
NDA-CDS 1 2025
GS
LIVE
PHYSICS
MISCELLANEOUS
CLASS 3
NAVJYOTI SIR
SSBCrack EXAMS

MISCELLANEOUS TOPICS - III

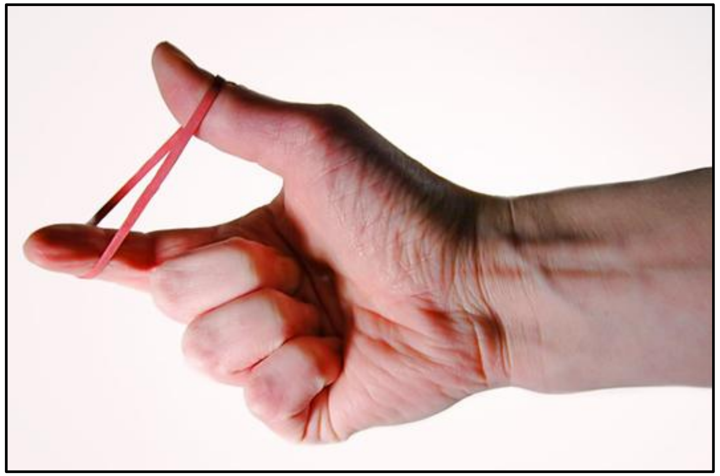
(MECHANICAL PROPERTIES OF SOLIDS)

WHAT WILL WE STUDY ?

- Elasticity
- Stress and Strain
- Hooke's Law

ELASTICITY

Elasticity is the property of body by virtue of which a body regains or tends to regain its original configuration (shape as well as size), after the removal of applied forces. The body is called elastic body.



deforming force

STRESS

- **The internal restoring force acting per unit area of a deformed body is called stress.**

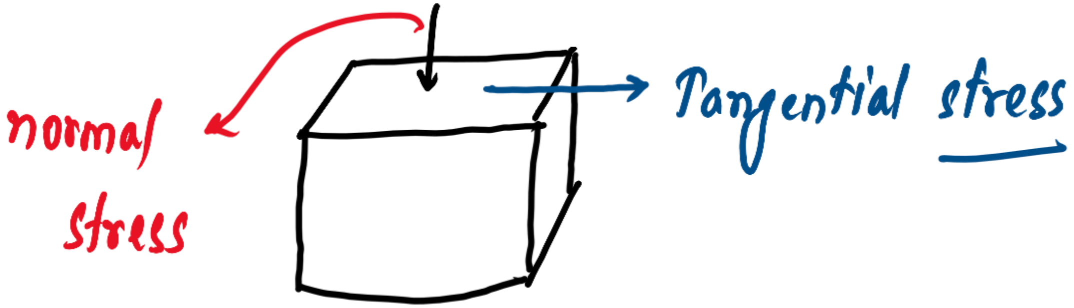
$$\text{Stress} = \frac{\text{Restoring force}}{\text{Area}}$$

Unit of stress → $N m^{-2}$ or Pa

TYPES OF STRESS

Two Types :

- **Normal stress : The normal stress is defined as the deforming force acting per unit area normal to the surface of the body.**
- **Tangential stress / Shear Stress : The tangential stress is defined as the deforming force acting per unit area tangential to the surface of the body.**



STRAIN

- **Strain is the ratio of change in configuration produced in a body to the original configuration of the body.**
- **3 types : Longitudinal , Volumetric and Shearing Strain**

$$\text{strain} = \frac{\text{change}}{\text{original}}$$

Unit → no units

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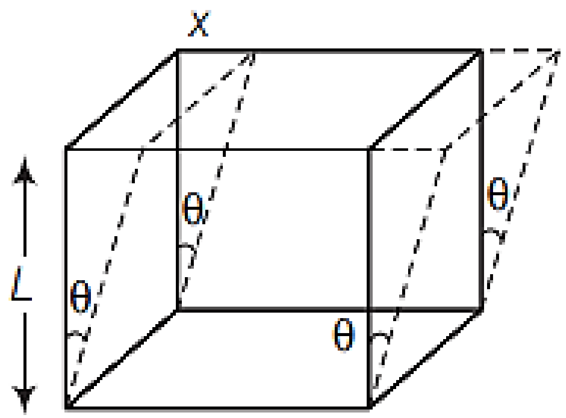

Fixed surface

① Longitudinal — Length,

$\text{strain} = \frac{\Delta L}{L}$

② Volumetric — volume

$\text{strain} = \frac{\Delta V}{V}$

③ shearing —

$\text{Strain} = \left(\frac{x}{L} = \theta\right)$

$\tan\theta = \frac{x}{L}$

(for very small $\theta \rightarrow \tan\theta \sim \theta$)

HOOKE's LAW

Within the elastic limit, the stress developed in a body is directly proportional to the strain produced in the body.

maximum limit till which body can regain its original configuration when deforming force is removed.

