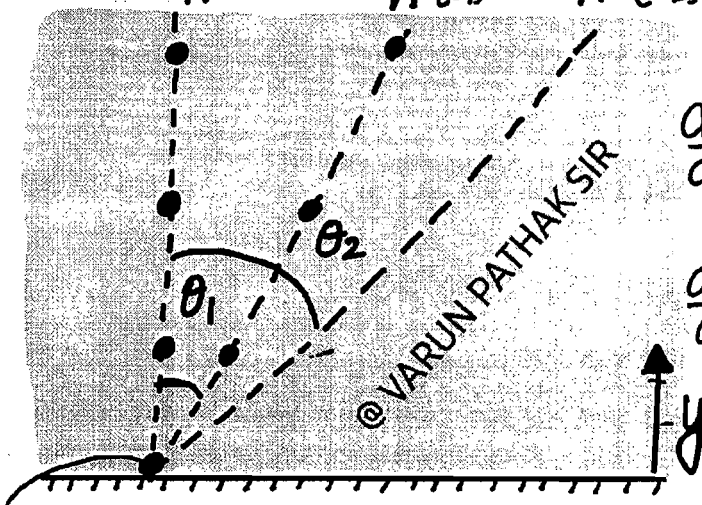
Difference between Solids & Fluids

① In case of solids the deformation is constant with respect to time whereas in case of fluids

deformation is continuos with respect to time i.e. In case of fluids Rate of Deformation $\left(\frac{d\theta}{dt}\right)$ is more important than deformation. @ VARUN PATHAK SIR

(2.) In case of solids on removal of load, solids will try to Regain their Original Shape where as fluids will never try to Regain original Shape.

Fluids



$\frac{d\theta}{dt}$ → Rate of Angular Deformation

$\frac{du}{dy}$ → Velocity Gradient

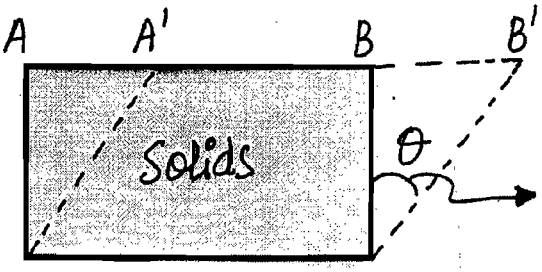
@ VARUN PATHAK SIR

No slip condition (or) Maxwellian condition

[Relative velocity between the Molecule and the Boundary is zero $V_R = 0$]

@ VARUN PATHAK SIR

Solids



Angular Deformation

Note : @ VARUN PATHAK SIR

The Intermolecular force of attraction between molecules of same nature is known as cohesion whereas intermo-lecular force of attraction between molecules of different Nature is known as adhesion.

*

Eg. Water in contact with Glass →
Mercury in contact with Glass →
Water in contact with Plastic Sheet →

Mechanics :

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- Engg. Mechanics
- SOM
- Fluid Mechanics

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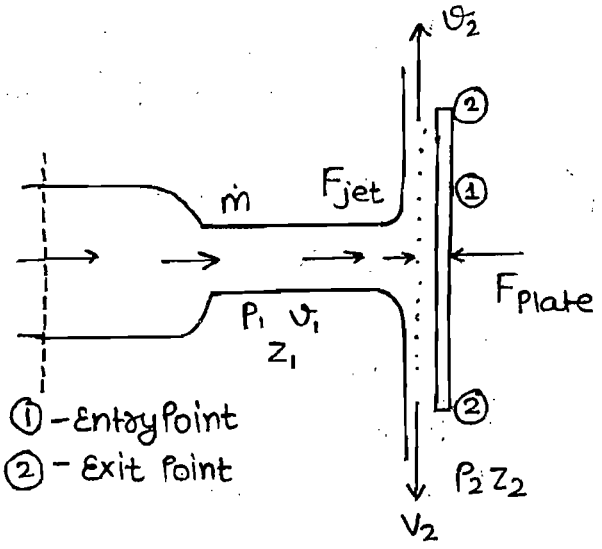
Fluid Machinery

- Impact of Jet
- Turbine
  - Impulse → Pelton Wheel
  - Reaction
    - Francis
    - Kaplan
    - Propeller
- Pump
  - Centrifugal Pump
  - Reciprocating Pump (ESE only)

Book :→ R.K. Bansal
D.S. KUMAR

Impact of Jet :→



Water → Reaction force
Plate → Initial force

Newton's II Law

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

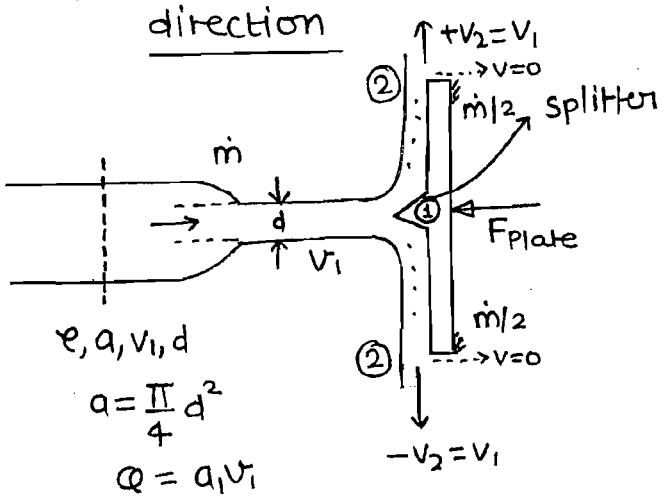
F_{Plate} = (Final - Initial) momentum of Water

$$\boxed{F_{jet} = -F_{Plate} = \dot{m}\vec{V}_1 - \dot{m}\vec{V}_2}$$

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

Case: I

Jet strikes Stationary Flat Plate in Normal direction



e, a, V_1, d

$a = \frac{\pi}{4} d^2$

$Q = a_1 v_1$

$P_1 = P_2 = P_{atm}$

$z_1 = z_2$

$$\frac{P_1}{\rho g} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + z_2 + h_f$$

→ Smooth Plate ($V_2 = V_1$)

→ Rough Plate ($V_2 < V_1$)

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

$$\rightarrow F_x = F_N = \dot{m}V_1 - \left[\frac{\dot{m}}{2} \times 0 + \frac{\dot{m}}{2} \times 0\right]$$

$$\rightarrow F_x = F_N = \dot{m}V_1 = \rho a V_1^2 N$$

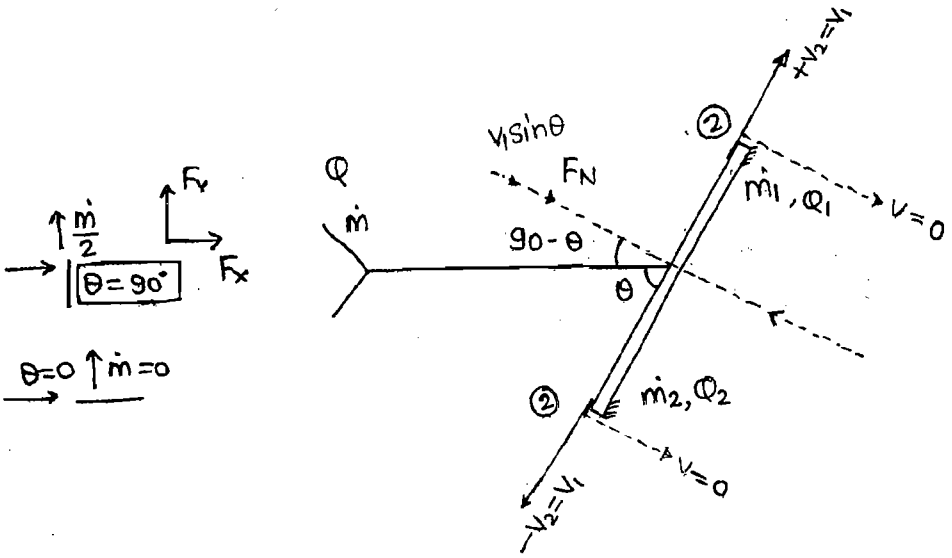
$$\rightarrow F_y = F_T = \dot{m} \times 0 - \left[\frac{\dot{m}}{2} \times V_2 + \frac{\dot{m}}{2}(-V_2)\right]$$

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

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



$$\dot{m} = \dot{m}_1 + \dot{m}_2 \Rightarrow \boxed{Q = Q_1 + Q_2} \rightarrow (1)$$

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

$$F_N = \dot{m} V_1 \sin\theta - [\dot{m}_1 \times 0 + \dot{m}_2 \times 0]$$

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

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

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

$\dot{m}_1, \dot{m}_2 / Q_1, Q_2 = ?$

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

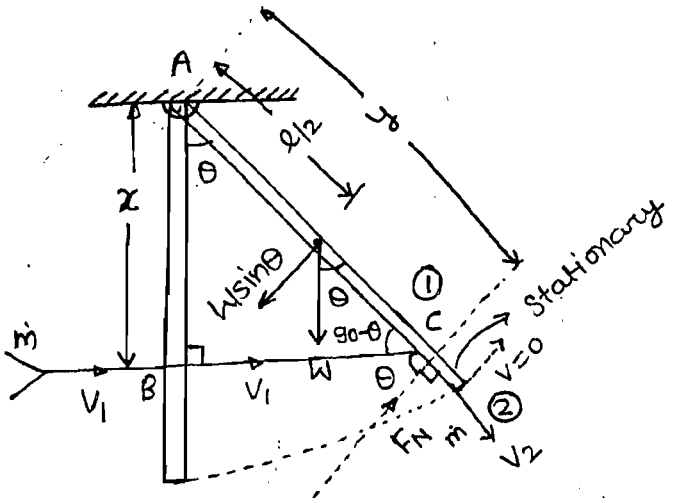
$$\rightarrow \quad \dot{m} V_1 \cos\theta - (\dot{m}_1 \times V_1 + \dot{m}_2 \times (-V_1)) = 0$$

$$Q \cos\theta - Q_1 + Q_2 = 0 \rightarrow (11)$$

$$Q = Q_1 + Q_2 \longrightarrow (1)$$

Case-III

Jet Strikes Vertical Hanging Plate



l = length of Plate

W = Weight of Plate = Mg

$\rightarrow \Sigma M_A = 0$

$\rightarrow F_y \cdot y = W \sin\theta \cdot \frac{l}{2}$

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

$\rightarrow F_N = \dot{m} v_1 \cos\theta - \dot{m} \times 0$

$$\boxed{F_N = \rho a v_1^2 \cos\theta} \quad \text{(Newton)}$$

ΔABC

$$\cos\theta = \frac{x}{y} \Rightarrow y = \frac{x}{\cos\theta}$$

$$\rho a v_1^2 \cos\theta \cdot \frac{x}{\cos\theta} = W \sin\theta \cdot \frac{l}{2}$$

$$\boxed{\sin\theta = \frac{2\rho a v_1^2}{Wl} \cdot x}$$

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Heat And Mass Transfer

By-Kakkar SIR

- Theory
- Explanation
- Derivation
- Example
- Shortcuts
- Previous Years Question With Solution

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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

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

Text Books

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

Ref. Book

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

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, condensor, Radiator, evaporator, Economisor to achieve a desire heat transfer rate under given temp. diffrent

• 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 →

Q = Heat transfer ⇒ Unit = J

q = Rate of Heat transfer ⇒ unit = J/sec (W)

q'' = Rate of Heat flux ⇒ unit = W/m^2

q → Total heat transfer Per sec

q'' → Local Heat transfer Per sec
(Rate of Heat transfer Per unit Area)

