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Best Quality Classroom Topper Hand Written Notes to Crack GATE, IES, PSU's & Other Government Competitive/ Entrance Exams

MADE EASY
MECHANICAL ENGINEERING
Engineering Mechanics
By-Ravendar SIR

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

Engg. Mechanics

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

- Statics (Rest)
  - Equilibrium
  - Plane Trusses Imp
  - Principle of virtual work
  - CC) centroid & centre of gravity (G)
- Dynamics (motion)
  - → Translation
  - → Friction Imp.
  - → Circular motion
  - → Impulse momentum eq^n
  - → Rotation
  - → General motion
  - → Work Energy time

• **Exclusivity for Gate**

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

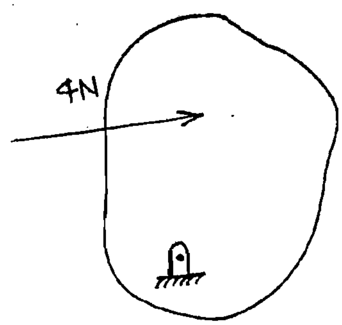
- **Actual Force :→**

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**

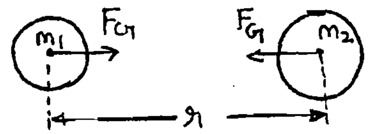
1. Gravity (W)

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

3. Tension (T)

4. Spring Force (F_s)

- **Gravity →**

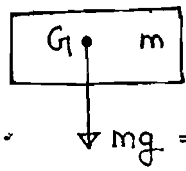


$$\boxed{F_G = \frac{G m_1 m_2}{r^2}} \star$$

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

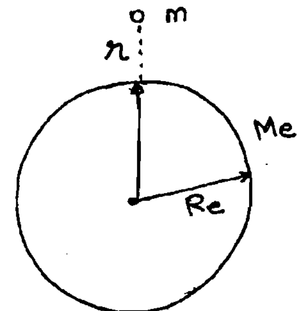
$$\boxed{g = \frac{G M_e}{R_e^2}} \star$$

M_e = Mass of Earth
R_e = Radius of Earth



$mg \Rightarrow$ on mass m by Earth

$$\star \boxed{\begin{matrix} W = mg \\ \text{(Pulling)} \end{matrix}}$$



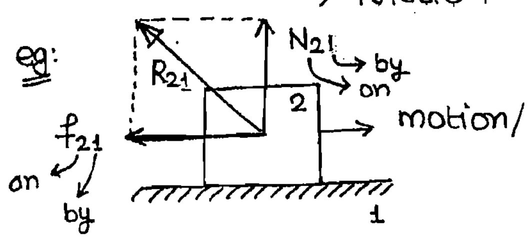
$$F_G = \frac{G M_e m}{R_e^2}$$

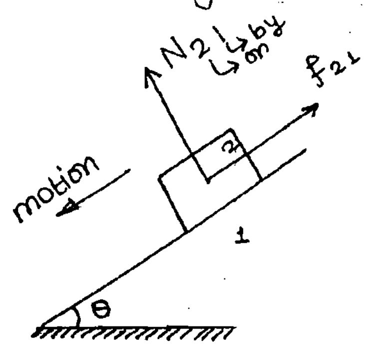
$$\boxed{F_G = mg}$$

$(R_e + r \simeq R_e)$

- **Contact Force →**
  - → Normal Reaction (Pushing)
  - → Friction

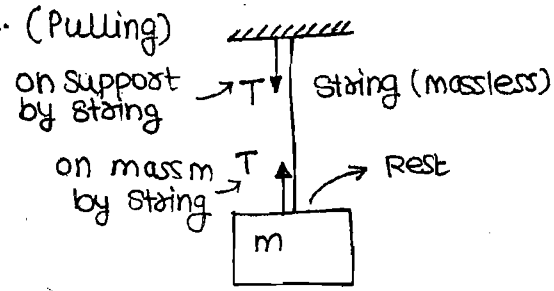
eg:



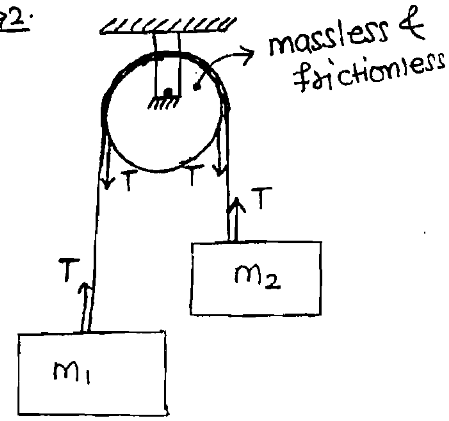


- **Tension →**

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

K → Spring constant

• **Newton's First Law (NFL):** $\rightarrow$

For a Particle

if $\Sigma\vec{F}=0$ then $\vec{a}=0$ at the same Instant

$\vec{a}=0$

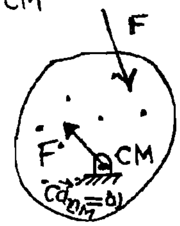
- Rest
- Uniform Linear Velocity

For a Rigid body

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

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

$\odot$ Particle



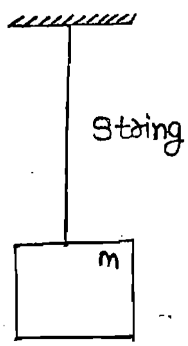
Rigid Body

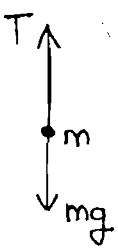
$\vec{a}_{CM}=0$

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

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

Eg:-1





(m) $\rightarrow$ Rest $\Rightarrow$ $\vec{a}_{CM}=0$

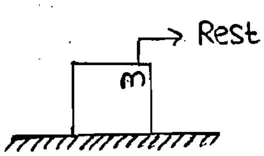
$\Sigma\vec{F}_{ext}=0$

$\hookrightarrow$ Newton's 1^{st} Law

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

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

$\vec{Eg}:2$

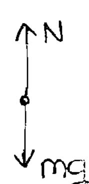


(m) $\rightarrow$ Rest

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

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

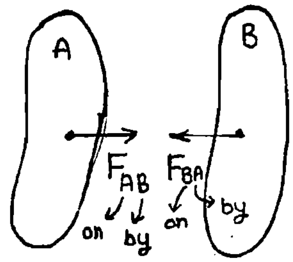
$\hookrightarrow$ (NFL)



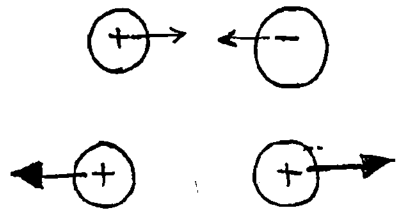
$N-mg=0$

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

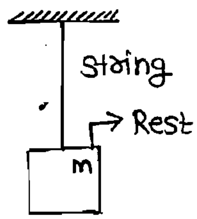
- Newton's Third Law (NTL) →

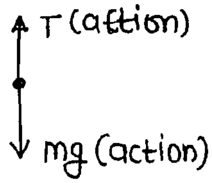


$$\boxed{\vec{F}_{AB} = -\vec{F}_{BA}}$$

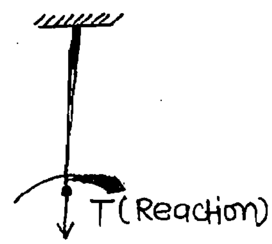


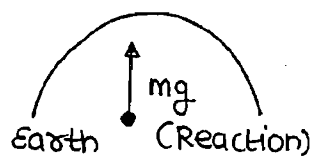
Ex : 1



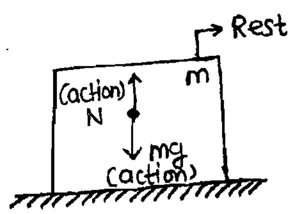


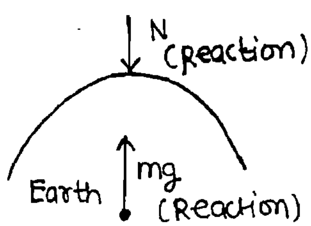
$$\boxed{\downarrow g = \frac{GM_e}{R_e^2}}$$





Ex : 2





Reading of weighting

"If a Body A exerts ~~ex~~ 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

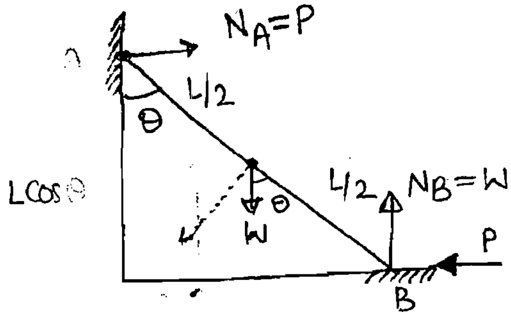
NOTE: → In FBD Surrounding should not be shown.