Stress = k × strain

k → modulus of elasticity

Unit → Nm^{-2}

$k = \frac{stress}{strain}$

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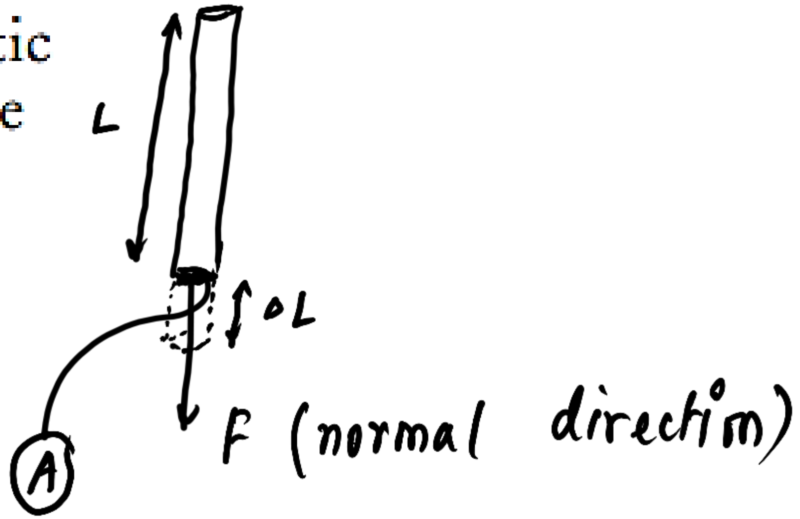
MODULUS OF ELASTICITY

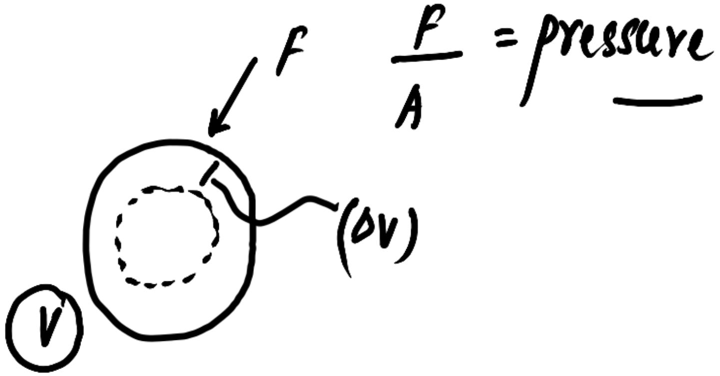
* **Young's modulus of elasticity (*Y*)** With in the elastic limit it is defined as the ratio of normal stress to the longitudinal strain.

Thus, $Y = \dfrac{\text{normal stress}}{\text{longitudinal strain}} = \dfrac{F/A}{\Delta L/L}$



Bulk modulus of elasticity (*K*) With in the elastic limit it is defined as the ratio of normal stress to the volumetric strain.

Thus, $K = \dfrac{\text{normal stress}}{\text{volumetric strain}} = -\dfrac{F/A}{\Delta V/V} = -\dfrac{pV}{\Delta V}$ $[\because F/A = p]$



(volume decreasing with pressure ⟶ -ve sign)

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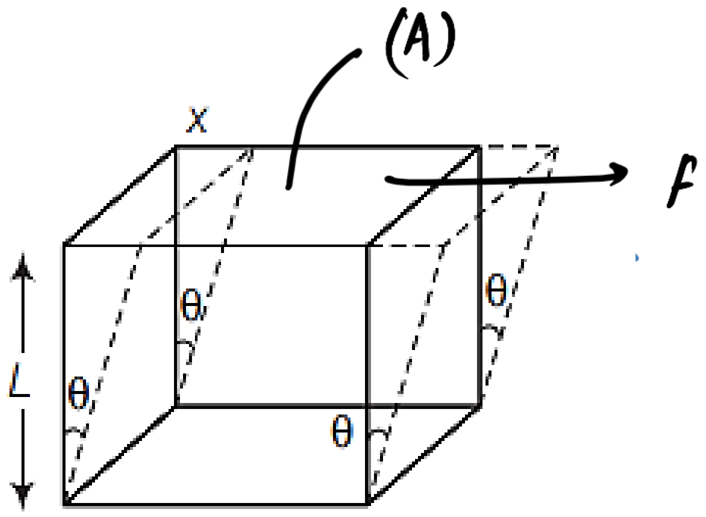
MODULUS OF ELASTICITY

Modulus of rigidity or shear modulus of elasticity (η)

With in the elastic limit it is defined as the ratio of tangential stress to the shearing strain.