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I.C Engine

BY- Amrinder Sir

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- Derivation
- Example
- Shortcuts
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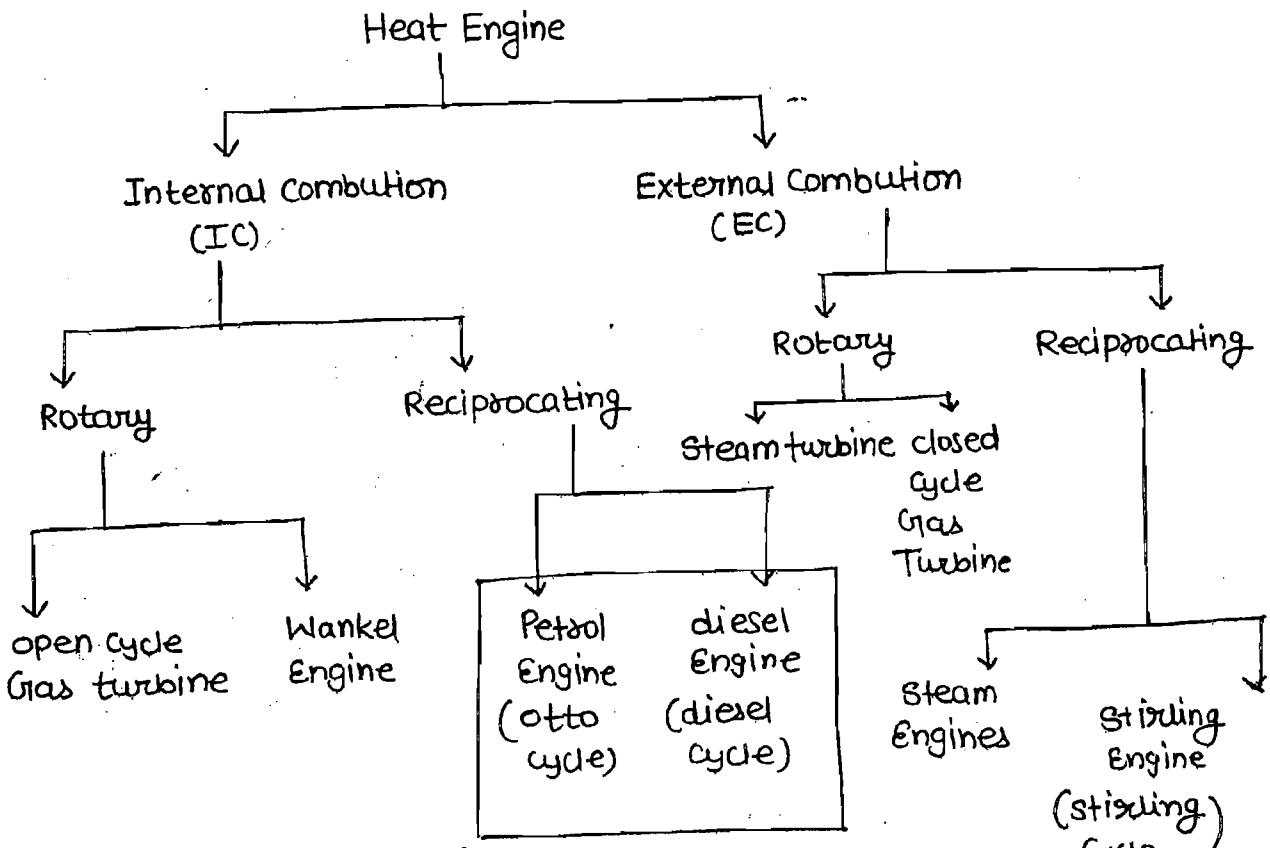
IC ENGINE

Books :

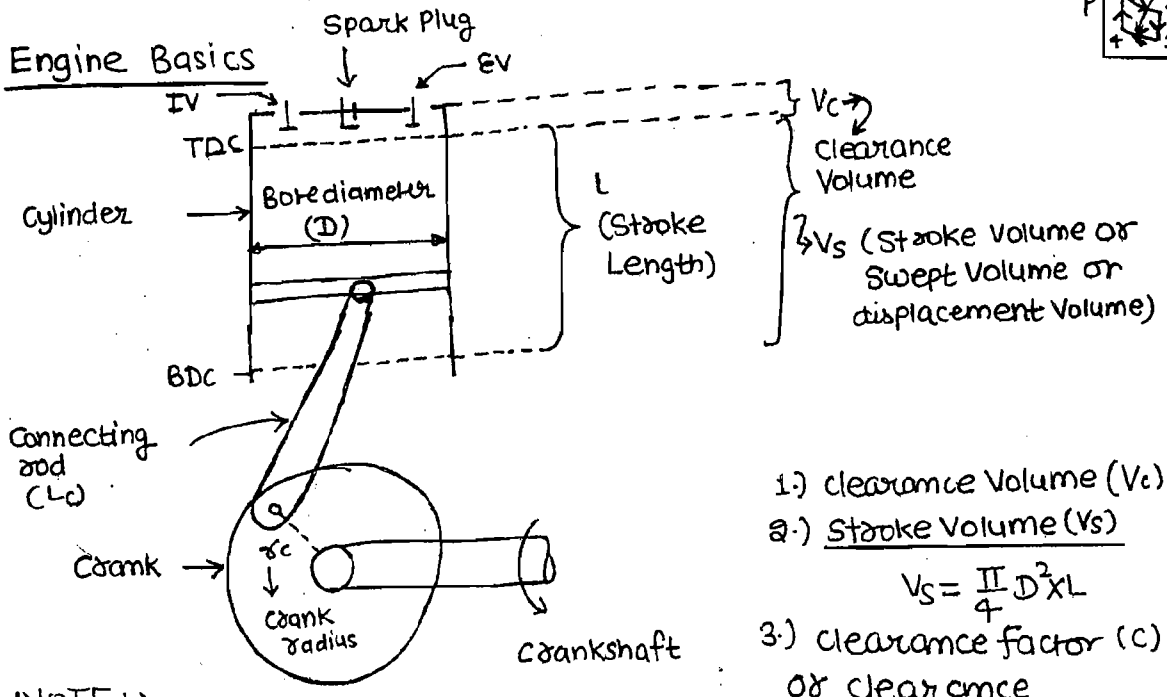
- V. Ganeshan
- Mathur and Sharma

(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)

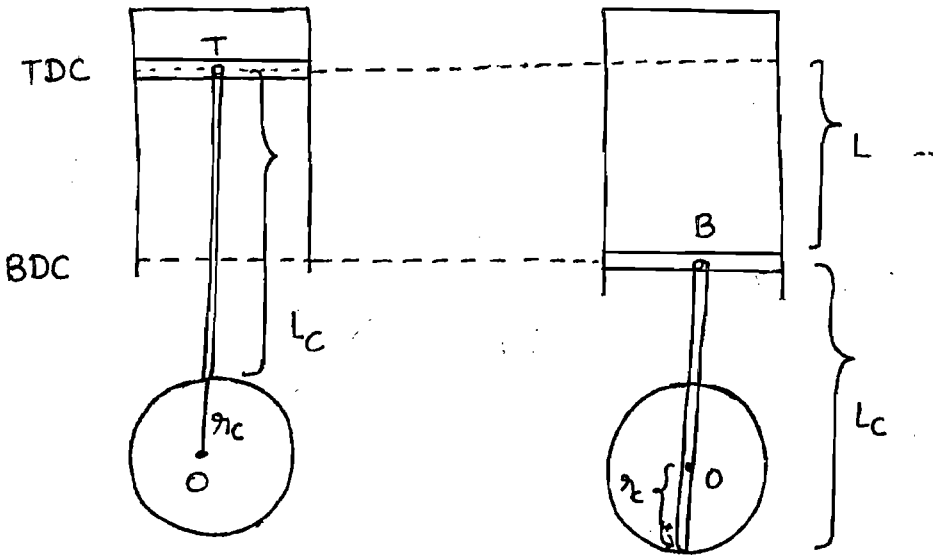
2.) Stroke Volume (V_s)

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

3.) clearance factor (C)
or clearance ratio
or clearance Volume ratio ★

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

4.) $L = 2r_c$



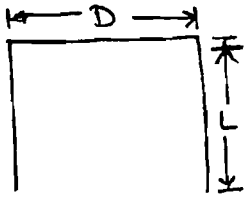
$$L = OT - OB$$
$$= (L_c + r_c) - (L_c - r_c)$$
$$\boxed{L = 2r_c}$$

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

$$\bar{V}_p = 2L \times \frac{N}{60} \frac{\text{rev}}{\text{sec}} = \frac{2LXN}{60}$$

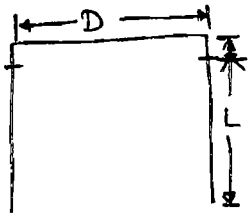
($N \rightarrow$ rpm; $2L \rightarrow$ dis/rev.)

(6)



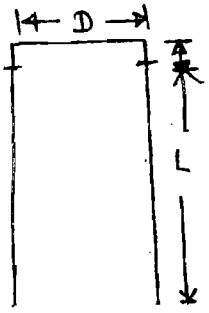
oversquare or Short stoke

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



Square engine

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



Under or Long square Stroke

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

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INDUSTRIAL ENGINEERING

→ SAURABH PANDY SIR

Saurabh Pandy Sir
9891395224
(whatsapp)

Pandesaurabh22@gmail.com
(Saurabh.Pande.35)

• Saurabh Pande Sir

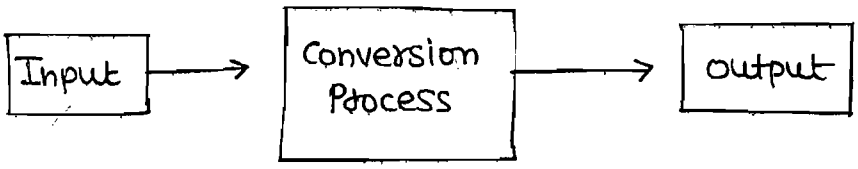
- Introduction & BEA
- Inventory **
- Sequencing
- PERT- CPM **
- Forecasting **
- Line Balancing
- Queuing
- Linear Programming (Graphical, simplex, Transportation, Assignment) *
- MRP & JIT
- PPC & Plant Layout
- Lean Manufacturing

GIATE → 6marks
(4 to 8 marks)

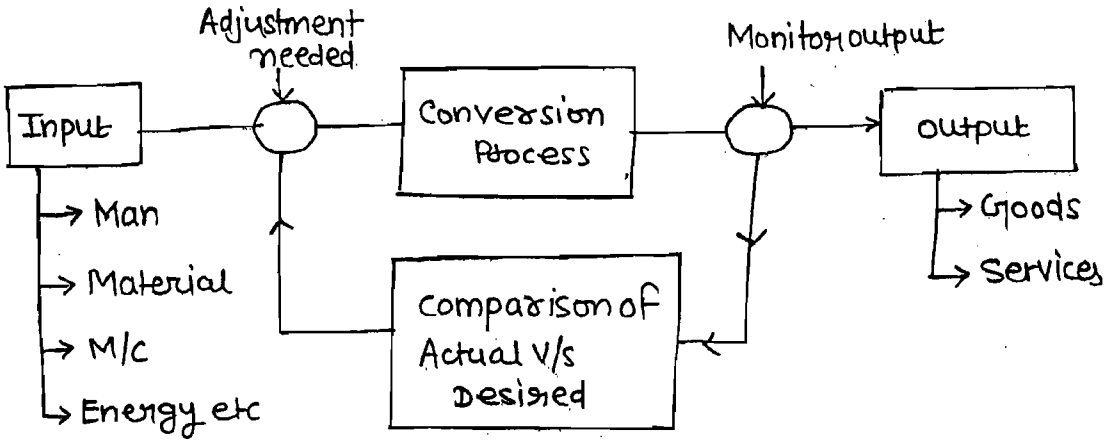
ESE → Prelims (8 to 12 questions)
Mains → 60 marks

Books:
- Hira & Gupta / Kanti Swarup / ND Vohra → For OR
- O.P. Khanna / Mahajan / 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 quantative ratio blw what we produce and what we use as resources to produce them. Every organization always want to increase productivity by applying New technique and method.