• Equilibrium → Rest / uniform Linear Velocity

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

(II) $\Sigma \vec{M} = 0$
(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 × L = P tan~~

$\Sigma M_B = 0$

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

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

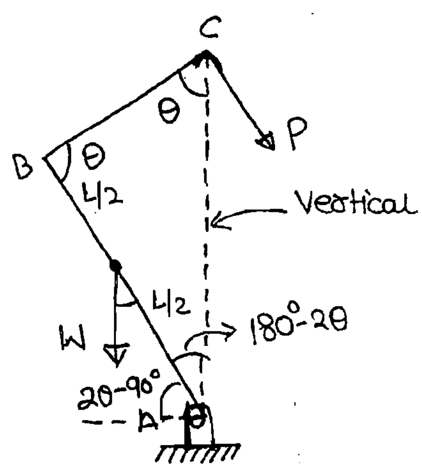
Que. A uniform Rod of weight W and Length L is movable in vertical Plane about hinge at A but it is held in equilibrium by a ~~String Be~~ force P which is attached to a String BC Passing over a Smooth Peg C. If AB = AC then the force P is

(a) $W\cos\theta$

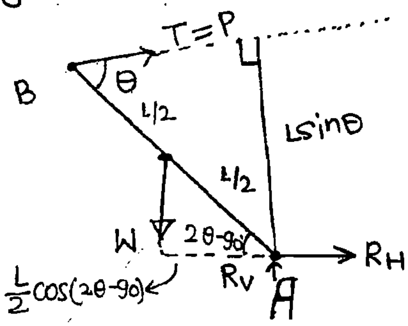
(b) $\frac{W}{\cos\theta}$

(c) $W\tan\theta$

(d) $W\sin\theta$



Considering equilibrium of Rod 'AB'



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

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

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

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

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

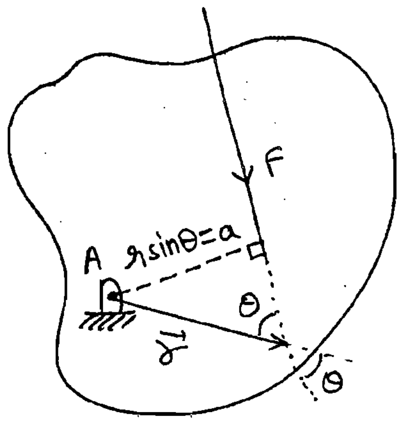
$(\vec{M}$ 'or' $\vec{T})$

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

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

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

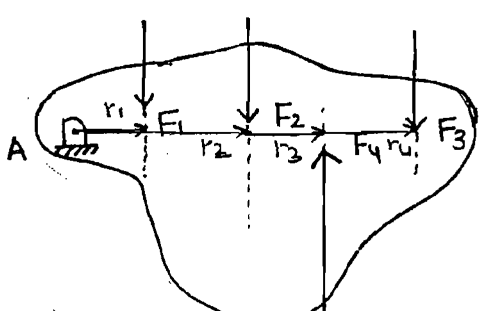
direction → $\perp_r$ inward through A

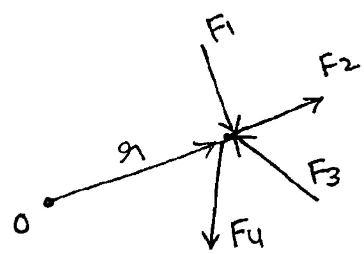


*** Imp: Property of Numericals (Vector algebra)

- 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

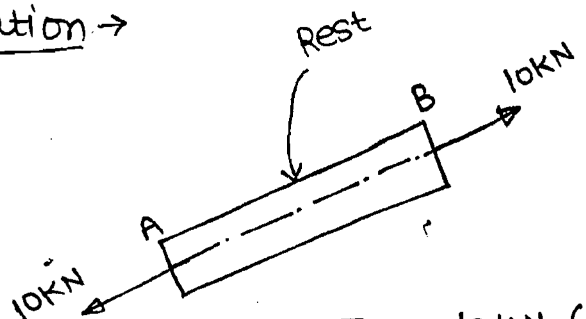
Ex. Joints in Truss

• Systems of Equilibrium :→

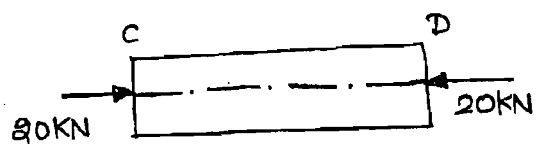
1. Two Force System →

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 →



$$\underbrace{F_{AB}}_{\text{Intensity of Internal resisting force}} = 10\,KN \text{ (Tensile)}$$



$$\underbrace{F_{CD}}_{\text{Intensity of internal resisting force in member CD}} = 20KN \text{ (Compressive)}$$

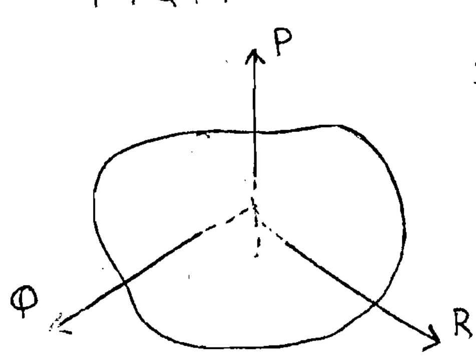
2. Three force system →

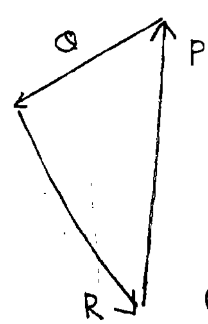
To keep a body in equilibrium under the action of 3 forces they must be coplaner and concurrent.

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

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

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





(Force Triangle)

MADE EASY

MECHANICAL ENGINEERING

Fluid Mechanics

BY- Varun Pathak Sir

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

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 :

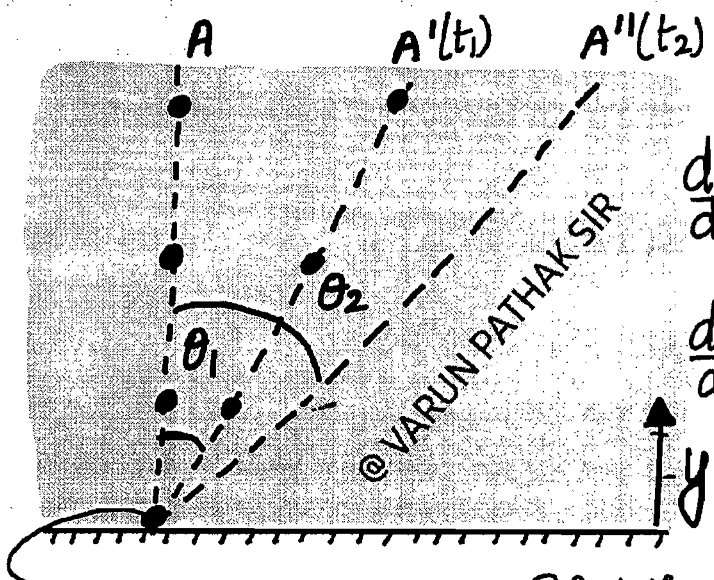
Difference between Solids & Fluids

(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.

(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



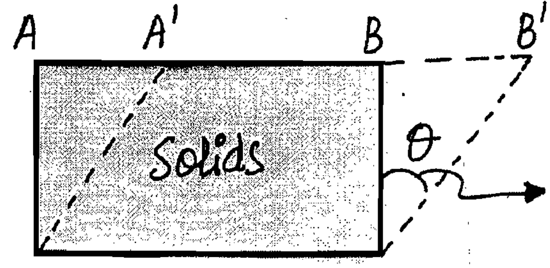
$\frac{d\theta}{dt} \rightarrow$ Rate of Angular Deformation

$\frac{du}{dy} \rightarrow$ Velocity Gradient

→ No slip Condition (or) Maxwellian condition

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

Solids



→ Angular Deformation

Note :

The Intermolecular force of attraction between molecules of same nature is known as cohesion whereas intermolecular 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 :

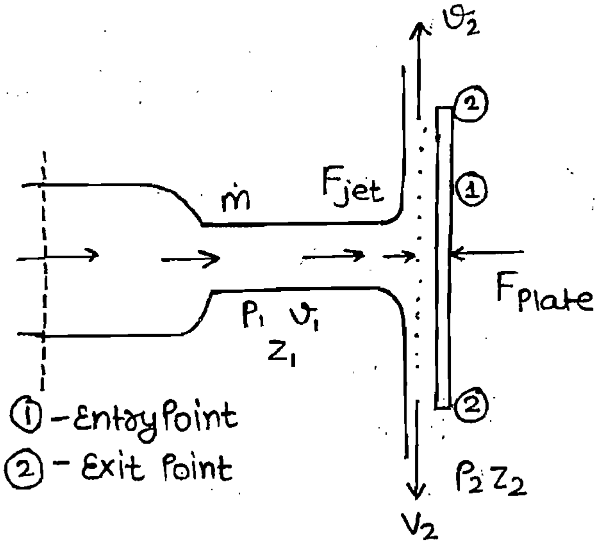
Engg. Mechanics | SOM | Fluid Mechanics

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 :→



① - Entry Point
② - Exit Point

Water → Reaction force
Plate → Initial force

Newton's II Law

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

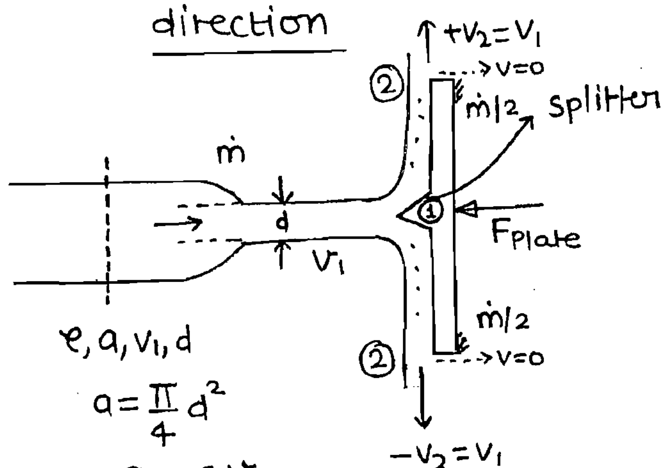
F_{Plate} = (Final - Initial) momentum of Water

$$\boxed{F_{jet} = -F_{Plate} = \dot{m}\vec{V_1} - \dot{m}\vec{V_2}}$$

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

Case : I

Jet strikes Stationary flat Plate in Normal direction



ρ, 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 ($V_2 < V_1$)