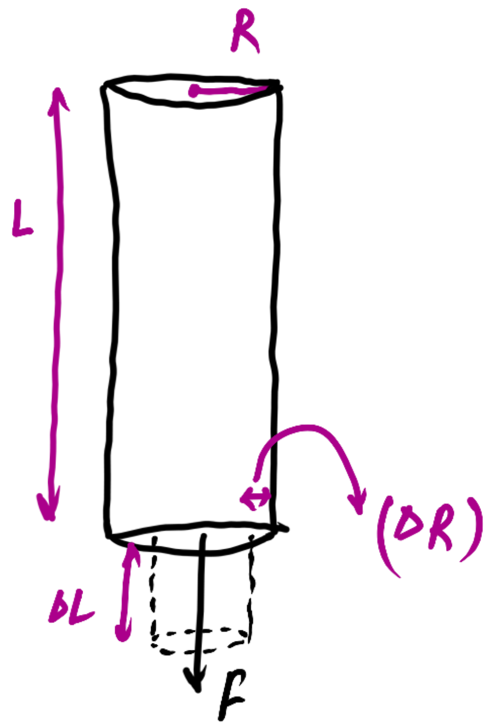
$$\text{Thus, } \eta = \frac{\text{tangential stress}}{\text{shearing strain}} = \frac{F/A}{\theta} = \frac{FL}{Ax}$$



Fixed surface

POISSON's RATIO

The ratio between the lateral strain and the longitudinal strain.



Poisson's ratio (σ) is given by

$$\sigma = \frac{\text{Lateral strain}}{\text{Longitudinal strain}} = -\frac{\Delta R/R}{\Delta L/L}$$

- Theoretical value of σ lies between -1 and $+\frac{1}{2}$.
- Practical value of σ lies between 0 and $+\frac{1}{2}$.

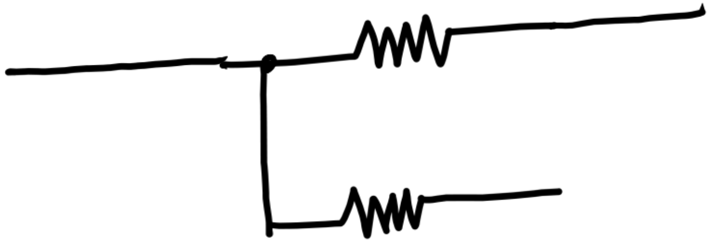
DOUBTS

COMBINATION OF RESISTORS

→ series

(no break or single path of current)

→ parallel



(Two different paths for current)