Industrial Engineer:→

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

Production Manager:→ Production manager is concerned planning, controlling and directing the day to day working of production system. his objective is to produce goods & services of sigh 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 = Indirect Material + Indirect Labour + Indirect Expenses
   or
   Factory Expenses
   - → cutting fluid,
   - → Grease, Lubricants,
   - → cotton, Jute, Stationary items etc
   - → Watchman, Superviser, 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

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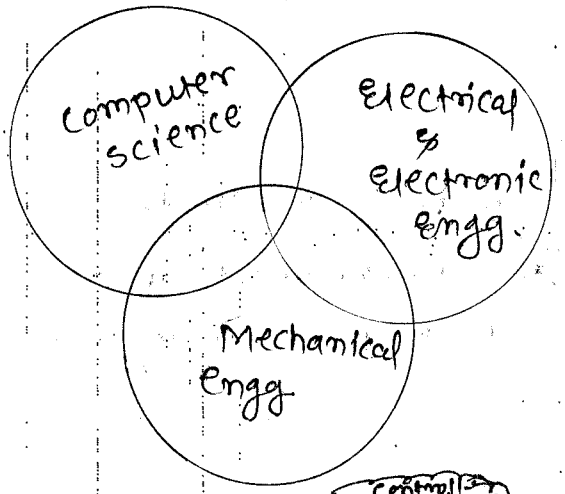
MECHATRONICS

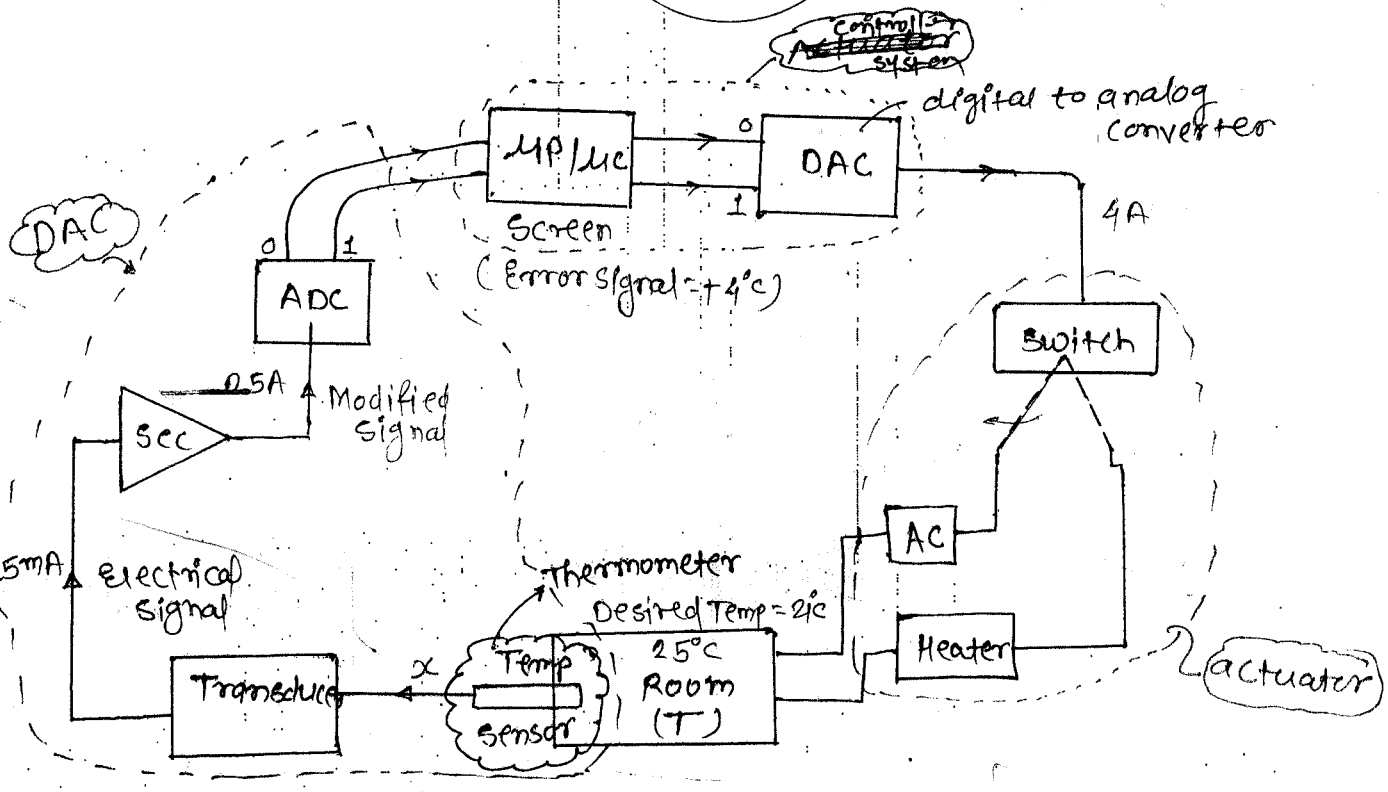
- Sensors & Actuators
- Programmable Logical devices
  - µp 8085
  - µc 8051
  - PLC
- Control Engineering

Sensors > Actuators > µp & µc > PLC > control engg.

Sequence of question / weightage

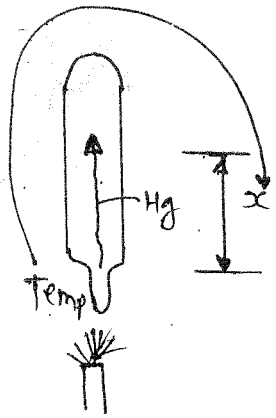


* Smart AC :-



9983322722

* SENSOR (thermometer) :-

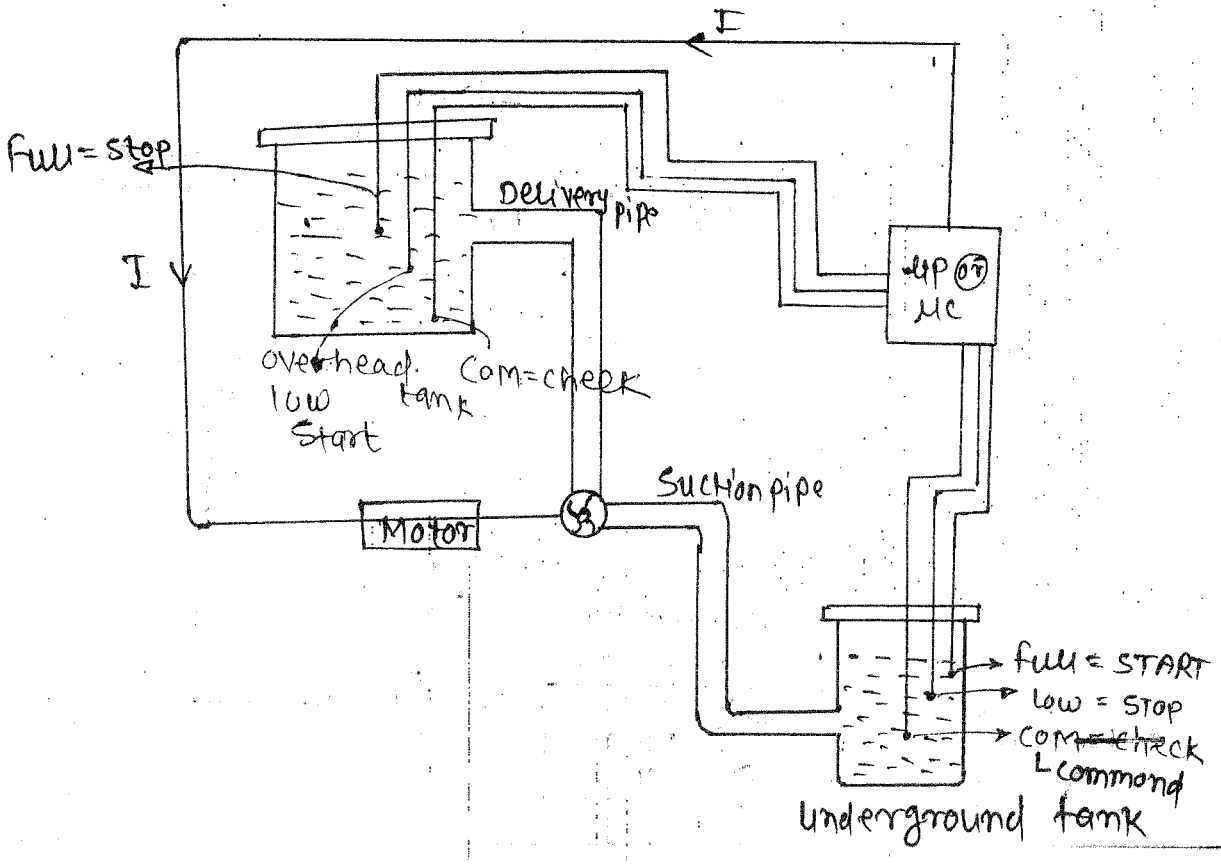


→ electrical form

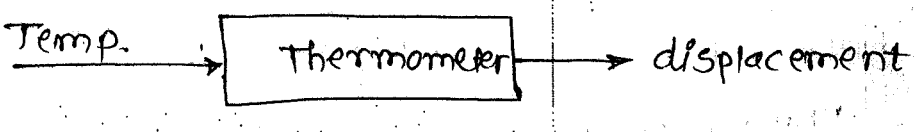
General electrical signal are analog in nature.

* Integration of electrical and electronic devices with the mechanical system lead to the development of ~~mechanical~~ mechatronics eng.

e.g. Overhead tank water filling mechanism.



* SENSOR:- It is a device which is used to sense physical quantities.



A sensor is a device which is used to convert physical quantities into measurable quantity.

Physical quantity	derived quantities	Passive electrical quantities	Active electrical quantities	Digital output.
Temp, Pressure, force, humidity Vibration sound light etc	x $\dot{x}$ $\ddot{x}$	R / L / C	V / I / P (P → power; I → current; V → voltage)	0 / 1.

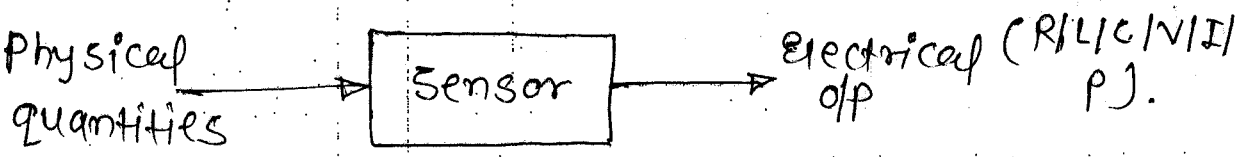
Main aim is to convert physical quantities into V/I/P.

A sensor is a device / an element which is used to produce signal relating to the quantity to be measured.

(or)

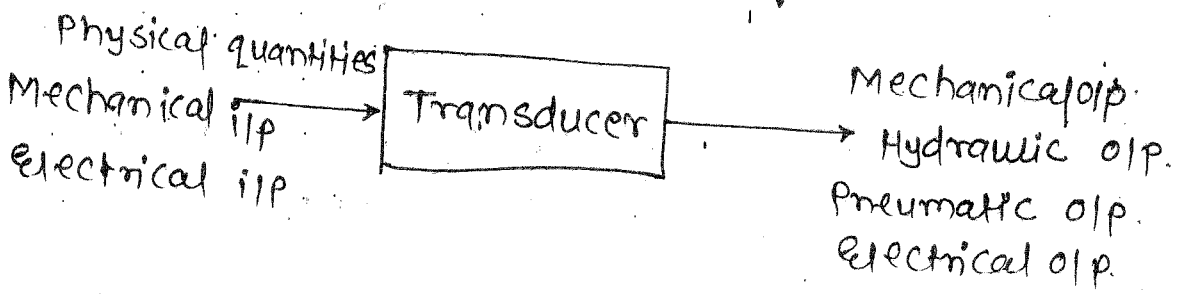
It is a device which produces o/p (usable) in response to a specific measurand.

