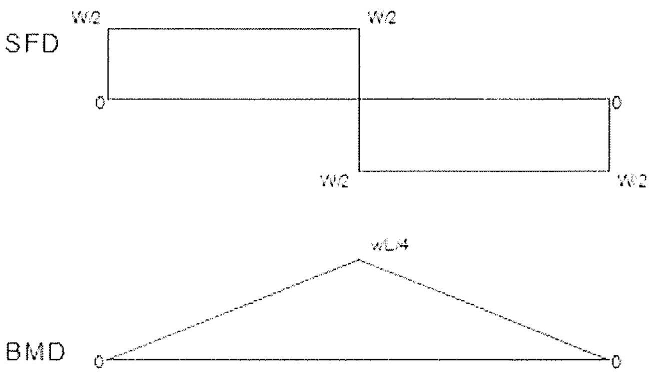
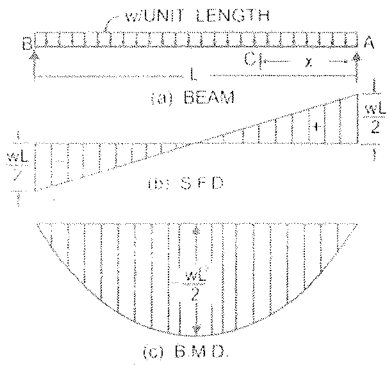
SET A