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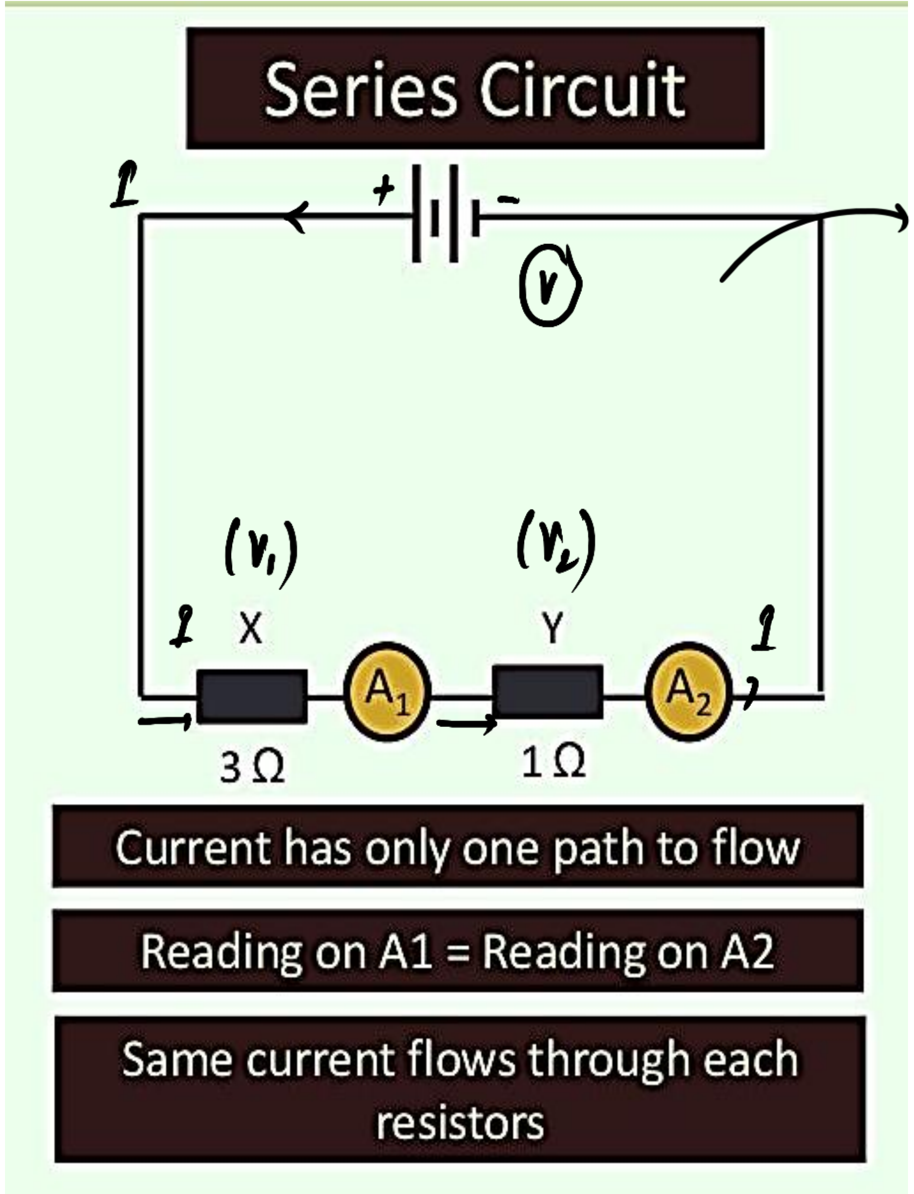
COMBINATION OF RESISTORS



$V = V_1 + V_2$

Total / overall resistance / combined resistance,

$R = R_1 + R_2 + \ldots$

→ current remains same on all resistors.

→ voltage is different on all resistors.

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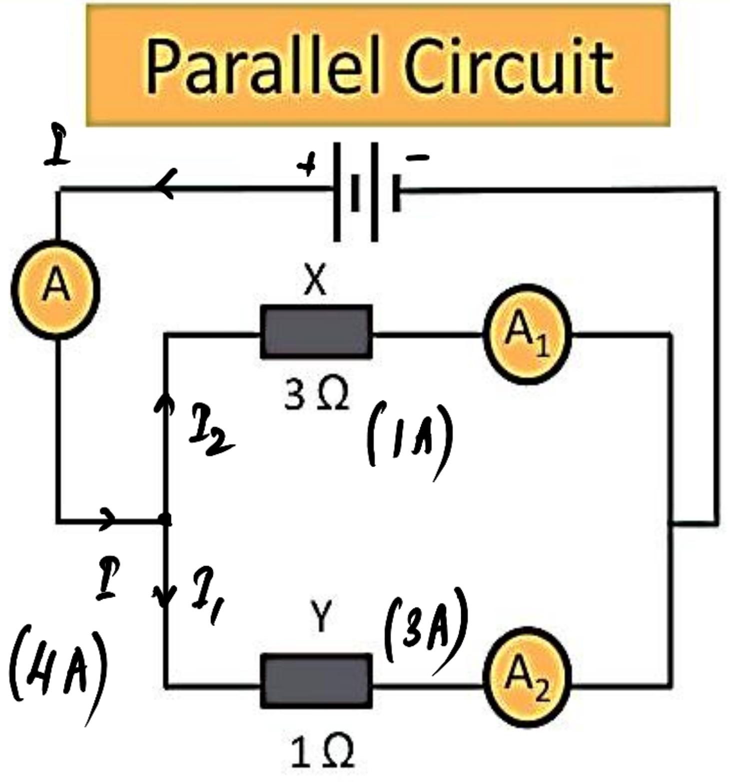
COMBINATION OF RESISTORS