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

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

→ $F_x = F_N = \dot{m}V_1$

$= \rho a V_1^2 \text{ N}$

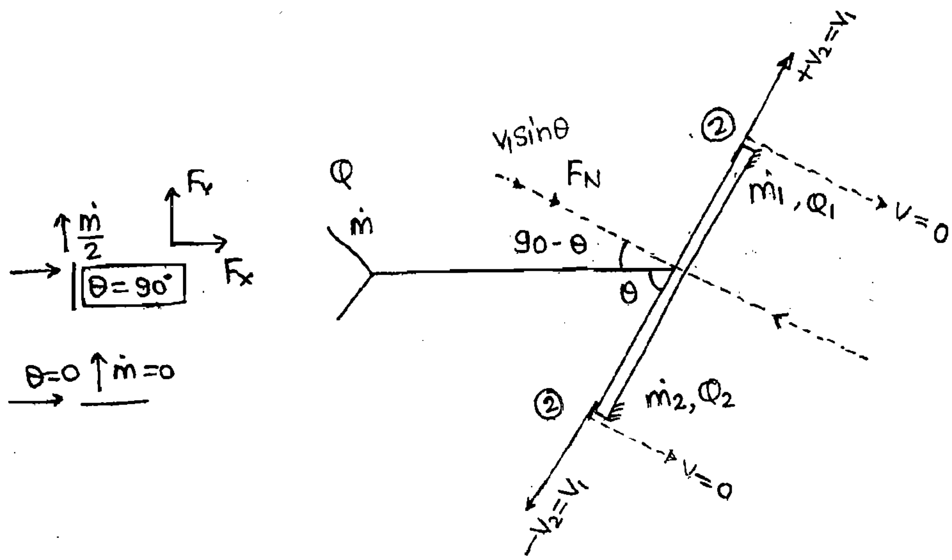
→ $F_y = F_T = \dot{m} \times 0 - \left[\frac{\dot{m}}{2} \times V_2 + \frac{\dot{m}}{2}(-V_2)\right]$

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

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



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

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

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

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

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

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

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

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

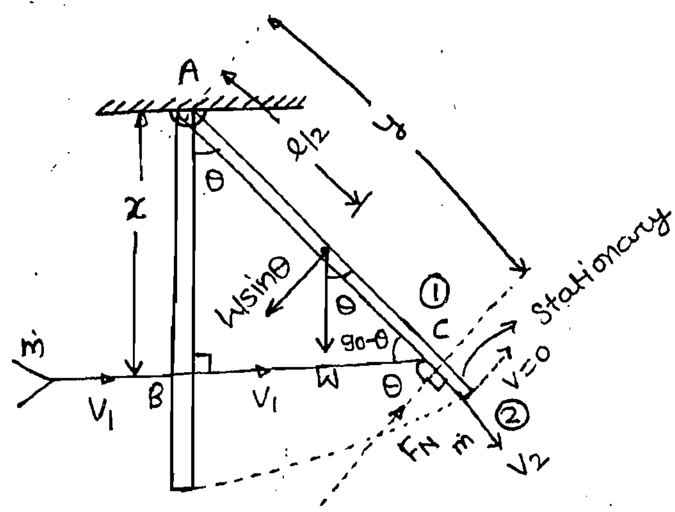
→ $\dot{m} V_1 \cos\theta - (\dot{m}_1 \times v_1 + \dot{m}_2 \times (-v_1)) = 0$

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

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

Case-III

Jet Strikes Vertical Hanging Plate



l = length of Plate

W = Weight of Plate $= Mg$

$\rightarrow \Sigma M_A = 0$

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

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

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

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

ΔABC

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

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

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

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
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 Studys 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. 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 →

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)

MADE EASY

MECHANICAL ENGINEERING

I.C Engine

BY- Amrinder Sir

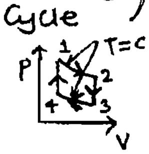
IC ENGINE

Books :
- V. Ganeshan
- Mathur and sharma

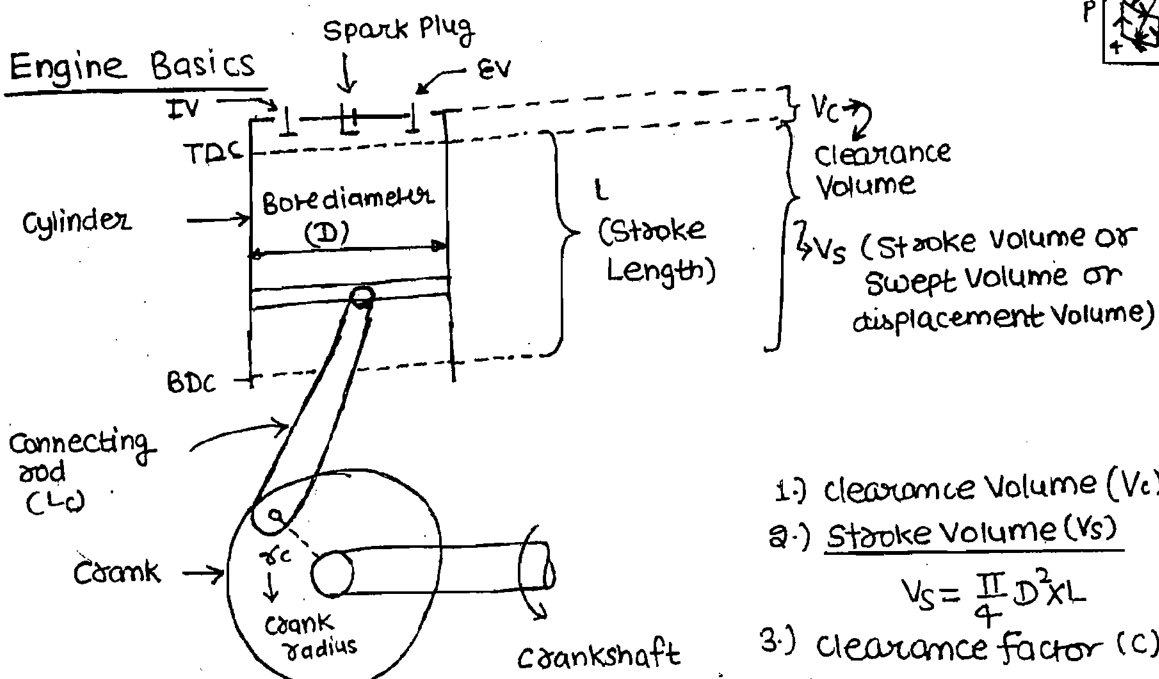
(I) Engine Basics
(II) Air Standard cycles → otto → Diesel → Dual
(III) Thermochemistry
(IV) Performance Parameters
(V) engine tests

Various types of Engines:→

- Heat Engine
  - Internal Combution (IC)
    - Rotary
      - open cycle Gas turbine
      - Wankel Engine
    - Reciprocating
      - Petrol Engine (otto cycle)
      - diesel Engine (diesel cycle)
  - External Combution (EC)
    - Rotary
      - Steam turbine
      - closed cycle Gas Turbine
    - Reciprocating
      - Steam Engines
      - Stirling Engine (stirling Cycle)



- Engine Basics



1.) clearance Volume (V_c)

2.) Stroke Volume (V_s)

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

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

$$\boxed{c = \frac{V_c}{V_s}}$$

4.) $\boxed{L = 2r_c}$

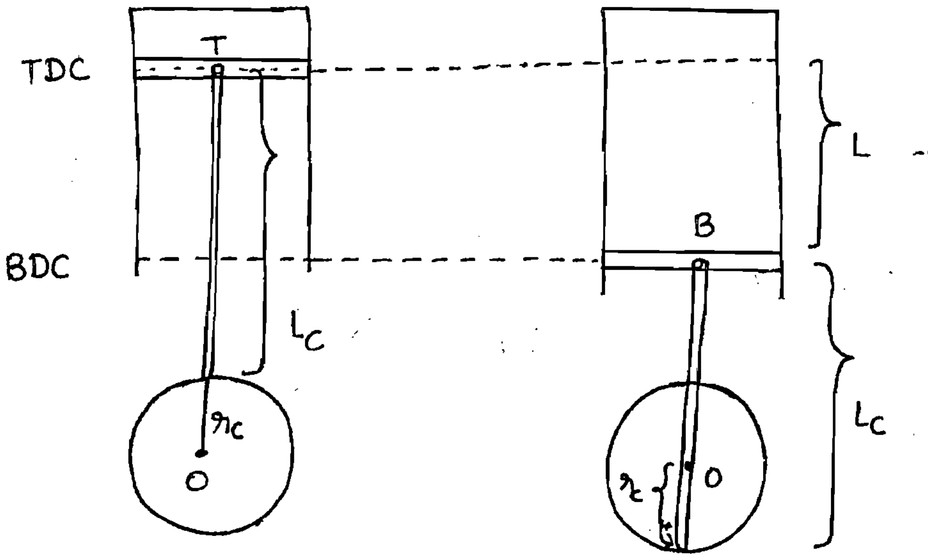
NOTE:→

IV : Inlet Valve

EV : Exhaust Valve

TDC : Top dead centre

BDC : Bottom dead centre

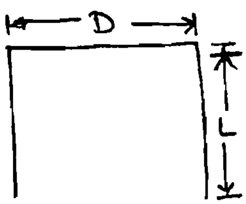


$$L = OT - OB$$
$$= (L_c + r_c) - (L_c - r_c)$$
$$\boxed{L = 2r_c}$$

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

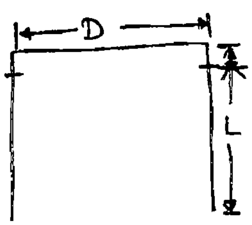
$$\bar{V}_p = \underbrace{2L}_{\text{dis/rev.}} \times \overbrace{\frac{N}{60}}^{\text{rpm}} \frac{\text{rev}}{\text{sec}} = \frac{2L \times N}{60}$$

(6)



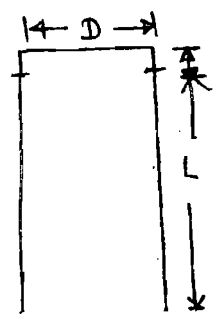
oversquare or Short stoke

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



Square engine

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



Under square or Long Stroke

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

MADE EASY
MECHANICAL ENGINEERING
Industurial Engineering
By-Saurbh Pandey Sir

INDUSTRIAL ENGINEERING

→ SAURABH PANDY SIR

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- 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

GATE → 6 marks
(4 to 8 marks)

ESE → Prelims (8 to 12 questions)