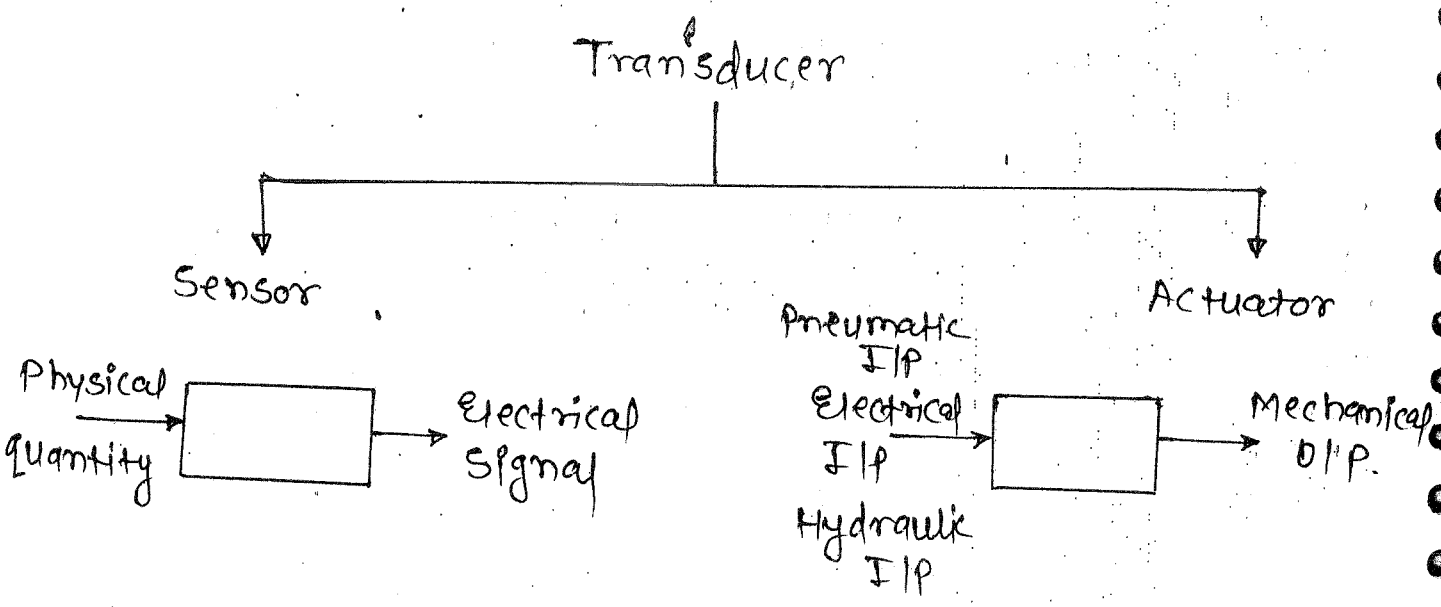
Mechatronics:-



Transducer :-

It is a device which one form of energy into another form.



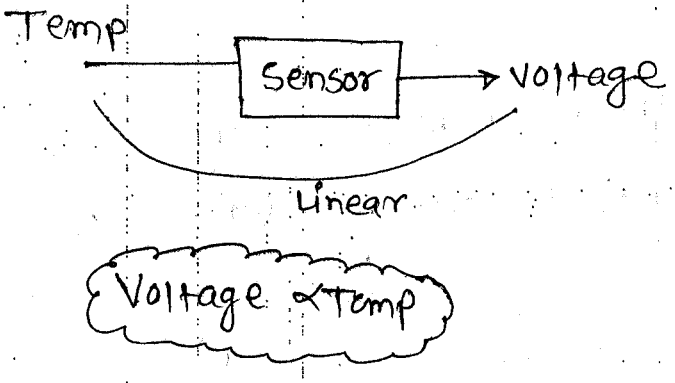


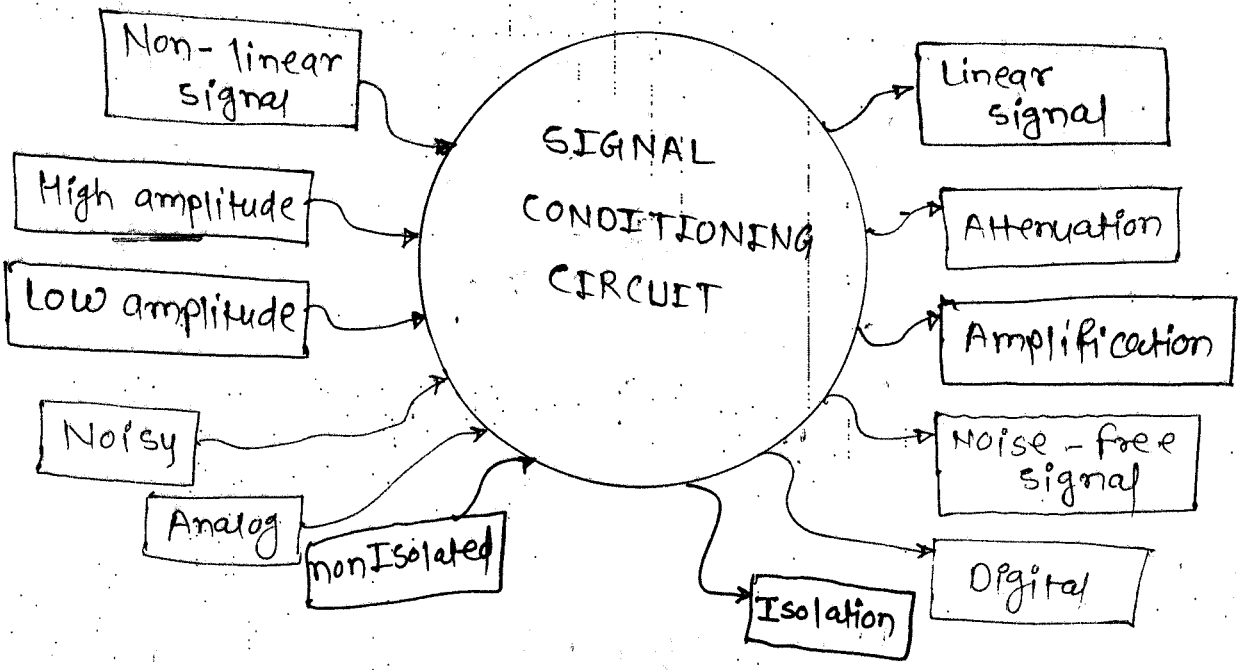
A transducer is a relative term which is used to convert one form of energy into another ~~form~~.

→ An actuator is a device which is used to generate mechanical o/p from a given input (generally electrical I/P).

Problem with signal produced by sensor :-

- Very weak signal
- Very strong signal
- noisy signal
- non-linear signal
- multiple signals.





The signals generally delivered by sensors are not appropriate for further use, a S.C.C is used to convert the sensor's signal into most appropriate form.

1> Amplifier :-

It is an electronic element which is used to enhance or amplify the input signal.

2> Attenuation :-

It is an electronic device which is used to reduce the amplitude of i/p signal.

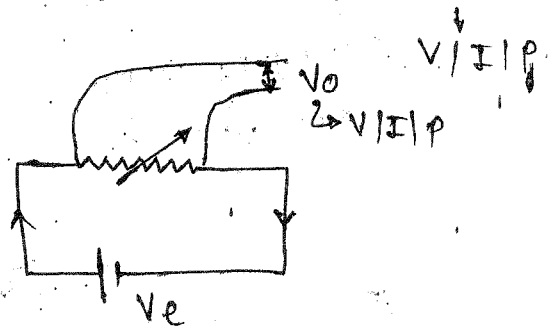
3> filtering :-

It is a process of removing/rejecting signals outside our pre-defined range.

- Low pass
- High pass

4> Excitation :-

Some circuits have/sensors have passive element as an o/p so an external excitation is required to generate desired o/p.

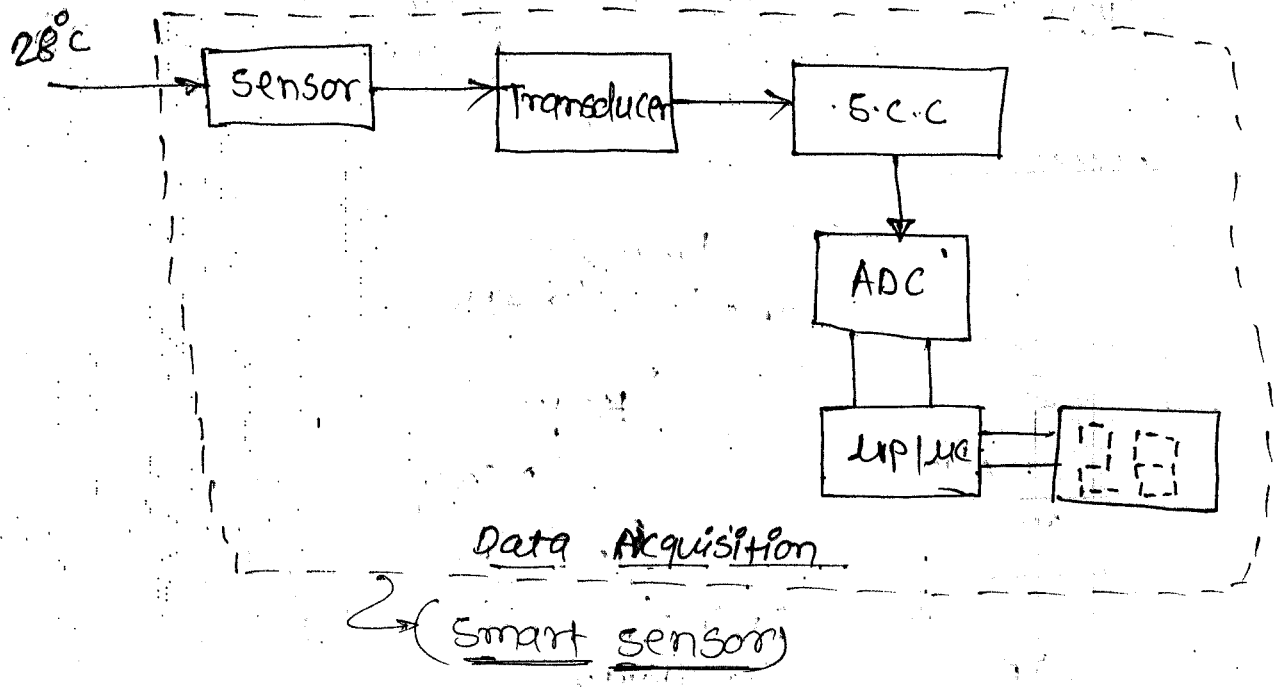


5> Linearization :-

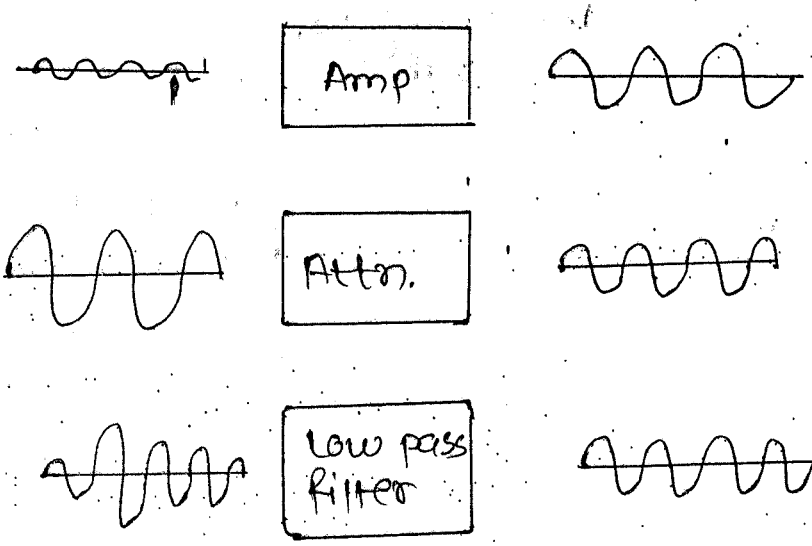
It is needed when the signal produced by sensor doesn't have a linear relation with input.