Current splits into different paths

Reading on A = Reading on A1 + A2

Main current is shared between the two resistors

$I = I_1 + I_2$

Overall resistance in parallel,

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots$$

→ voltage remains same on resistors

→ current is different on resistors,

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For 2 resistors, $R = \frac{R_1 R_2}{R_1 + R_2}$

→ n resistors in series, $\Rightarrow$ $R_{equivalent} = nR$
(R Ω each)

→ n resistors in parallel $\Rightarrow$ $R_{equivalent} = \frac{R}{n}$
(R Ω each)

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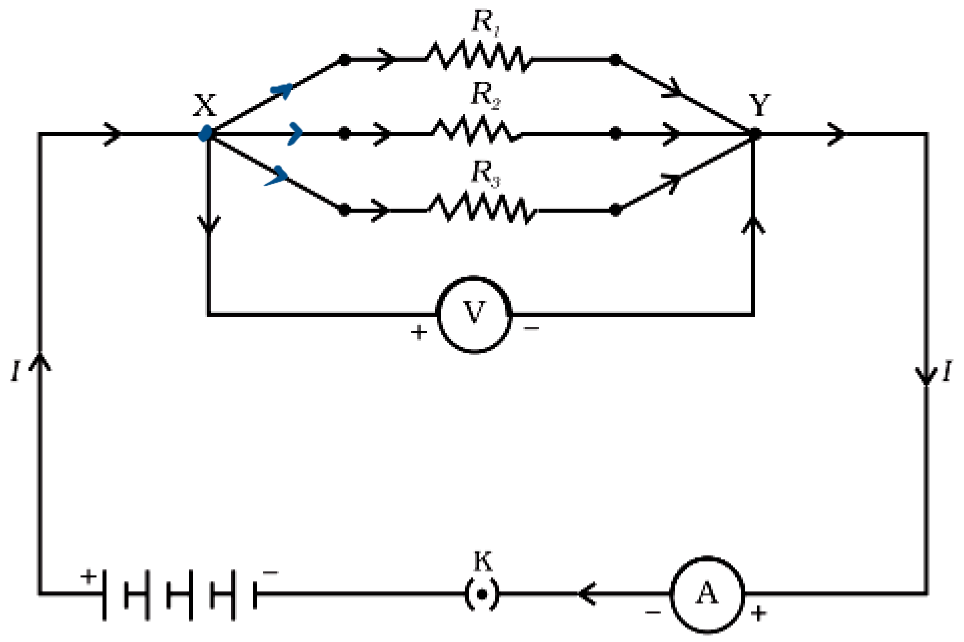
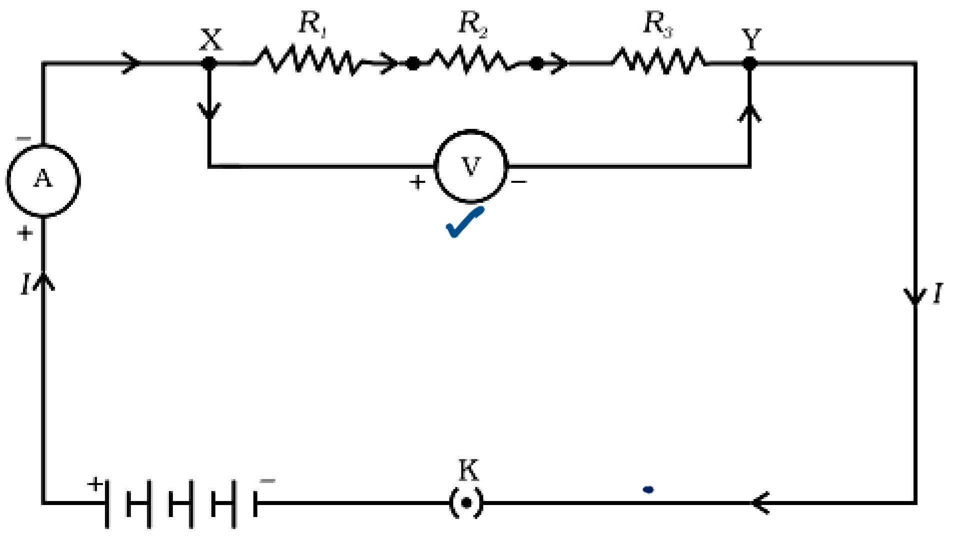
COMBINATION OF RESISTORS



$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$



$$R = R_1 + R_2 + R_3$$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