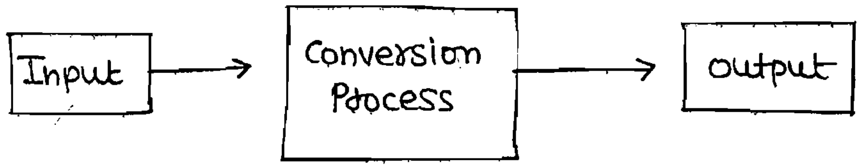
Mains → 60 marks

Books:

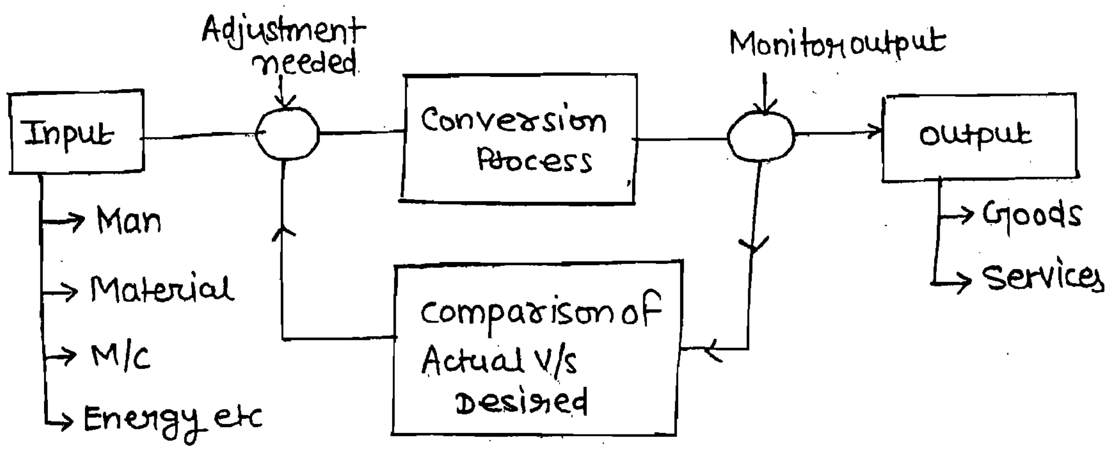
Hira & Gupta or Kanti Swarup or ND Vohra → For OR

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:→ $\text{Productivity} = \dfrac{\text{output}}{\text{Input}}$

It is a quantative ratio b/w 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 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

   - Indirect Material → cutting fluid, → Grease, Lubricants, → cotton, Jute, stationary items etc.
   - Indirect Labour → Watchman, Superviser, Higher officers etc.
   - Indirect Expenses → 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

MADE EASY

MECHANICAL ENGINEERING

Machine Design

By-Padmesh Sir

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

MACHINE DESIGN (MD)

or

MACHINE ELEMENT DESIGN (MED)

or

DESIGN OF MACHINE ELEMENT (DME)

GATE
6-7 Marks

ESE

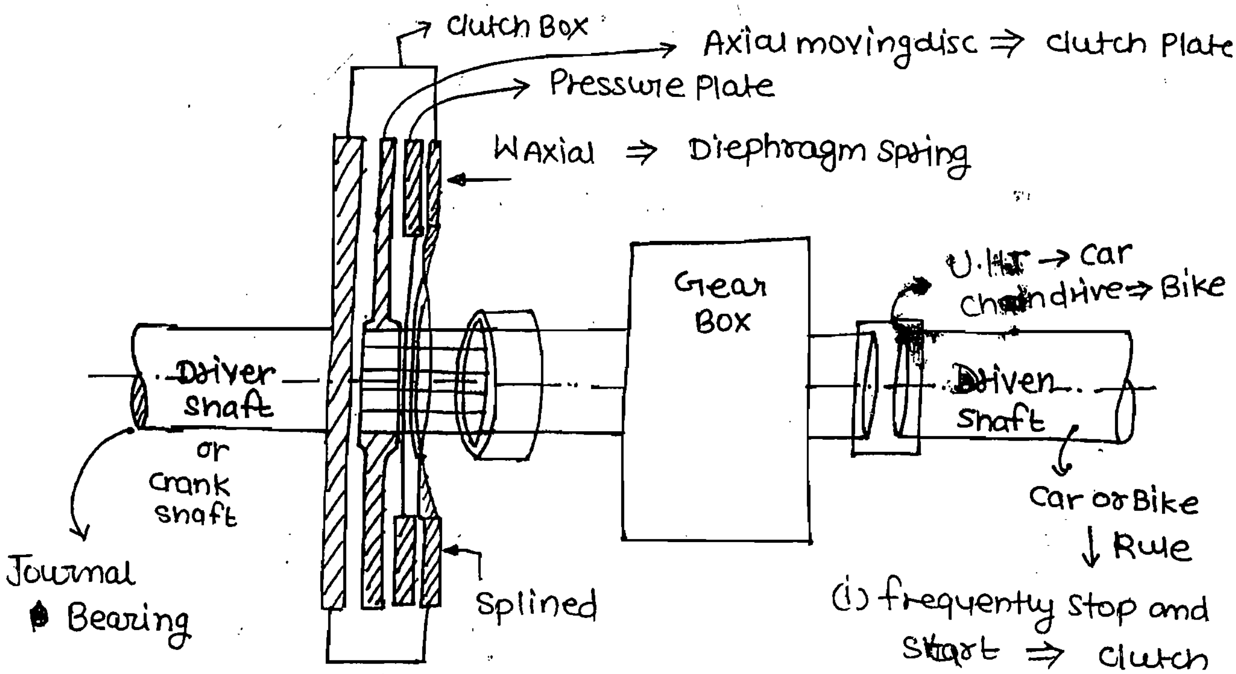
Pre → 16-18 marks

Mains → 68-70 marks

(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.



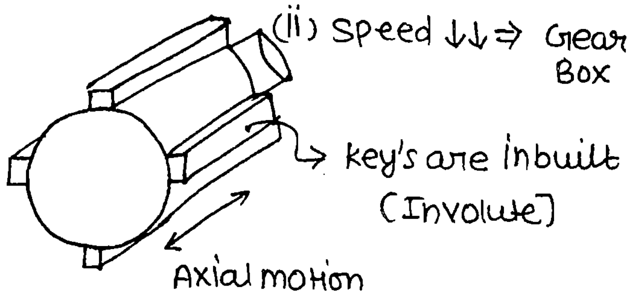
↓ Rule

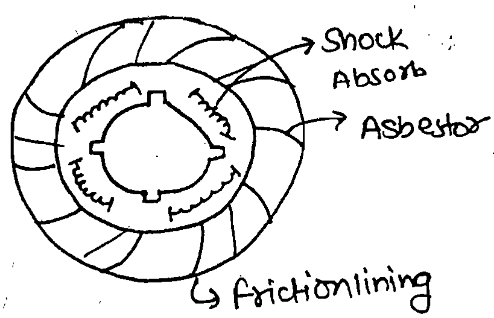
(i) frequently stop and start ⇒ clutch

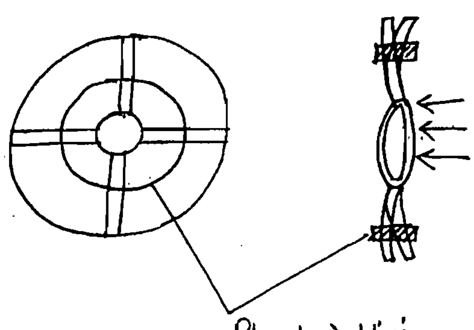
(ii) Speed ↓↓ ⇒ Gear Box

(i) Run continiously

(ii) Speed ↑↑







Q Why clutches are Prefer at High Speed Side or engine side ?

Ans → Power $= T_f \times \omega$ ↑↑↑

High speed

$T_f \rightarrow$ Required torque Less
$\Downarrow$
Clutch design Simple

→ To minimize wear and Losses
Clutch @ Low speed side
$Power = T_f \cdot \omega \downarrow\downarrow\downarrow$
$\downarrow$
(Torque Required will be more)

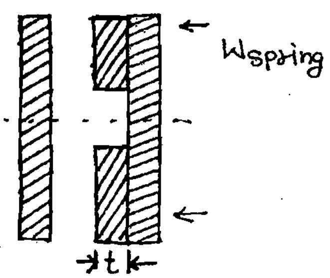
clutch

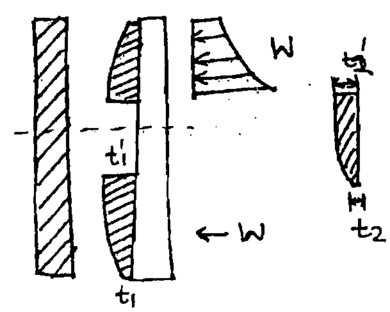
Wear friction is resposible for wear

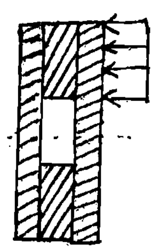
[UPT]
NEW CLUTCH
(uniform wear नहीं होता है)

wear friction $\propto V$ ↳ Linear Velocity
wear friction $\propto P$ ↳ Pressure

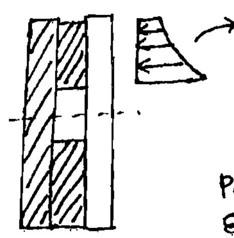
[UWT]
OLD CLUTCH
(uniform wear होता है।)





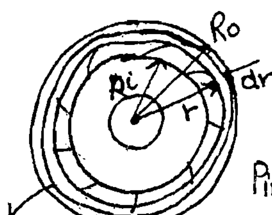


P_{ind} = uniform Pressure
$\Downarrow$
Perfect Engage



$P_{ind} \rightarrow$ Non uniform Pressure
$\Downarrow$
Perfect Engage नहीं होता है

Pressure $\cdot r$ = constant $\Rightarrow P \cdot r = C$
wear friction = constant
$\Downarrow$
uniform wear Theory (UWT)



$R_o \rightarrow$ outer radius of Lining
$R_i \rightarrow$ Inner radius of Lining

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

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

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

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

For Safe Condⁿ
$P_{ind} \le P_{Per}$ or P_{allow}
$$\frac{W}{\pi(R_o^2 - R_i^2)} \le P_{Per}$$