* Signal processing circuit :-

It converts the o/p / manipulated / conditioned signal of S.C.C into more appropriate form such that end user can understand the information.



SCADA ⇒ Supervisory control and Data Acquisition.



Data Acquisition systems are the group of process they are used to measure real world physical quantities (or) conditions & converting them into digital numerical values which can be manipulated by controllers &

Q.1 (b)

Voltage sensitivity $\rightarrow$ $E_{(V)} = 38.740 + 3.3\times10^{-2}\theta^2 + 2.07\times10^{-4}\theta^3 - 2.2\times10^{-6}\theta^4$

$$S = \frac{dE}{d\theta} = 38.74\times100 + 3.3\times10^{-2}\times100\times100 + 2.07\times10^{-4}\times100\times100\times100 - \frac{2.2\times10^{-6}\times100\times100\times100\times100}{100}$$

$$= 38.74 + 3.3 + 2.07 - 2.2$$

$$= 41.91$$

Q. An ammeter requires a change of 3A in its coil for produce a change in deflection of pointer by 12mm. What is static sensitivity. ?

displacement sensitivity.

I/P $\rightarrow$ 3A

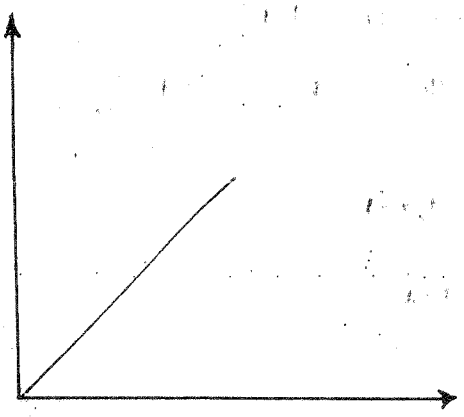
O/P $\rightarrow$ Reading $-$ 12mm

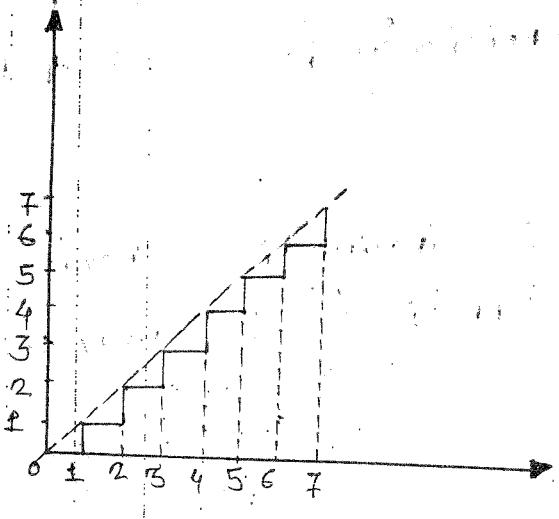
$$S = \frac{12mm}{3A} = 4\ mm/A$$

---

* RESOLUTION :-

2 $\rightarrow$ Least count of a sensor.





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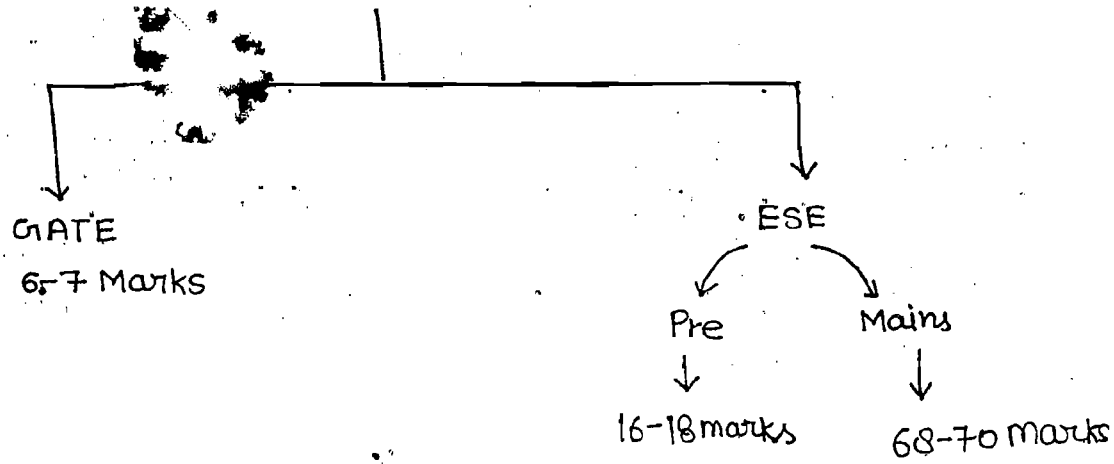
MACHINE DESIGN (MD)

(or)

MACHINE ELEMENT DESIGN (MED)

(or)

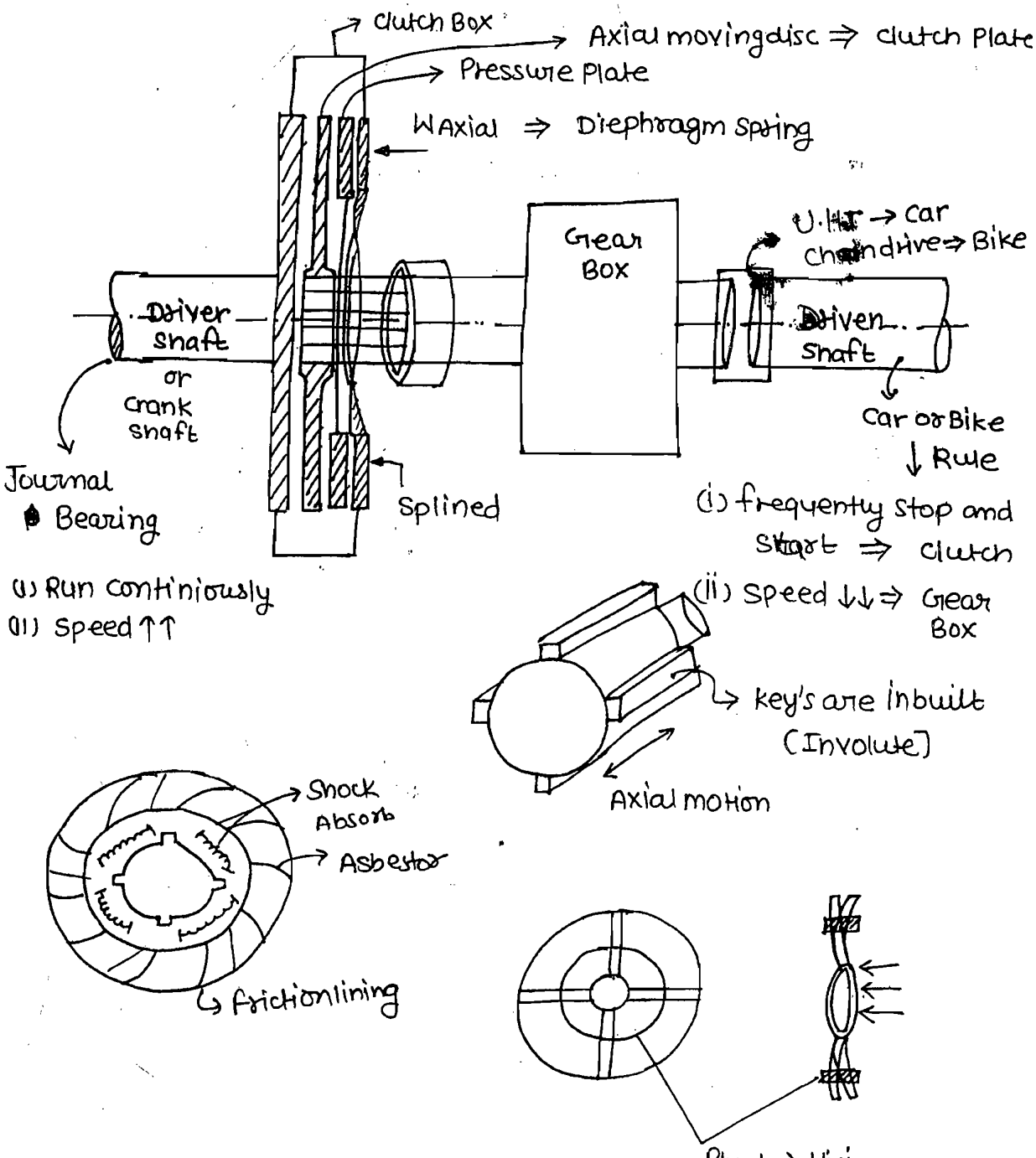
DESIGN OF MACHINE ELEMENT (DME)



(I) Clutches
(II) Brakes
(III) Gear ⇒ (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.



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)

clutch

Wear friction is responsible for wear

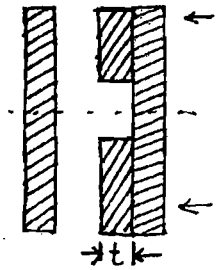
[UPT]

NEW CLUTCH

(Uniform wear नहीं होता है)

wear friction α V → Linear Velocity

Wear friction α P → Pressure



P_{ind} = uniform Pressure

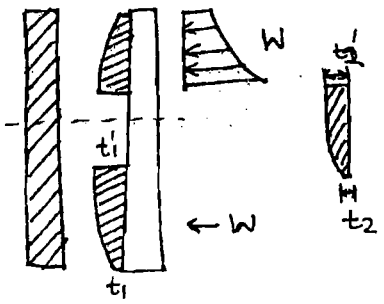
⇓

Perfect Engage

[UWT]

OLD CLUTCH

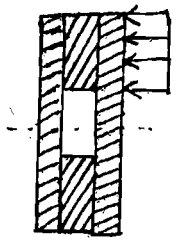
(Uniform wear होता है)



P_{ind} → Non uniform Pressure

⇓

Perfect Engage नहीं होता है



Pressure · r = constant ⇒ P.r = C

wear friction = constant

⇓

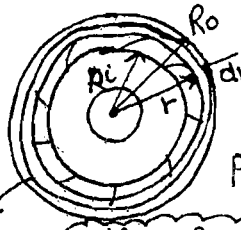
Uniform wear Theory (UWT)

$\int 2\pi r P \cdot dr = \int dw$

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

R_o → outer radius of Lining

R_i → Inner radius of Lining



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

$P_{ind} = P$ (uniform Pressure Theory)

$\int_{R_i}^{R_o} 2\pi r \cdot dr \cdot P = \int_0^{dw} dw$

(UPT) New Clutch

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

For Safe Cond^n

$P_{ind} \le P_{per}$ (or) P_{allow}

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

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

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

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

For Safe cond^n

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

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

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

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

$W_{max} = 2\pi R_i (R_o - R_i) P_{per}$ → Strength of old lining

New clutch

Frictional torque

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

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

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

Old clutch

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

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

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

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

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

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

NEW CLUTCH $\Rightarrow$ UPT

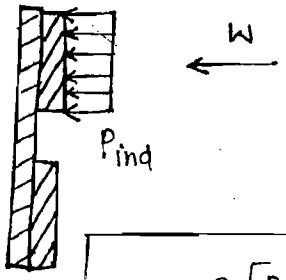
$\Downarrow$

$P_{ind} = c$

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

$P_{ind} \le P_{per}$

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



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

OLD CLUTCH $\Rightarrow$ UWT

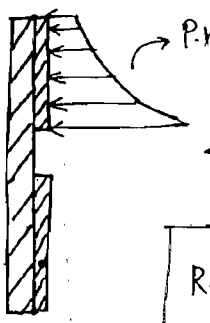
$\Downarrow$

$P \cdot r = c$

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

Safe condition

- $(P_{ind})_{max} \le P_{per}$
- $W_{max} = 2\pi R_i (R_o - R_i) P_{per}$
- $T_{f_{max}} = \mu\pi P_{per}(R_o^2 - R_i^2)$



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

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MECHANICAL ENGINEERING
Power Plant Engineering
By-Bansal Sir