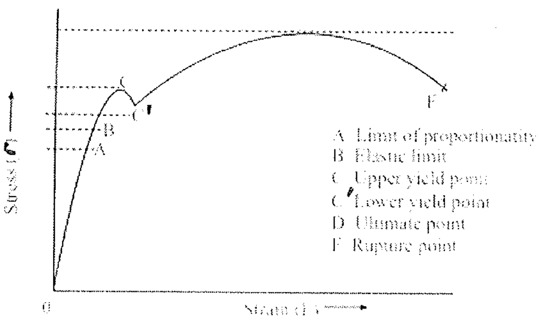
Scoring Indicator

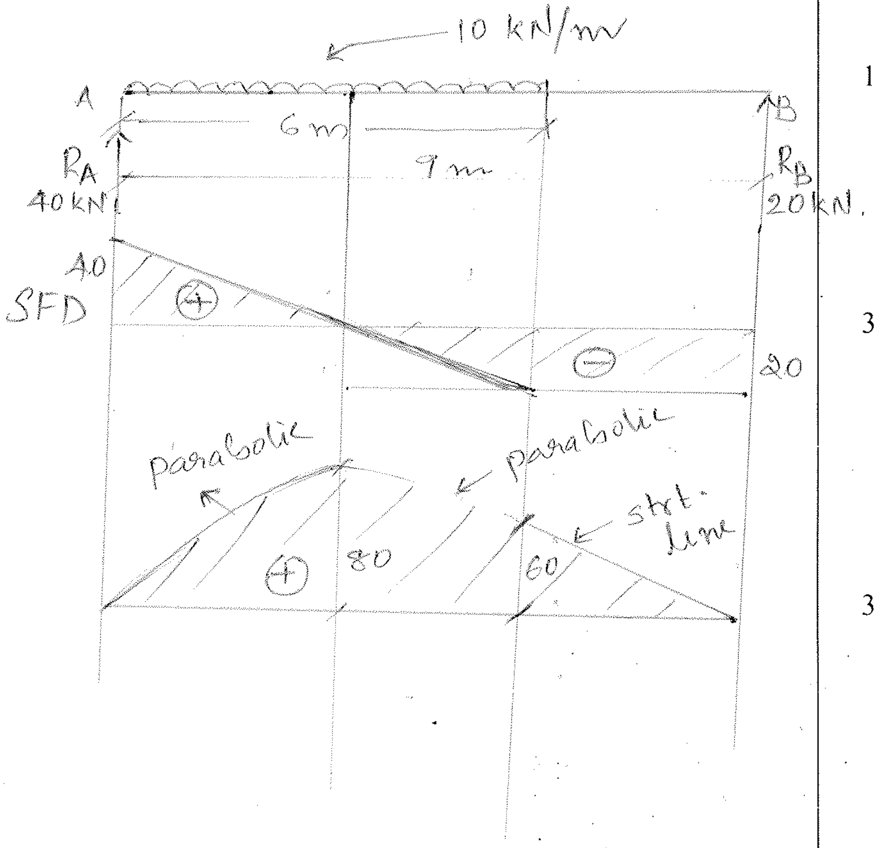
Course Name: **Strength of materials**

Course Code: Rev (21)-3021 QID: 2110220174

Q.No	Scoring Indicator	Split Score	Sub Total	Total Score
	PART - A			9
I.1	Hardness		1	
I.2	$E=2G(1+\mu)$		1	
I.3	/^{o}C		1	
I.4	Shear force ~~diagram~~		1	
I.5	~~[illegible]~~ $F = dM/dx$.		1	
I.6	l/d		1	
I.7	long		1	
I.8	D/d		1	
I.9	two		1	
	PART - B			24
II.1	Malleability: Malleability is the property of metal associated with the ability to be hammered into a thin sheet. Ductility: Ability of material to deform under tensile load.	1.5 1.5	3	
II.2	Factor Safety = Ultimate stress/Working stress Explanation	1.5 1.5	3	
II.3	Statement: Within the elastic limit, stress is directly proportional to strain Equation: (Stress/Strain = E)	1.5 1.5	3	
II.4	Young's Modulus: Tensile or compressive stress/Strain Modulus of rigidity = Shear stress/Shear Strain Bulk Modulus = Direct stress/Volumetric strain	1 1 1	3	

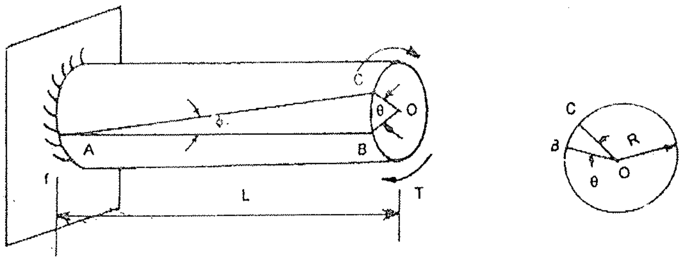
II.5		1.5 1.5	3	
II.6		1.5 1.5	3	
II.7	Definition: The minimum axial load at which the column tends to have lateral displacement is called buckling load. Euler's formula: $\pi^2 EI/l^2$	1.5 1.5	3	
II.8	Definition: Polar moment of inertia of a plane area is basically defined as the area moment of inertia about an axis perpendicular to the plane of figure and passing through the center of gravity of the area. Formula: $\pi(D^4-d^4)/32$	1.5 1.5	3	
II.9	Solid length = nd Free length = solid length + max. compression + clearance Spring stiffness = W/δ	1 1 1	3	

II.10	Hoop stress, $\sigma_h = pd/2t$ $\rightarrow t = pd/2\sigma_h$ $= 2x1000/2x100$ $= 10$ mm	1.5 1.5	3	
	PART - C			42
III.1		Fig. (3) Markings (4)	7	
III.2	1. Stress, $\sigma = P/A = 30x1000/ (\pi/4)x30^2 = 42.44$ N/mm^2. 2. $\sigma/e = E \rightarrow e = \sigma/E = 42.44/2x10^5 = 0.000212$ 3. $\delta l = PL/AE = 30x1000x2000/(\pi/4)x30^2x\ 2x10^5 = 0.0424$ mm	2 2 3	7	

III.3		1 3 3	7	
III.4	Point Load, Uniformly distributed load, Uniformly varying load Figure Explanation	 4 3	7	
III.5	Deflection at free end = $wl^4/8EI = Wl^3/8EI$ $= 15x6x1000x6000^3/8x2x10^5x95x10^7$ $= 12.78$ mm	Formula(3) Finding I(2) Ans (2)	7	
III.6	Both end hinged, One end hinged and other free, one end hinged and other fixed, both ends fixed Figure Explanation	 4 3	7	