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

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

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

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

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

For safe condⁿ
$(P_{ind})_{max} \le P_{Per}$
$\uparrow P_{ind} = \frac{W}{2\pi r(R_o - R_i)}$

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

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

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

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

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

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

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

NEW CLUTCH $\Rightarrow$ UPT

$\Downarrow$

$P_{ind} = c$

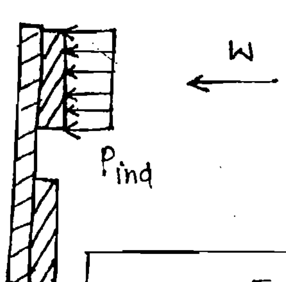
OLD CLUTCH $\Rightarrow$ UWT

$\Downarrow$

$P.r = c$

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

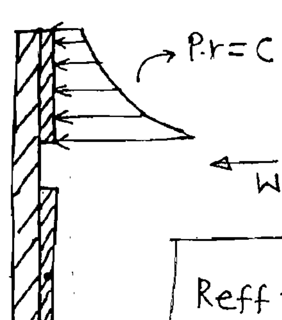
  $P_{ind} \le P_{Per}$
- $W_{max} = \pi (R_o^2 - R_i^2) P_{Per}$
- $T_{f_{max}} = \dfrac{2}{3} \mu \pi P_{Per} (R_o^3 - R_i^3)$



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

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

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



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

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. } ESE
10. Condu & Cooling Tower }
11. Comp. Flow - Gate
12. Misc? Topic
    (nozzle & diffuser) X
    (nuclear PP) X

Ref. Books:

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

GAS TURBINE

Engine:

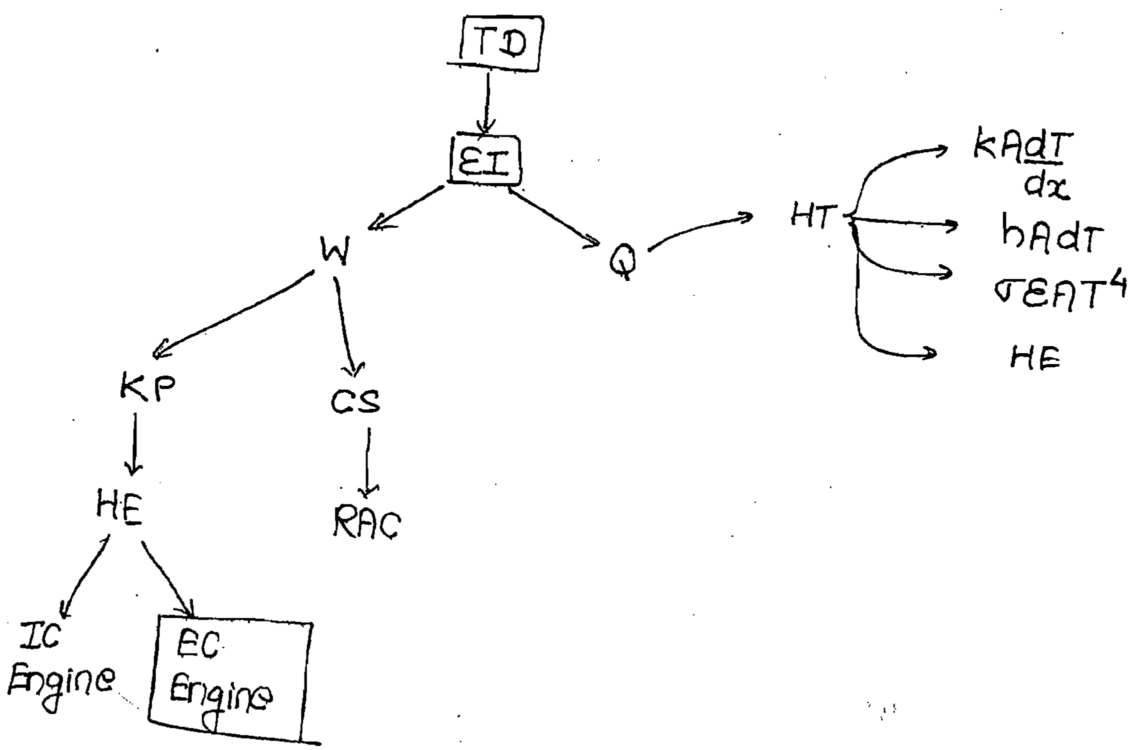
It is a Mechanical Device which convert 1 form of Energy into another useful form of energy.

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 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) ~~At~~ 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 comparison to the turbine work which will reduces the net work o/p. & finally the efficiency decreases.

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

$$\downarrow W_{net} = \underset{\int v_g\, dP}{\underset{\downarrow}{W_T}} - \underset{\int v_g\, dP}{\underset{\downarrow}{W_C}} \uparrow$$

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.

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

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

MADE EASY
MECHANICAL ENGINEERING
Production Engineering

MADE EASY

MECHANICAL ENGINEERING

Casting & Welding

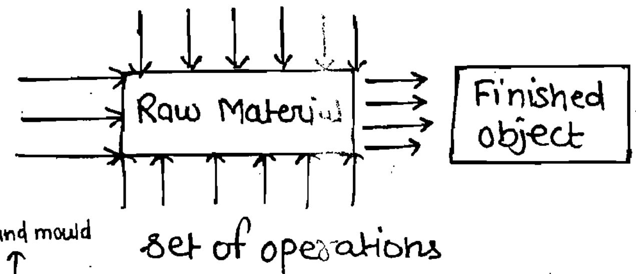
BY- Vinod Sir

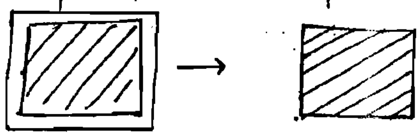
Manufacturing Process :→

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.

ORE
↓
Furnace
↓
Liquid Metal
↓
Casting





Classification of Manufacturing Process :→

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

A. Zero Process

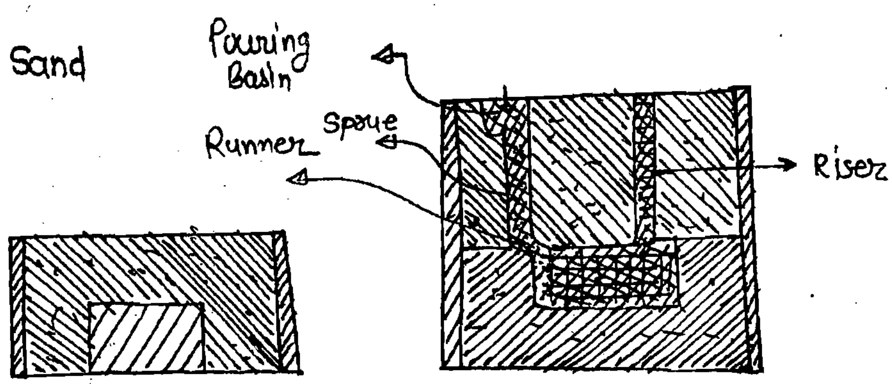
B. Additive Process

C. Subtractive Process

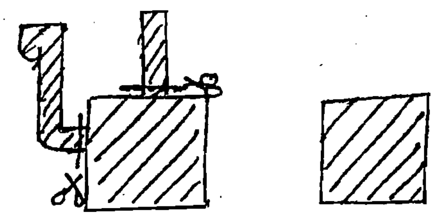
Casting:→ It is a Process in which molten Liquid metal is allow to Solidify in a Predefined mould cavity.

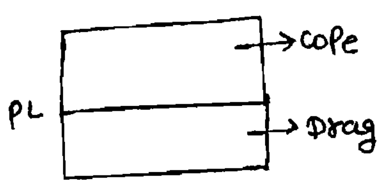
After Solidification by breaking the mould required shape of the object is Produced

1. Pattern
2. Moulding Sand
3. Tools

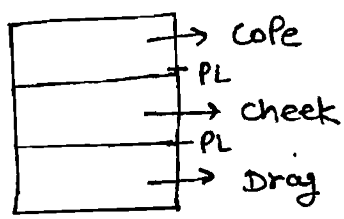


draw spike

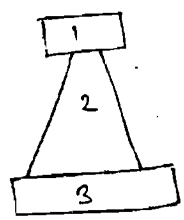




Two Box



Three Box

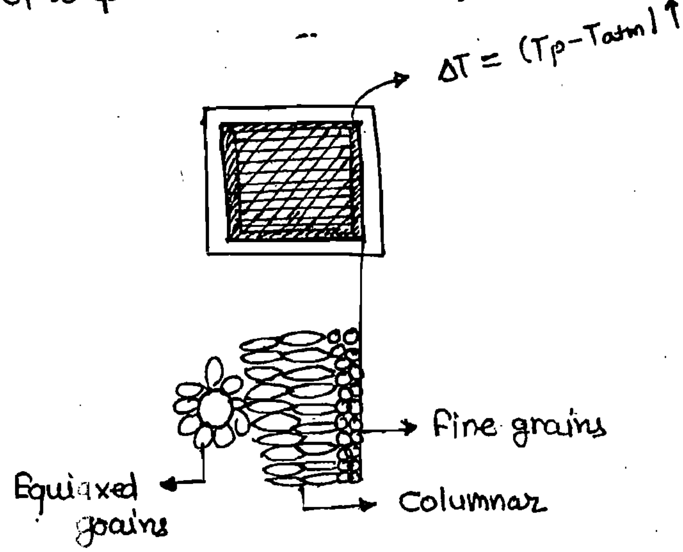


Advantanges:→
1. Complex shapes of the object can be easily Produced
2. Less expensive Process
3. Ductile and Brittle materials can be easily Produced.
4. Large Size objects Can be Produced by casting only. (100-150 Ton)
   eg. Machine tools Bed (lathe Bed), Road Roller, Turbine Housing etc

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

⟶ Melting temp.

⟶ Pouring temp.