- Theory
- Explanation
- Derivation
- Example
- Shortcuts
- Previous Years Question With Solution

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Power Plant

1. Gas Turbine.
2. Rankine Cycle → (PS / VCRS)
3. Rec. Comp
4. Cen. Comp
5. AFC
6. IT
7. RT
8. Binary vapour cycle
9. Boiler & its comp.
10. Condn & Cooling Towers } ESE
11. Comp. Flow – Gate
12. Misc? Topic
    (nozzle & diffusers) ×
    (nuclear PP) ×

Ref. Books:

- P K Nag → Inter
- R - Yadav → Num.
- Ganeshan → Gas Turbine
- S.M. Yaha → comp. flow

GAS TURBINE

Engine:

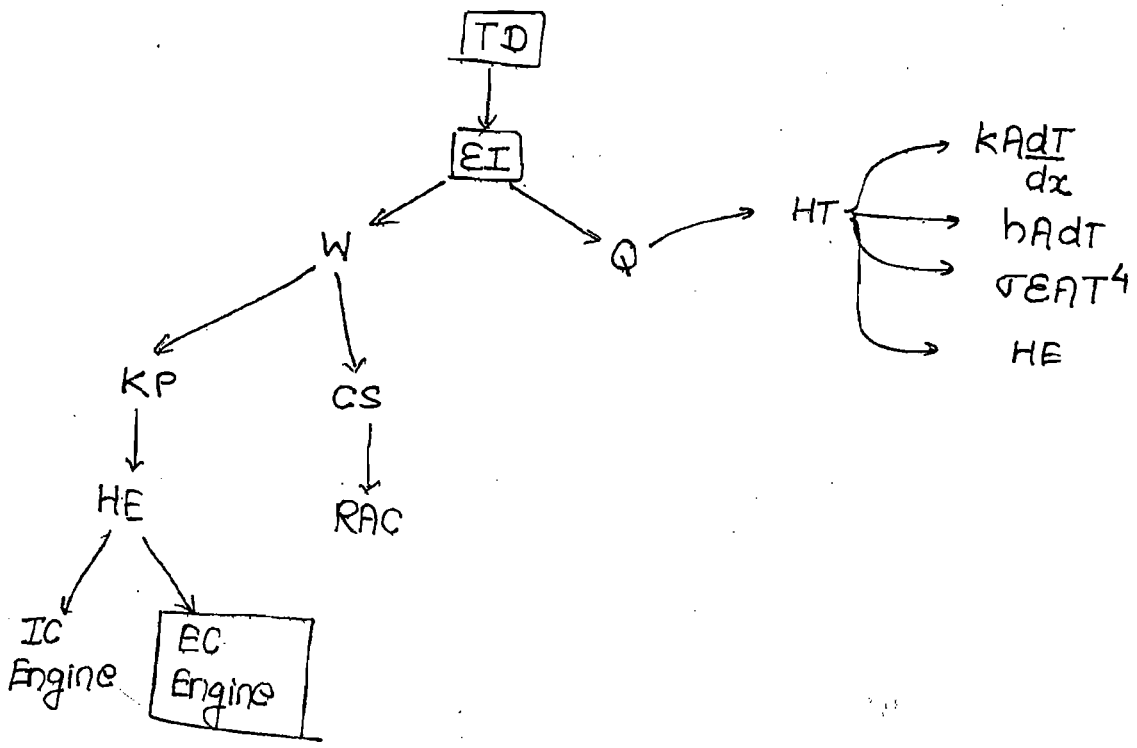
It is a Mechanical Device which convert 1 form of Energy into another useful form of energy.

IC Engine:

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

EC Engine:

In this, combustion & expansion takes place at diff. location (or) products of combustion are transfere 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 Balacing.

(iv) Simple Mechanism.

Disadvantage of Gas Turbine:

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

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

$\downarrow W_{net} = W_T - W_C \uparrow$

$\downarrow \quad \downarrow$

$\int v_g dP \quad \int v_g dP$

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

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

$F_c = m r \omega^2$

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

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MECHANICAL ENGINEERING

Casting & Welding

BY- Vinod Sir

- Theory
- Explanation
- Derivation
- Example
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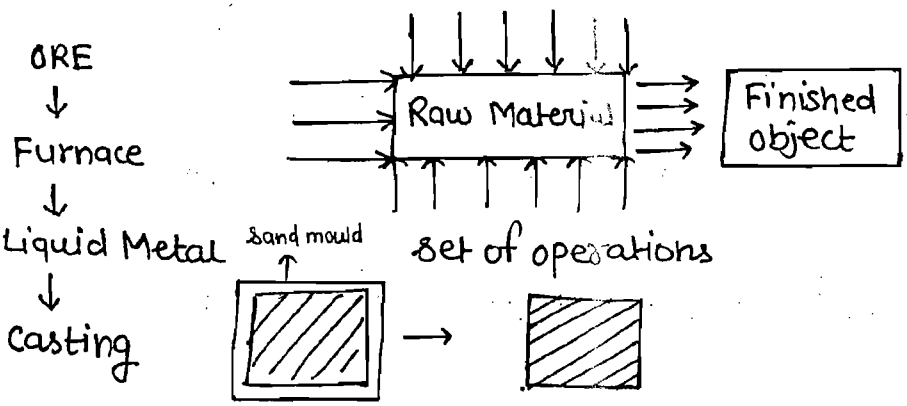
• Manufacturing Process :→

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

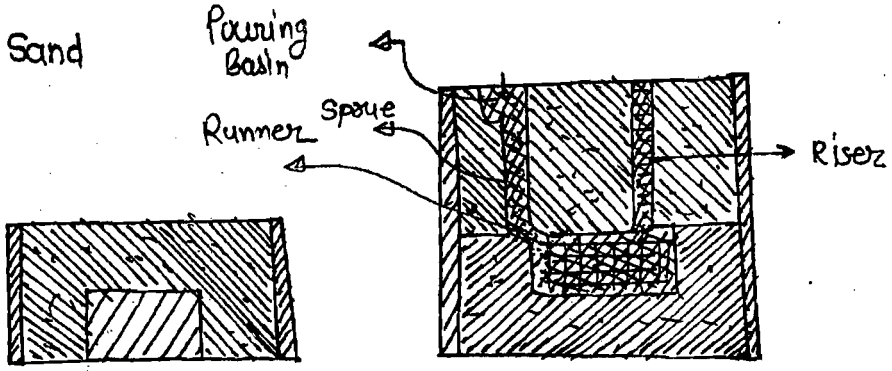
B. Additive Process

C. Subtractive Process

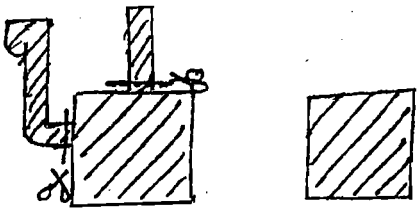
Casting:→ It is a process in which molten liquid metal is allow to solidify in a predefined mould cavity.

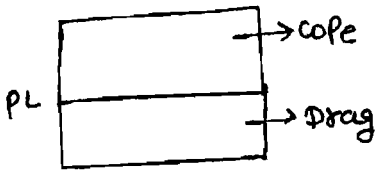
After solidification by breaking the mould required shape of the object is produced

1. Pattern
2. Moulding Sand
3. Tools

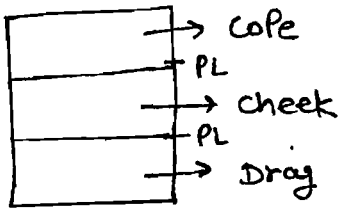


draw spike

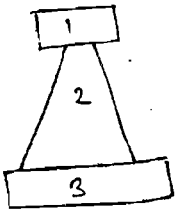




Two Box



Three Box



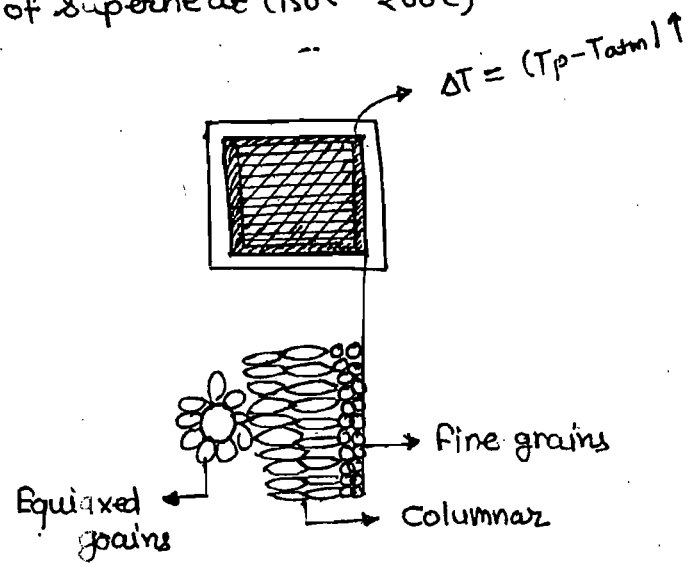
Advantanges:→

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

$T_p = T_m + \Delta t$ → degree of superheat (150°c – 200°c)

T_m → Melting temp.

T_p → Pouring temp.



·Limitations of casting:→

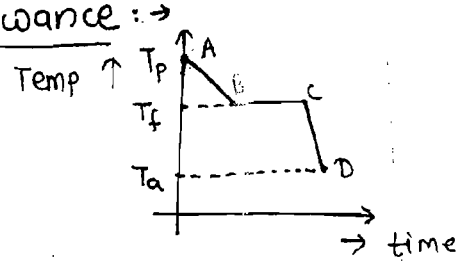
1. Casting objects are not having smooth surface finish.
2. It is Laborious and time consuming process.
3. There is a possibility of gas defects can be formed in the casting.
4. Due to Non-uniform cooling, non-uniform Grain-structure is produced in the casting because of this Non-uniform Mechanical Properties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

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

Allowances:→

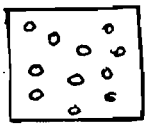
1. Shrinkage or contraction
2. Draft or Taper
3. Machining or finish
4. Shake or Rapping
5. Distortion or camber

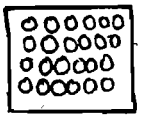
1. Shrinkage Allowance:→

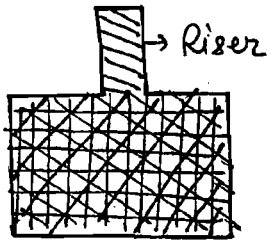


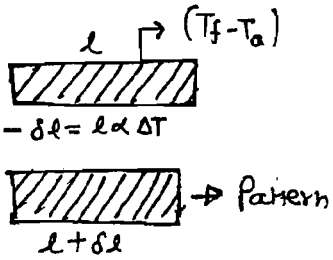
$(t_s)_r > (t_s)_c$

$t_s \rightarrow$ Solidification time

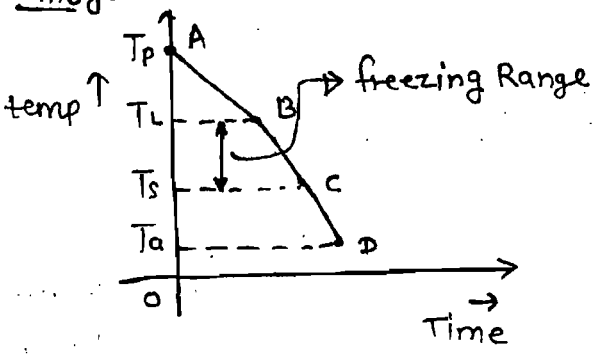








Alloy:



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 compesated by Providing Shrinkage allowance in the Pattern.