III.7	$M = WL/4 = 100x5/4 = 125$ Nm. $I = \pi(D^4 - d^4)/64 = 510508.8062$ $M/I = \sigma/y \rightarrow \sigma = My/I = 125x1000x30/510508.8062$ $= 7.34\ N/mm^2$	2 2 3	7	
III.8	It is the ratio of moment of inertia of a section about the neutral axis to distance of the outermost layer from the neutral axis. $Z = I/y_{max}$ Section modulus for circular section: $\cancel{\pi d^4/32}$ $\frac{\pi d^3}{32}$ Section modulus for hollow section: $\pi(D^4-d^4)32D$	2 2.5 2.5		
III.9	$T_{solid} = \pi\tau d^3/16$ $T_{hollow} = (\pi\tau/16)x(65D^3/81)$; D = outside diameter of hollow shaft. $T_{solid} = T_{hollow} \rightarrow d = 0.929D$ W_{solid} = volume x density x g = $(\rho x\pi d^2 l/4)g$ W_{hollow} = volume x density x g = $((\rho x5\pi D^2 l)/36)g$ $W_{solid}/W_{hollow} = 1.55$	1 1 2 2 1	7	
III.10	$\sigma_h = pd/2t = 1.5 \text{ x } 1000/2x20 = 75\ N/mm^2$ $\sigma_l = pd/4t = 1.5 \text{ x } 1000/4x20 = 37.5\ N/mm^2$	3.5 3.5	7	
III.11				

Consider a circular shaft of radius R and length l rigidly fixed at one end A, and torque T is applied at free end as in Fig. ~~8.2(a)~~



(a) (b)

~~Fig. 8.2~~

As a result of torque line AB on the surface is changed to AC, and radius OB rotates to OC.

$$\text{Shear strain} = \frac{BC}{AB} = \tan\phi$$

Since ϕ is very small, $\tan\phi \approx \phi$

$$\therefore \text{ Shear strain, } \phi = \frac{BC}{l} \qquad \text{.......... (i)}$$

Also from Fig. ~~8.2~~ (b)

$$BC = R.\theta \qquad \text{.......... (ii)}$$

Where θ = Angle of twist, in radians

R = Radius of the shaft

From equations (i) and (ii)

$$R.\theta = \phi.\,l$$

$$\text{or} \qquad \phi = \frac{R.\theta}{l}$$

But from definition,

$$\phi = \frac{\text{shear stress}}{\text{modulus of rigidity}}$$

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

$$\therefore \qquad \frac{\tau}{G} = \frac{R.\theta}{l}$$

$$\text{or} \qquad \tau = \frac{RG.\theta}{l}$$

For a given shaft and for a given torque, the values of G, θ and l are constant; therefore, the shear stress induced is proportional to radius

$$\text{i.e.,} \qquad \frac{\tau}{R} = \text{constant}$$

Thus, if the 'q' is the shear stress induced at a radius, r from the centre,

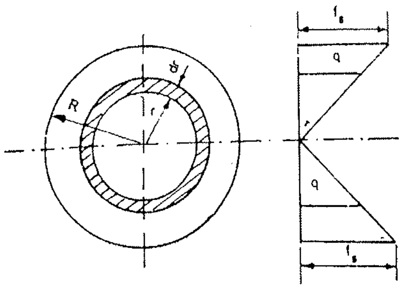
$$\frac{q}{r} = \frac{\tau}{R} = \text{constant}$$

$$\text{or} \qquad \frac{q}{r} = \frac{\tau}{R} = \frac{G\,\theta}{l} \qquad \text{.........} \; (1)$$

Torque Transmitted by Shaft : Consider a small ring of area dA at a distance 'r'. The shear stress acting on the ring

$$q = \frac{\tau}{R} \cdot r$$

Force on the ring, $dF = q.\,dA = \frac{\tau}{R} \cdot r\,dA$



Torque due to dF, $dT = \frac{\tau}{R} r \cdot dA\, r$

$$= \tau/_R \cdot r^2 dA$$

$\therefore$ Total torque, $T = \frac{\tau}{R} \int r^2 dA$

$$\rightarrow T = \frac{\tau}{R} J$$

$$\rightarrow \frac{T}{J} = \tau/_R \qquad -(2)$$

from (1) & (2) $\quad \frac{T}{J} = \tau/_R = \frac{G\theta}{l}$

III.42	Helical spring (Explanation + fig.)	3.5	7	
	Laminated spring (Explanation + fig.)	3.5		