· Limitations of casting :→

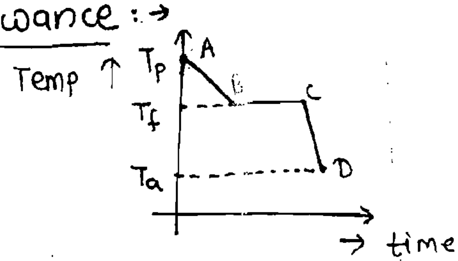
1. Casting objects are not having smooth surface finish.
2. It is Laborious and time consuming Process.
3. There is a Possibility of gas defects can be formed in the casting.
4. Due to Non-uniform cooling, non-uniform Grain-structure is Produced in the casting. because of this Non-uniform Mechanical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

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

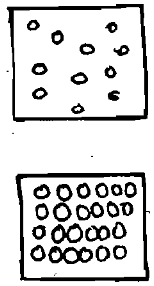
Allowances :→

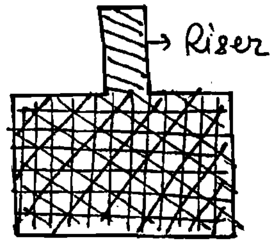
1. Shrinkage or contraction
2. Draft or Taper
3. Machining or finish
4. Shake or Rapping
5. Distortion or camber

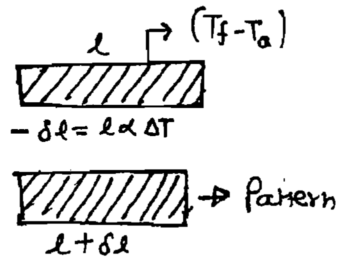
1. Shrinkage Allowance :→



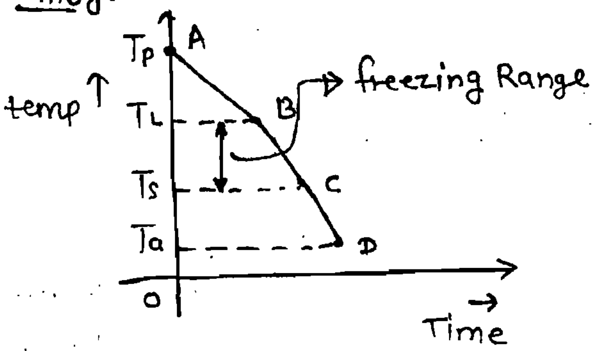
$(t_s)_r > (t_s)_c$ $\qquad$ $t_s \rightarrow$ Solidification time







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 : →

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

Refrigerator and Air Conditioning

Basic concept
VCRS
Ref
VARS
RBC
Ref Equipment

Psychrometry
Summer & winter AC

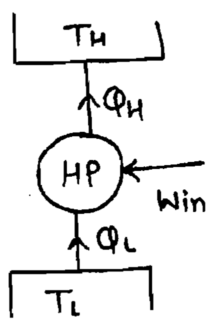
BOOKS : CP Arora
PL Ball

BASIC CONCEPTS

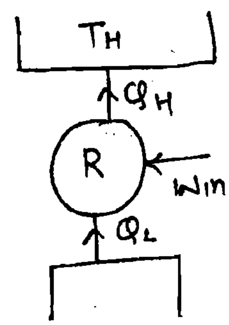
- **Refrigeration Effect** :- It is the amount of heat which is required to extract from the Storage space in order to provide & maintain lower temperature than that of surroundings

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 :→ $\boxed{COP = \frac{DE}{W_{in}}}$



$Q_L + W_{in} = Q_H$



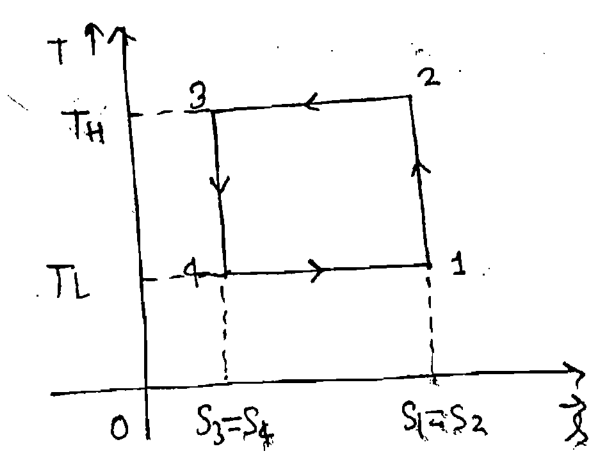
$$\boxed{(COP)_{HP\ Actual} = \frac{Q_H}{Q_H - Q_L}}$$

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

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

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

- Ideal Refrigeration Cycle or Reversed Carnot Cycle :→



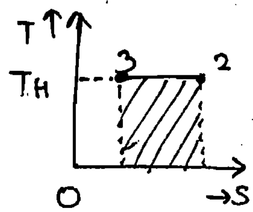
Process 1-2 Rev. adiabatic compression

Process 2-3 Isothermal Heat rejection

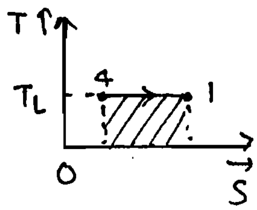
3-4 Isentropic Expansion

4-1 Isothermal heat addition

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



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



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

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.

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

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

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

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

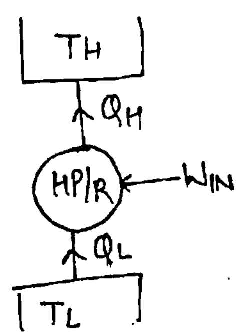
T_L = constant — $(COP)_s < (COP)_w$

$(T_H)_s > (T_H)_w$

Relationship between Heat Pump COP & COP of Refrigerator:→

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

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



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

MADE EASY

MECHANICAL ENGINEERING

Strength Of Material

By-Krishna Sir

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

STREGTH OF MATERIAL

OR

MECHANICS OF MATERIAL

OR

MECHANICS OF SOLIDS

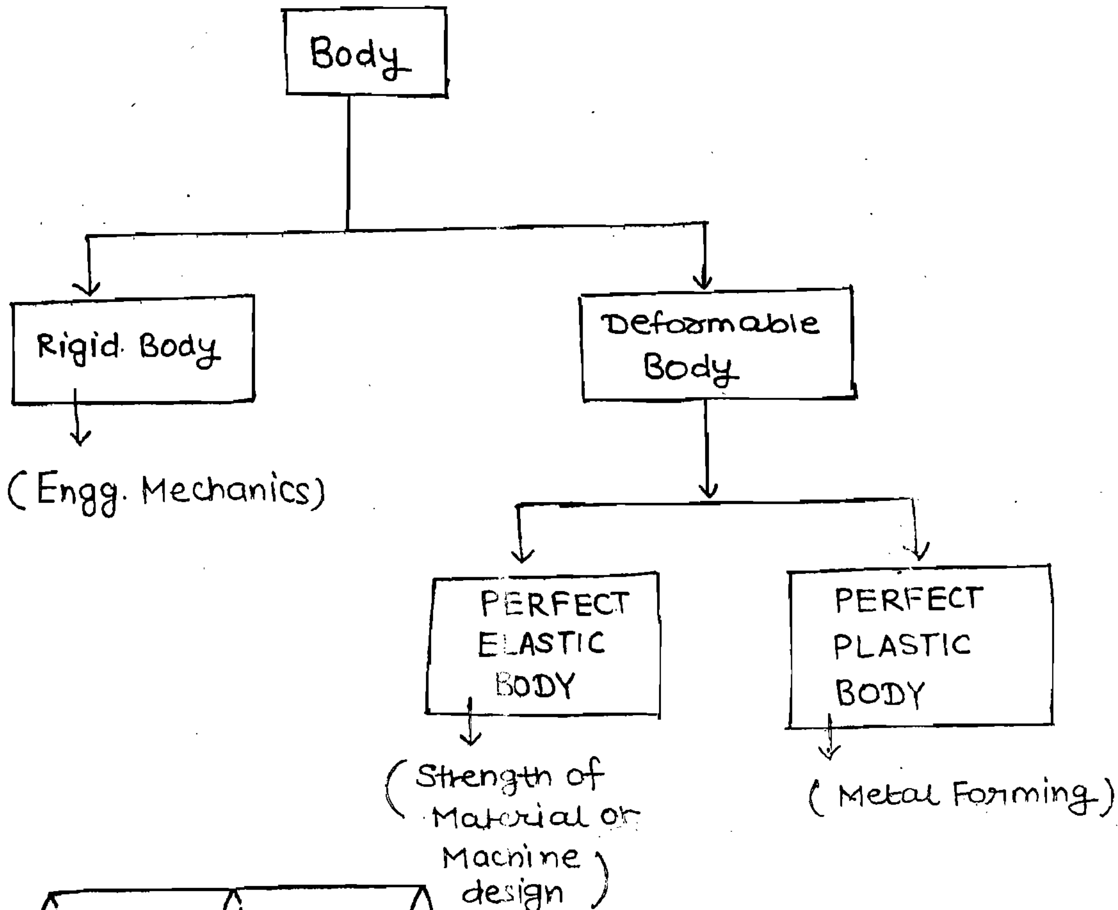
OR

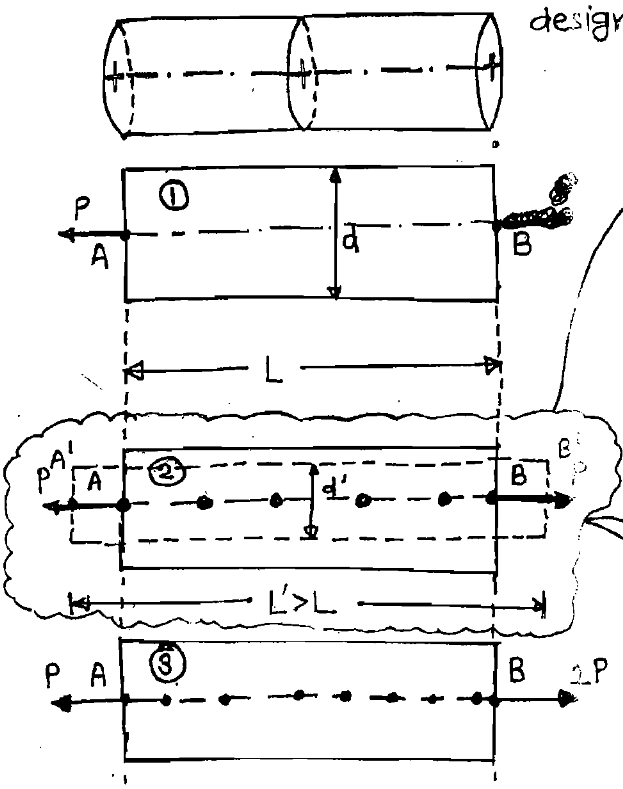
MECHANICS OF STRUCTURE

OR

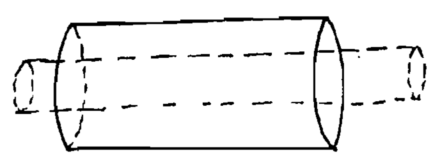
MECHANICS OF PERFECT ELASTIC BODIES

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



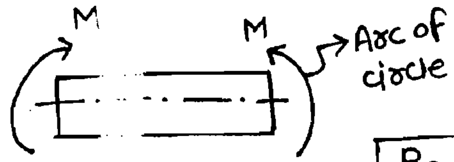


Undergoes Pure elastic deformation



A Prismatic cylindrical Perfect elastic Bar is subjected to Pure Axial tensile Load [PATL]