- Shrinkage Value: →

(i) Bismuth → Negligible
(ii) Whitemetal → 5mm/m
(iii) Cast Iron → 10mm/m
(iv) Aluminium → 13mm/m
(v) Brass → 15mm/m
(vi) Copper → 17mm/m
(vii) Steels → 20mm/m
(viii) Lead & Zinc → 23mm/m

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Refrigeration and Air Conditioning

- Basic Concept
- VCRS
- Ref
- VARS
- RBC
- Ref Equipment

- Psychrometry
- Summer & winter AC

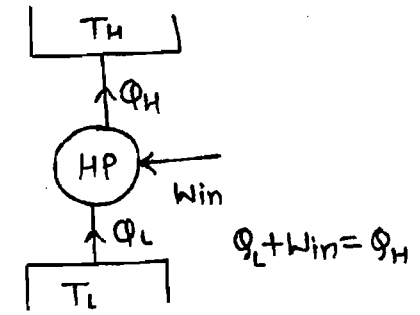
BOOKS: CP Arora
PL Ball

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 → It is the working fluid or working substance which is use to extract the heat from the storage space

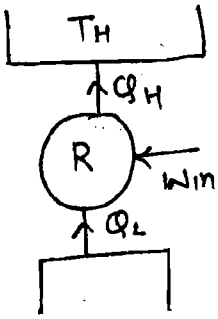
COP→ Coefficient of Performance or Energy Performance or EPR ratio :→ $COP = \frac{DE}{W_{in}}$



$Q_L + W_{in} = Q_H$

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

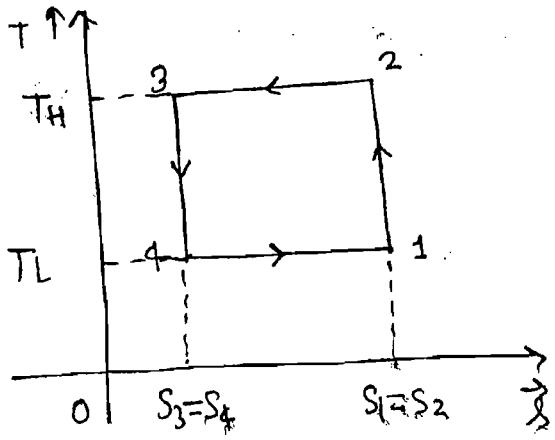
$$(COP_{HP})_{Ideal} = \frac{T_H}{T_H - T_L}$$



$$(COP)_{R\ Actual} = \frac{Q_L}{Q_H - Q_L}$$

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

- **Ideal Refrigeration Cycle or Reversed Carnot Cycle :→**



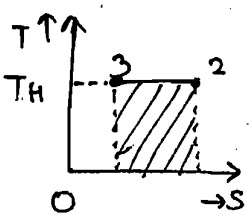
Process 1-2 Rev. adiabatic Compression

Process 2-3 Isothermal Heat rejection

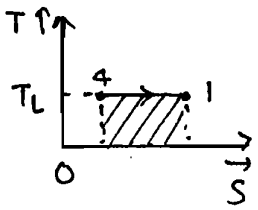
3-4 Isentropic Expansion

4-1 Isothermal heat addition

$$COP = \frac{DE}{W_{NET}} \qquad W_{Net} = Q_{Net} = \cancel{Q}^{\,0}_{1-2} + Q_{2-3} + \cancel{Q}^{\,0}_{3-4} + Q_{4-1}$$



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



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

Use eqn (2) & (3) in eqn (1)

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

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

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

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

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

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

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

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) $(COP)_{Sumer} > (COP)_{winter}$

~~(b)~~ $(COP)_S < (COP)_W$

(c) $(COP)_S = (COP)_W$

(d) Can't say

Summer	Winter
$T_L = 0°C$	$T_L = 0°C$
$T_H = 30°C$	$T_H = 10°C$

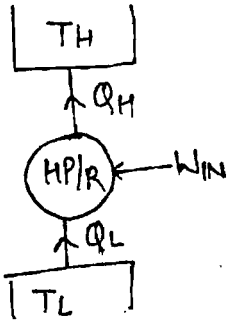
T_L = constant — $(COP)_S < (COP)_W$

$(T_H)_S > (T_H)_W$

Relationship between Heat Pump COP & COP of Refrigerator: →

$$COP_{HP} = COP_R + 1$$

$$1 + COP_R = \frac{T_L}{T_H - T_L} + 1 = COP_{HP}$$



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

RSE

BY RAHUL SIR

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

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.

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

Difficulties in harnessing renewable energy:

- It is present it 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. SILAR COLLECTOR

3. SOLAR APPLICATION

4. ENERGY STORAGE

5. BIOMASS ENERGY

6. WIND ENERGY

7. TIDAL ENERGY

8. PHOTO-VOLTAIC CONVERTORS

9. FUEL CELL

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MADE EASY

MECHANICAL ENGINEERING

ROBOTIC

By-GUNJAN Sir

- Theory
- Explanation
- Derivation
- Example
- Shortcuts
- Previous Years Question With Solution

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Khushal K. Katore.

Mechatronics And Robotics :-

Mechatronics :-

- Microprocessor & Microcontrollers,
- Architecture, Programing, 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". (KAREL CAPEK sci-fic writer)
- The "official" defination of an industrial robot is provided by the Robotics Industries Association (RIA), formerly the Robotics Institute of America (RIA):-

"An industrial robot is a reprogrammable, multifunctional (malfunctional), 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.
- NETRA → 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.

* Asimov's three laws of Robotics :-

- First law (Human safety) :-
  - A robot may not injure a human being or through inaction, allow a human to be harmed.
- Second law (Robots are slaves) :-
  - A robot must obey orders given it by human beings, except where such orders would conflict with the first law.
- Third law (Robot survival) :-
  - A robot must protect its own existence as long as such protection does not conflict with the first or second law.

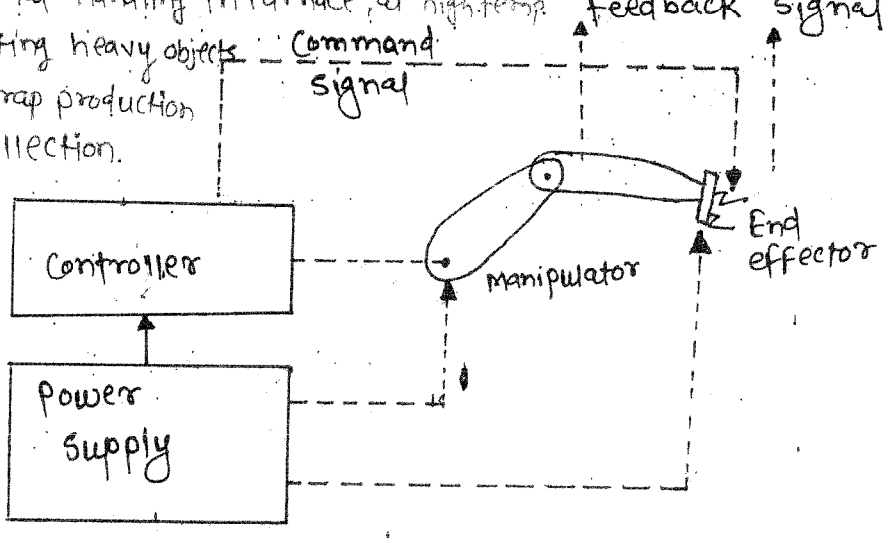
- It is interesting to note that in the real world, industrial robots obeys law that are the opposite of the ones stated above! A robot may injure a human, it may not obey humans and it also may not protect its own existence.

* 4D's of Robotics :-

- If one of 4D's exist then use of Robot is justified.
  - D - Dangerous → Material handling in furnace, at high temp.
  - D - Difficult task - lifting heavy objects
  - D - Dull operation - Scrap production
  - D - Dirty → Garbage collection.

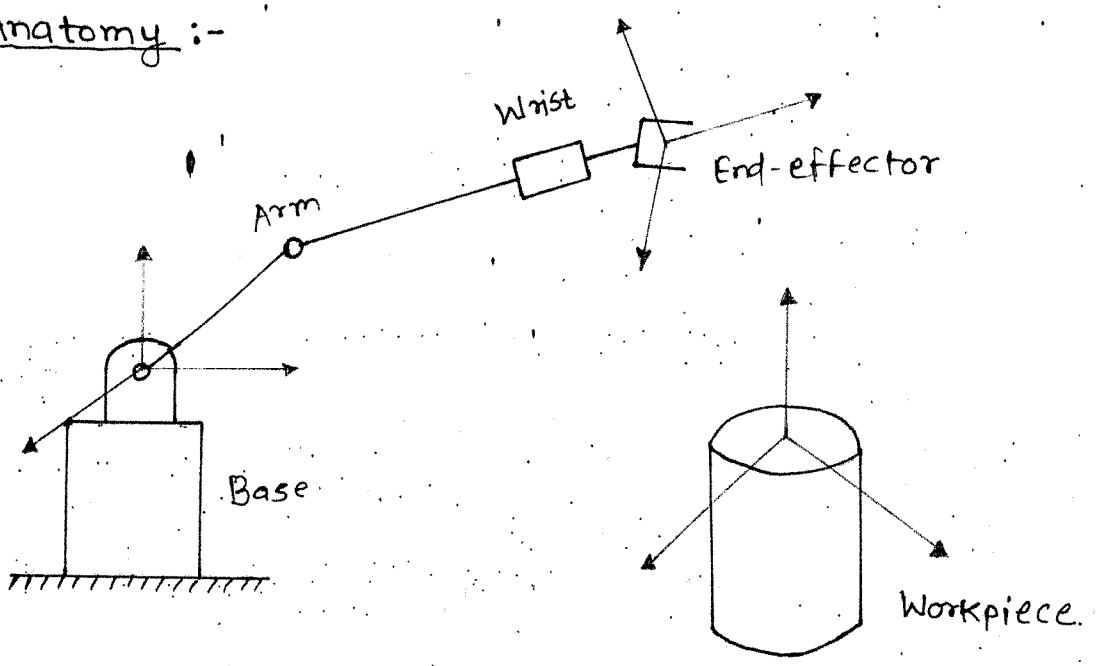
Components.

1. Manipulator
2. End effector
3. Actuator & sensor
4. Power supply.
5. controller.



9. Which is the following is not among the five basic part of a robot.
   a) peripheral tools
   b) End effectors
   c) controller
   d) actuator and sensor.

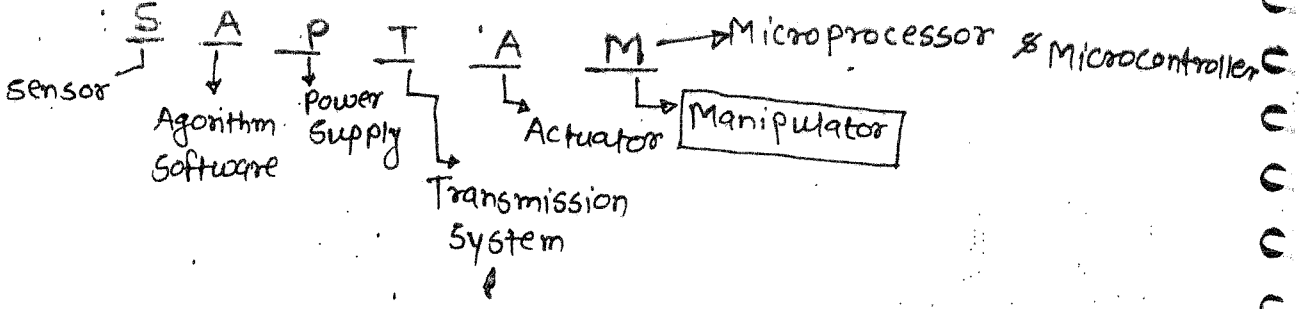
* Robot Anatomy :-



- Robot anatomy is concerned with the physical construction of the body, arm and wrist of the machine.
- The robot body is attached to the base and the arm assembly is attached to the body
- At the end of the arm is the wrist. the wrist consists of a number of components that allow it to be oriented in a variety of positions.
- Relative movements b/w the various components of the body, arm, and wrist are provided by a series of joints.
- The body, arm & wrist assembly is sometimes called as manipulator.

→ either rotary or sliding motion.

- Attached to the robot's wrist is a hand or a tool called the "end effector".
- The end effector is not considered as part of the robot's anatomy.
- The arm and body joints of the manipulator are used to position the end effector.
- The wrist joint of the manipulator are used to orient the end effector.