i.e. $\boxed{\sigma_{induced} \leq \text{Elastic Limit}}$



Pure Bending

i.e.

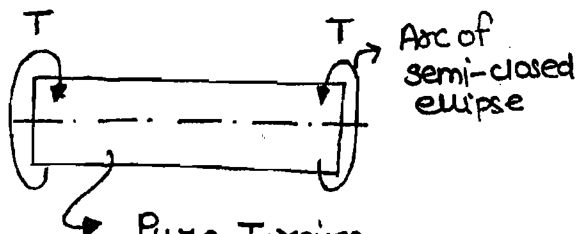
Axial Load = Shear Force = Twisting Moment = ZERO

Bending moment = Constant

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

Axial load = Constant

Bending Couple → Two equal Parallel opposite eccentric axial load



Pure Torsion

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

Axial load = Shear force = Bending Moment = zero

Torsional Moment = Constant

Pure Axial Load

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

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

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

MADE EASY
MECHANICAL ENGINEERING
Theory Of Machine
By-Amit Kakkar Sir

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

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 case of Motion i.e. Force

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

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

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

(kinetics)

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

Dynamics viscosity $(\mu) \rightarrow \frac{N\text{-}s}{m^2}$

Kinematic viscosity $(\nu) = \frac{\mu}{\rho}$

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

• <u>Text Book</u>

→ S.S. Rattan

→ Prof V.P. Singh

• <u>Reference Book</u> (For Teachers)

→ Shigley

→ Norton

→ Thomas Beven

• 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

MADE EASY

MECHANICAL ENGINEERING

Thermodyanamics

By-Amrinder Sir

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

Thermodynamics

Books : Cengel & Boles ⇒ Theory
P.K. Nag ⇒ Questions

Questions → Work Book → Class
→ Gdrive
→ Theory Book

→ GATE Previous Year
→ ESE PYQ (5 Year)
→ GATE OTS

t.me/amrindersir2223

@ Amrindersinghmadeeasy

HW
TH-B
P-224
Q8, Q9

"Reversible & Irreversible"
↳ Video
Pme

Youtube

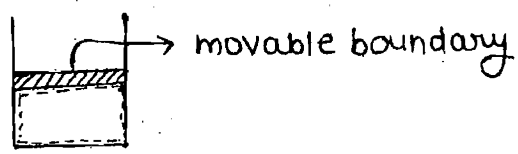
Amrinder Sir entropy
"Civil Services questions"
....

* **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.

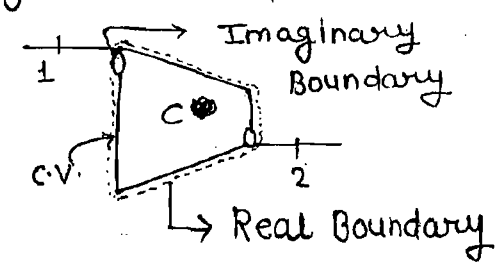


→ **Surrounding** – Everything except the system becomes surrounding.

- 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.

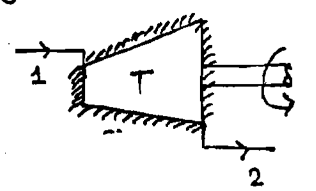


Type of System :→

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	✓	✓	×
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, ρ, μ, velocity (c), thermal conductivity (k)

NOTE: All specific Properties are intensive Properties,
eg. h, s, u, w, q, C
(C → specific heat)

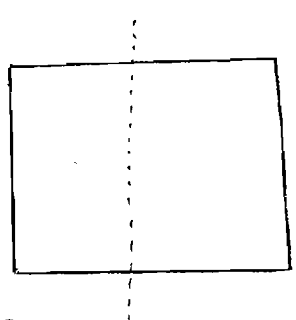
2. Extensive (Extrinsic) :→

Depense of mass of the system under consideration.

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

$$\boxed{C_{rms}^2 \propto T}$$

$$\boxed{\frac{1}{2}m_1c_1^2 + \frac{1}{2}m_2c_2^2 + \cdots = \frac{1}{2}\Sigma m\, C_{rms}^2}$$



$P_L = P$
$T_L = T$
$V_L = V/2$

MADE EASY

ESE /GATE/PSU

MATHMATICS

By-SAGAR SONKAR Sir

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

MATHEMATICS

GATE → 13 - 15 M

ESE → 15 Questions

- Sagar sir

- sagarsankar@gmail.com

Telegram → @sagarsankar

Syllabus:

1. Linear Algebra
2. Probability
3. Calculus
4. Vector Calculus
5. Differential Equation
6. Complex number
7. Numerical Methods.
8. Laplace Transform.
9. Fourier series

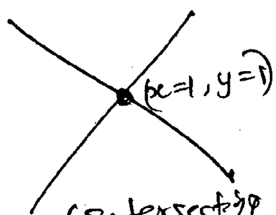
* LINEAR ALGEBRA :

study of Linear system of equation :

$x+2y=3 \rightarrow (1)$

$2x+3y=5 \rightarrow (2)$

⇓



(Intersecting Line)

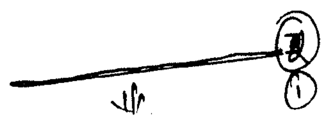
⇓

Unique soln

$x+2y=3 \rightarrow (1)$

$2x+4y=6 \rightarrow (2)$

⇓



⇓

Coincident Line

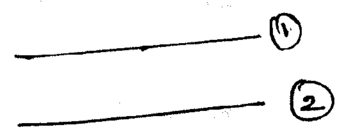
⇓

Infinite soln

$x+2y=3 \rightarrow (1)$

$x+2y=5 \rightarrow (2)$

⇓



⇓

parallel line

⇓

No solution.

If there are more than two variables

⇓

we cannot plot graph and know about the soln.

⇓

∴ To get soln → we find Rank

⇓

∴ we study Matrix, in Linear Algebra

Matrix :

$A = [a_{ij}]_{m\times n}$

$m \rightarrow$ No. of row $\rightarrow$ horizontal

$n \rightarrow$ No. of column $\rightarrow$ vertical

$a_{ij} \Rightarrow$ Element of matrix

$i \rightarrow$ row $\quad j \rightarrow$ column

$R \rightarrow$ Row
$C \rightarrow$ column

$$A = \begin{array}{c} \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & & \vdots \\ a_{m1} & a_{m2} & \cdots & a_{mn} \end{bmatrix}_{m\times n} \begin{array}{l} \rightarrow R_1 \\ \rightarrow R_2 \\ \\ \rightarrow R_m \end{array} \\ \begin{array}{cccc} \downarrow & \downarrow & & \downarrow \\ C_1 & C_2 & & C_n \end{array} \end{array}$$

(i) If $m \neq n \Rightarrow$ Rectangular Matrix.

(ii) If $m = n \Rightarrow$ square matrix
$\Downarrow$
Diagonal element exist only in square matrix.
$\Downarrow$

$$A = \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix}$$

$\downarrow$
principal diagonal
main diagonal
leading diagonal
primary diagonal
diagonal elements

***

$\boxed{\text{Trace of } A = \text{Sum of main diagonal elements}}$

$\Downarrow$

$Tr(A) = \sum a_{ij} \;\forall\; \underline{i=j}$

(i) for diagonal element $\Rightarrow i=j \ \forall i,j$

(ii) for lower diagonal element $\Rightarrow i>j \ \forall i,j$

(iii) For upper diagonal element $\Rightarrow i<j \ \forall i,j$

(iv) for other than diagonal element
(or)
off diagonal element $\Rightarrow i \neq j \ , \forall i,j$

(v) corresponding element $= a_{ij}$ & $a_{ji} \ \forall i,j$

Ex: a_{31} & a_{13}

a_{23} & a_{32}

---

* **Diagonal Matrix :**

$$\boxed{\begin{array}{l}\text{All off diagonal element} = 0 \\ \& \\ \text{Atleast one diagonal element} \\ \text{must not be zero}\end{array}}$$

eg: $\begin{bmatrix} a & 0 & 0 \\ 0 & b & 0 \\ 0 & 0 & c \end{bmatrix}$, $\begin{bmatrix} a & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}$ non-zero

where a, b, c are non-zero.

Pb: Minimum no-of-zeroes in diagonal matrix of order 'n' ?

Minimum No-of zeroe's = total No-of element − No-of primary diagonal element

$= (n \times n) - n$

$= n^2 - n = \boxed{n(n-1)}$

**

$$\boxed{\begin{array}{l}\therefore \text{Minimum No-of zeroes} = n^2 - n \\ \text{Max No-of zeroes} = n^2 - 1\end{array}}$$ **

* Identity Matrix :

$I_2 = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$, $I_3 = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$

$\boxed{I_n = \text{Identity matrix of order } n}$

* Scalar Matrix :

$\boxed{A = K \cdot I}$

Ex: $\begin{bmatrix} 7 & 0 & 0 \\ 0 & 7 & 0 \\ 0 & 0 & 7 \end{bmatrix} = 7I_3$

Note :
All Scalar Matrix are Diagonal matrix
but
All Diagonal matrix are Not Scalar matrix

* Upper Triangular Matrix : (UTM)

$A = [a_{ij}]_{m \times n} \Rightarrow \boxed{a_{ij} = 0 \ \forall \ i > j}$

Ex: $\begin{bmatrix} 1 & 2 & 3 \\ 0 & 4 & 5 \\ 0 & 0 & 6 \end{bmatrix}$

* Lower Triangular Matrix (LTM) :

$A = [a_{ij}]_{m \times n} \Rightarrow \boxed{a_{ij} = 0 \ \forall \ i < j}$

Ex: $\begin{bmatrix} 1 & 0 & 0 \\ 2 & 3 & 0 \\ 4 & 5 & 6 \end{bmatrix}$

* Column matrix : (Column vector)

$A = [a_{ij}]_{n \times 1}$

Ex: $\begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \end{bmatrix}_{4 \times 1}$

ONLY ONE COLUMN

* Row matrix : (Row vector)

$A = [a_{ij}]_{1 \times n}$

$A = \begin{bmatrix} 1 & 2 & 3 & 4 \end{bmatrix}_{1 \times 4}$

ONLY ONE ROW

* Transpose matrix (A^T)

$A = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{bmatrix} \Rightarrow A^T = \begin{bmatrix} 1 & 4 & 7 \\ 2 & 5 & 8 \\ 3 & 6 & 9 \end{bmatrix}$

* Symmetric Matrix :

$$\boxed{\begin{aligned} * \quad & A^T = A \\ * \quad & a_{ij} = a_{ji} \end{aligned}}$$

Ex:

$A = \begin{bmatrix} 1 & 2 & 3 \\ 2 & 4 & 5 \\ 3 & 5 & 6 \end{bmatrix}$

* Skew-symmetric matrix:

**

$$\boxed{\begin{array}{l} A^T = -A \\ a_{ij} = -a_{ji} \; \forall \; i \neq j \end{array}}$$

$$A = \begin{bmatrix} 0 & 2 & 3 \\ -2 & 0 & 5 \\ -3 & -5 & 0 \end{bmatrix}$$

$$A^T = \begin{bmatrix} 0 & -2 & -3 \\ 2 & 0 & -5 \\ 3 & 5 & 0 \end{bmatrix}$$

☆ ALL LEADING DIAGONAL ELEMENTS MUST BE ZERO

$$A^T = -\begin{bmatrix} 0 & 2 & 3 \\ -2 & 0 & 5 \\ -3 & -5 & 0 \end{bmatrix} = -A$$

Note:

Sum of all elements of skew symmetric matrix = ZERO

Ex: $A = \begin{bmatrix} 2 & 5 \\ 6 & 8 \end{bmatrix}$; $A^T = \begin{bmatrix} 2 & 6 \\ 5 & 8 \end{bmatrix}$

$$\frac{A+A^T}{2} = \frac{1}{2}\begin{bmatrix} 4 & 11 \\ 11 & 16 \end{bmatrix} = \begin{bmatrix} 2 & 11/2 \\ 11/2 & 8 \end{bmatrix} \to (1) \to \text{symmetric matrix}$$

$$\frac{A-A^T}{2} = \frac{1}{2}\begin{bmatrix} 0 & -1 \\ 1 & 0 \end{bmatrix} = \begin{bmatrix} 0 & -1/2 \\ 1/2 & 0 \end{bmatrix} \to (2) \to \text{skew symmetric matrix}$$

$$(1)+(2) \Rightarrow \begin{bmatrix} 2 & 5 \\ 6 & 8 \end{bmatrix} = A$$

***

$$\therefore \boxed{A = \left(\frac{A+A^T}{2}\right) + \left(\frac{A-A^T}{2}\right)}$$

Any square matrix = symmetric matrix + skew symmetric matrix

Note:
Every square matrix can be expressed as the sum of symmetric & skew-symmetric matrix.

* Singular Matrix: $|A| = 0$

* Non Singular matrix: $|A| \neq 0$

* Invertible matrix
$\Downarrow$
$\boxed{A^{-1} \text{ exist}}$

$$A^{-1} = \frac{Adj\, A}{|A|}$$

A^{-1} exist only when $|A| \neq 0$ (i.e Non-Singular)

* Complex matrix:

$$A = \begin{bmatrix} 1+i & 3-2i \\ 2+i & 5 \end{bmatrix}$$

Conjugate of A
$\Downarrow$
$\bar{A}$ $= \begin{bmatrix} 1-i & 3+2i \\ 2-i & 5 \end{bmatrix}$

Conjugate transpose $(\bar{A})^T$ (or) A^{θ} $= \begin{bmatrix} 1-i & 2-i \\ 3+2i & 5 \end{bmatrix}$

* Hermitian matrix.

** $(\bar{A})^T = A$

$a_{ij} = \overline{a_{ji}}$

** Main diagonal Element are "purely Real"

ex: $A = \begin{bmatrix} 4 & 1+i \\ 1-i & 5 \end{bmatrix}$

* Skew-Hermitian Matrix:

** $(\bar{A})^T = -A$

$a_{ij} = -\overline{a_{ji}}$

** Main diagonal Element are "zero (or) purely Imaginary"

Ex: $A = \begin{bmatrix} i & -1+i \\ 1+i & i \end{bmatrix}$

* operation of matrix :

$$A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix} \; ; \; B = \begin{bmatrix} 5 & 6 \\ 7 & 8 \end{bmatrix}$$

* Addition :

$$A+B = \begin{bmatrix} 6 & 8 \\ 10 & 12 \end{bmatrix} = B+A$$

$\boxed{A+B = B+A}$ ← Cummulative (two matrix)

$\boxed{A+(B+C) = (A+B)+C}$ ← Associative (three matrix)

Addition operation are cummulative & Associative

+ Subtraction :

$$A-B = \begin{bmatrix} -4 & -4 \\ -4 & -4 \end{bmatrix} \; ; \; B-A = \begin{bmatrix} 4 & 4 \\ 4 & 4 \end{bmatrix}$$

$\boxed{A-B \neq B-A}$

Substraction is Neither cummultive Nor Associative

---

* Scalar Multiplication

$$A = \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} \qquad B = \underset{\text{scalar}}{k}A \Rightarrow B = \begin{bmatrix} ka_{11} & ka_{12} \\ ka_{21} & ka_{22} \end{bmatrix}$$

MADE EASY
GATE/PSU
GENERAL ENGLISH
BY-SRINIWAS SIR

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) Scarcily $\frac{\text{when}}{\text{before}}$
3. Degree of comparison
4. Articles.
5. Tenses + If clause.
6. Reported speech.
7. Preposition
8. Parts of speech.
9. concords and corrections.

Sentences : 4 kinds

(i) Assertive → Positive / Negative

(ii) Introgative

(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.

Introgative:

To make an introgative sentence, put the special veub 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 (Introgative)

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 introgative.

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 confimation 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 mddeeasy, aren't we ?

meaning: family

My ~~drive~~ neighbour comes tomorrow, does n'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 ~~negative~~ positive.

Example: I am not a teacher of English, am I ?

My friend does not know the address, does he ?

Formula: Special verb + pronoun.

<u>Usage of :</u>

Hardly, rarely, scarcely, barely, never, seldame

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 seldam bite, do they ?

They never came to my house, did they ?

<u>Usage of :</u>

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 $\underset{m.v}{\underline{\text{has}}}$ a car, ~~does he ?~~ doesn't he ?

He $\underset{S.V.}{\underline{\text{has}}}$ purchased a car, hasn't he ?

He $\underset{S.V}{\underline{\text{had}}}$ solved the problem, hadn't he ?

He $\underset{M.V}{\underline{\text{had}}}$ a problem earlier, didn't he ?

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 <u>they</u>.

Singular verb	Plural verb
is	are
was	were
has	have
does	do

Example: Everyone is coming, ~~isn't everyone~~ X
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 curruption, do they ?

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Usage of

a few = positive   a little = positive

few = Negative   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 in absent (But the meaning is implied in it)
2. Sentence begins with V_1
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 ?

Get lost , can't you ?

Keep silence, can't you ?

← Expresses command only.

* If the statement begins with Let's or Let us , the question is always "shall we?"

Example: Let's staut the work, shall we ?

Let's not staut 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 comeng, are you?

so, you are not coming aren't you?

Usage of a) as soon as

b) No sooneu than

c) Hardly-when

d) Scarcely - when / before

These four words aue 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 sooneu in the place of as soon as.

2. Change the as soon as into introgative form.

3. Put than before the second sentence.

Example: As soon as I went home, I had rest.
No sooneu did I go home than I had rest. } same meaning

As soon as the baby sees the doctor, she will cry.
No sooneu 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 + V_3 form and then change into introgative form.

3. Put when before the second sentence.

Example:

As soon as I went home, I had rest.

Hardly had I gone home when I had rest.

Usage of scarcely when / before

Rule: The same rules of hardly - when are applicable.

Example: As soon as the principal enterned the class room, all the students stood up.

Scarcely had the pricipal enterd the classroom when all the students stood up.

→ As soon as he had explained the topic, students felt happy

No sooner, had he explained the topic than students felt happy.

Scarcely had he explained the topic when students felt happy.

Hardly had he explained the topic when students felt happy.

Degree of comparision:

Three forms of the objective and adverbs are called as "Degree of comparision."

a) Positive degree — 1. as - as (accepting sense)
2. so - as (negative sense)

b) Comparative degree — (Takes than.)

c) Superlative degree — (Takes the)

Important pt.

i) positive degree, comparative degree sensentces are alway ended with the special verb.

ii) Positive degree comparative degree sentences always take subjective person.

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REASONING

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