1> Actuator :- that trigger's the motion. Actuator receives signals from controller, and then provides motion to manipulator & end-effector.

- Actuators are basically prime movers providing both force and motion.
- Pneumatic cylinders, hydraulics, permanent magnet motors, stepper motors, linear motors are some conventional actuators.
- More advanced onee are based on hi-tech polymers, shape memory alloys, piezo patches and pneumatic muscles.
- Brushless servo motor also exist for low noise levels, and printed armature motors are used for quick response.

2> Transmission systems :-

- The transmission system used in robot to transmit power and motion consists of chains, timing belts, metal belts, cables and pulleys and linkages.
- Gear boxes and harmonic drives serve to provide speed reduction.

- Ball screws are used with suitable mechanisms to convert rotary motion to linear motion and if needed back to oscillatory motion.
- Drives stiffness is an important consideration in robotics and so also is backlash

3) Power supplies :-

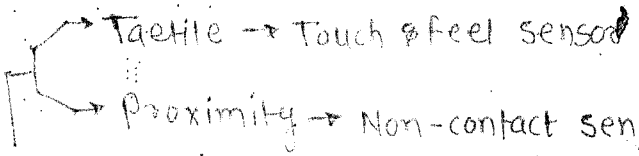
a) Hydraulic & pneumatic power packs:

These consist of a motor driving a positive displacement pump or compressor to generate the high pressure fluid flow. In using hydraulic systems the necessity of having an oil tank increases the weight of the system, additionally the issue of ensuring that the oil is free of contaminants is to be handled.

- In pneumatics power pack dry air is desired.

b) Electric motors :

It use what are known as PWM (pulse width modulation) amplifiers. These are electronic devices, consisting of transistors used as switches to rapidly switch on and off the supply in controlled manner to control motor speeds. Such drives have higher efficiency.



3) Sensor and Electronics :-

optical encoder ↓ Visual sensor.

- The sensor for feedback in robots consists of tachometers & encoders and potentiometers to sense motor motions, simple switches, force sensors, acceleration sensors, optical systems, special cameras and vision systems.

- There are a host of electronic circuits, motor controllers, analog to digital converter and digital to analogue converters, frame grabbers and so on utilized to handle sensors and vision system and convert the inputs from them into a form usable by the processor for control of the entire system in conjunction with the algorithms and software developed specifically for the purpose.

4> Software :-

- The software used consists of several levels.
- Motor control software consists of algorithms which help the servo to move smoothly utilizing the data from feedback units.
- At the next level there is software to plan the trajectory of the end effector and translate the same into commands to individual motor controllers.
- The output of sensors is also to be interpreted and decision made
- At the highest level there is software which accepts commands from the user of the robot and translates it into appropriate actions at the lower level.

5> Manipulators :-

- The mechanical unit, often called the "arm" that does the actual work of the robot.
- It is composed of mechanical linkages and joints with actuator to drive the mechanism directly or indirectly through gears, chains or ball screws.
- Manipulator are built as serial chains or parallel chains or occasionally a combination of both.

- Links and joints (revolute and prismatic) that are mostly used in manipulators.
- In spatial manipulators (open chains) adjacent axes are parallel or pendicular to each other.

6) End effectors :-

- The special tooling for a robot that enables it to perform a specific task.
- Two type.
  - Gripper - to grasp and manipulate objects (e.g. parts during work cycle.
  - Tools - to perform a process e.g. spot welding, spray painting.

* Joints and Links :-

- The individual bodies that make up a robot are called links.
- for example an assembly of two gears connected by a common shaft is treated as a link.
- Link of a robot are coupled by kinematic pairs and joints
- A joint couples to links and provide physical constraints on the relative motions b/w the links.
- They are termed as either lower or higher pair joints.

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Strength Of Material

By-Krishna Sir

- Theory
- Explanation
- Derivation
- Example
- Shortcuts
- Previous Years Question With Solution

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STREGTH OF MATERIAL

OR

MECHANICS OF MATERIAL

OR

MECHANICS OF SOLIDS

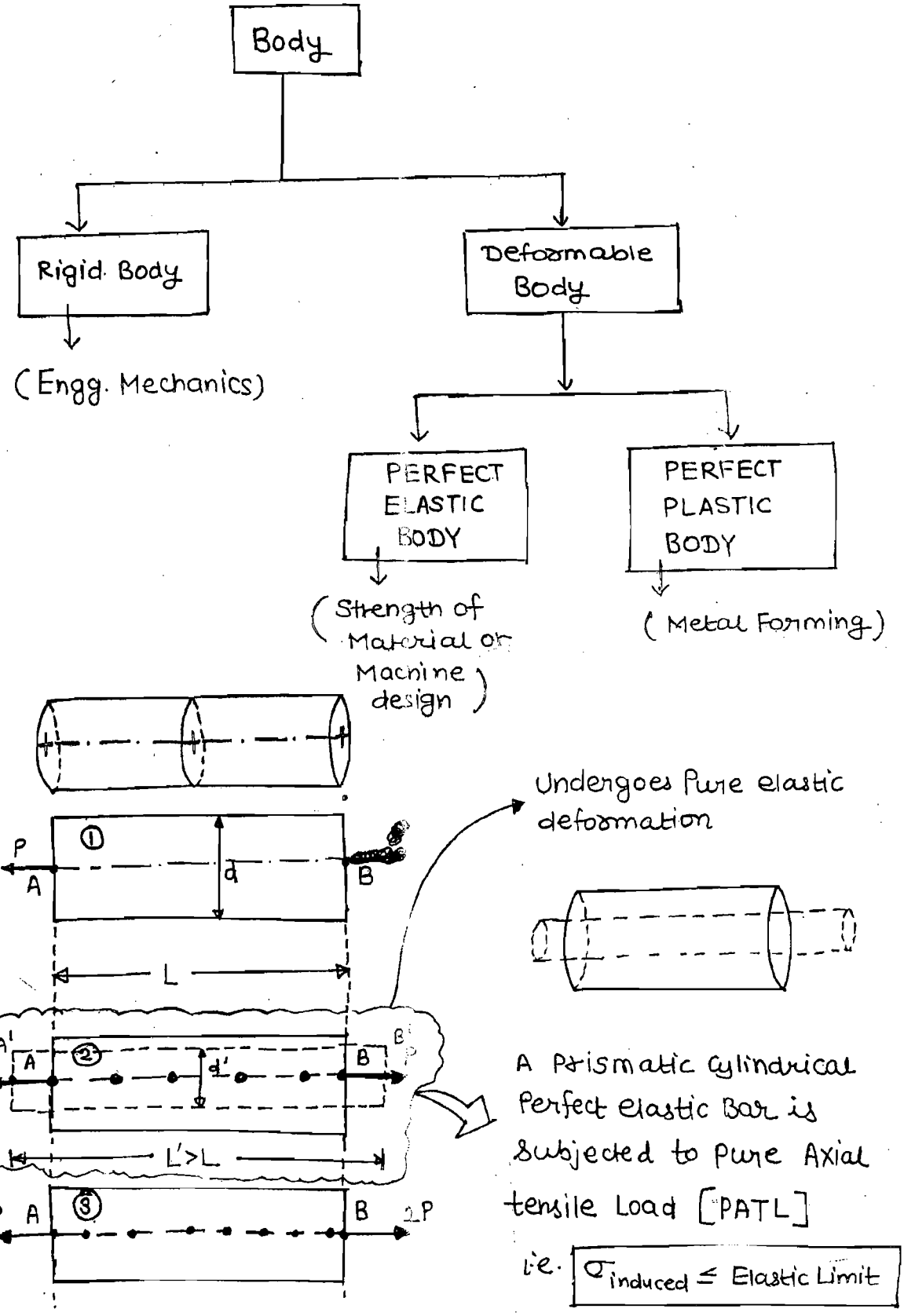
OR

MECHANICS OF STRUCTURE

OR

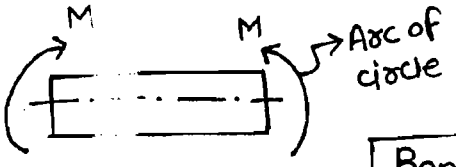
MECHANICS OF PERFECT ELASTIC BODIES

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



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

Axial load = Constant



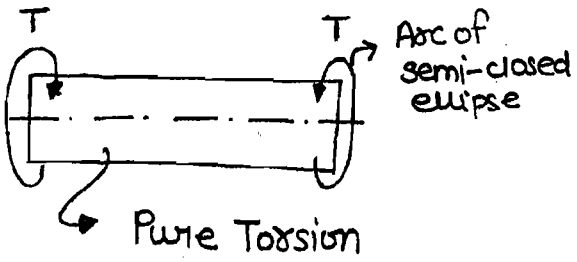
Pure Bending

Bending → Two equal Parallel opposite Couple eccentric axia load

i.e.

Axial Load = Shear Force = Twisting Moment = ZERO

Bending moment = Constant



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

Axial Load = Shear force = Bending Moment = zero

Torsional Moment = Constant

Pure Axial Load

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

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

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

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MECHANICAL ENGINEERING

Theory Of Machine

By-Amit Kakkar Sir

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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) ↓ ↓ (Kinetics)

Study of motion without considering the Basic case of motion i.e. Force

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

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

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

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

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

Kinematic Viscosity (ν) = $\frac{\mu}{\rho}$

$= \frac{m^2}{s}$

- Text Book
  - → S.S. Rattan
  - → Prof V.P. Singh

- Reference Book (For Teachers)
  - → Shigley
  - → Norton
  - → Thomas Beven

- Weightage of TOM :→

GIATE → 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

Thermodynamics

Books : Cengel & Boles ⇒ Theory

P.K. Nag ⇒ Questions

Questions → Work Book → Class / G drive

Theory Book

→ GATE Previous Year

→ ESE PYQ (5 Year)

→ GATE OTS

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HW

TH-B

P-224

Q8, Q9

"Reversible & Irreversible"

↳ Video

Prime

Youtube

Amrinder Sir entropy

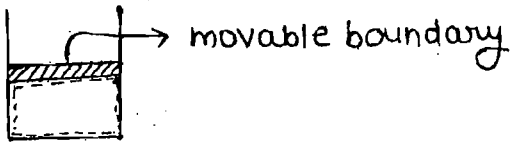
"Civil Services questions"

*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.

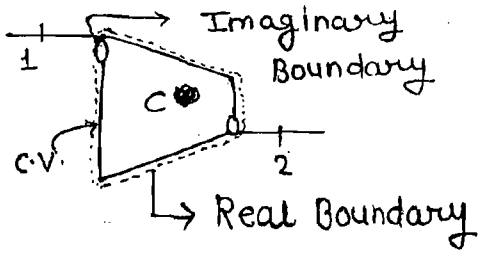


→ Surrounding – Everything except the system becomes surrounding.

- The Part of surrounding which is direcHy 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.

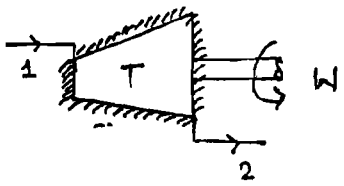


Type of System :→

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	✓	✓	×
Isolated	×	×	×

→ 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, e, u, velocity (c), thermal conductivity (k)

NOTE: All Specific Properties are intensive Properties,

eg. h, s, u, w, q, C (Specific heat)

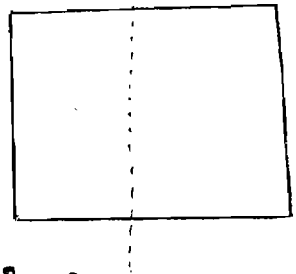
2. Extensive (Extrinsic) : →

Depense of mass of the System Under Consideration.

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

$C_{rms}^2 \propto T$

$\frac{1}{2} m_1 c_1^2 + \frac{1}{2} m_2 c_2^2 + \cdots = \frac{1}{2} \Sigma m C_{rms}^2$



$P_L = P$

$T_L = T$

$V_L = V/2$