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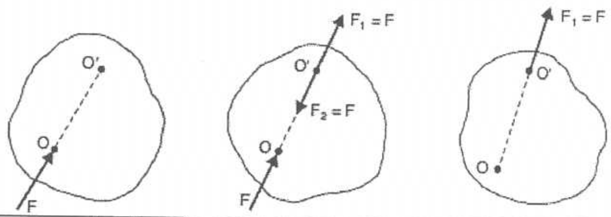
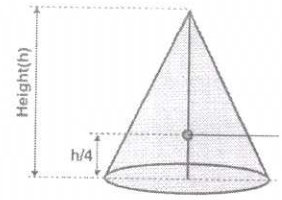
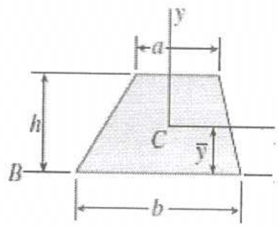
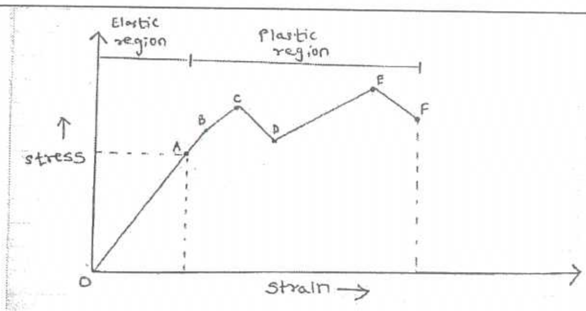
ScoringIndicators

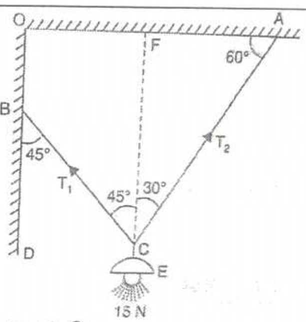
COURSENAME: ENGINEERING MECHANICS

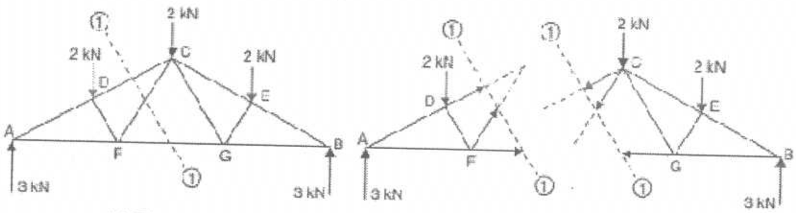
COURSECODE:2021 QID:2106220127

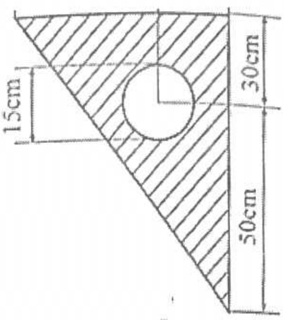
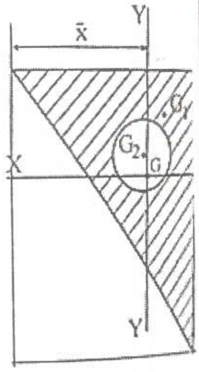
QNo	ScoringIndicators	Split score	Sub Total	Totalscore
	PARTA			9
I.1	Vector quantity	1	1	
I.2	Resultant force	1	1	
I.3	$\Sigma H=0, \Sigma V=0, \Sigma M=0$	1	1	
I.4	Method of sections	1	1	
I.5	Centroid	1	1	
I.6	$4r/3\pi$	1	1	
I.7	Rigid body	1	1	
I.8	Lateral strain	1	1	
I.9	Hooke's law states that the strain of the material is proportional to the applied stress within the elastic limit of that material	1	1	
	PARTB			24
II.1	It states that if a force, acting at a point on a rigid body, is shifted to any other point which is on the line of action of the force, the external effect of the force on the body remains unchanged.  	2 1	3	
II.2	Resultant $R=\sqrt{(P^2+P^2+2xPxPxcos60)}$ $30\sqrt{3} = \sqrt{(3P^2)}$ $P = 30$ N	2 1	3	
II.3	As the body is in equilibrium $\Sigma H=0$ $F_1\cos 50-F_2\cos 50=0$ $F_1 = F_2$ $\Sigma V=0$ $F_1\sin 50+F_2\sin 50 -500 =0$ $F_1 = F_2= 326.35$ N	1 1 1	3	
II.4	Following assumptions are made in finding out the forces in a frame. (a) Frame is a perfect frame.	1	3	

	(b) Load is applied at joints only. (c) All members are hinged or pin-jointed. (It means members will have only axial force and there will be no moment due to pin, because at a pin moment becomes zero.)	1 1		
II.5	Normal reaction R =W= 500 N Horizontal force required to slide the body over the plane, F= μR = 150 N	1 1 1	3	
II.6	  $\bar{y} = \frac{h(2a + b)}{3(a + b)}$	1·5 each	3	
II.7	It states that if I_{XX} and I_{YY} be the moment of inertia of a plane section about two mutually perpendicular axis X-X and Y-Y in the plane of the section, then the moment of inertia of the section I_{ZZ} about the axis Z-Z perpendicular to the plane and passing through the intersection of X-X and Y-Y is given by $I_{ZZ} = I_{XX} + I_{YY}$	3	3	
II.8	 Elastic limit: Up to this limit (point B), is material will regain its original shape is unloaded. Point B is known as elastic point. Ultimate stress: This is the maximum stress a material can bear. Value of stress corresponds to peak point on stress strain curve for mild steel is the ultimate stress. It is denoted by point E in diagram	1 1 1	3	
II.9	Bulk modulus is defined as the proportion of volumetric stress related to the volumetric strain for any material. $K = \frac{\text{Direct stress}}{\text{Volumetric strain}} = \frac{\sigma}{\left(\frac{dV}{V}\right)}$ The relation between Young's modulus and bulk modulus is $E = 3K(1 - 2\mu)$.	1 1 1	3	

II.10	Longitudinal strain = 0.0025 Lateral strain = 0.00075 Poisson's ratio = 0.3	1 1 1	3	
	PARTC			42
III.1	*(i) Consider force $F_1 = 104\,N$.* Horizontal and vertical components are Horizontal component, $Fx_1 = F_1 \cos 10° = 104 \times 0.9848$ $= 102.42$ N Vertical component, $Fy_1 = F_1 \sin 10° = 104 \times 0.1736$ $= 18.06$ N. *(ii) Consider force $F_2 = 156\,N$.* Horizontal and vertical components are Angle made by F_2 with horizontal axis $OX' = 90 - 24 = 66°$ ∴ Horizontal components, $Fx_2 = F_2 \cos 66° = 156 \times 0.4067$ $= 63.44$ N. $Fy_2 = F_2 \sin 66° = 156 \times 0.9135$ $= 142.50$ N. *(iii) Consider force $F_3 = 252\,N$.* Horizontal and vertical components are Horizontal component, $Fx_3 = F_3 \cos 3° = 252 \times 0.9986$ $= 251.64$ N. (–ve) Vertical component, $Fy_3 = F_3 \sin 3° = 252 \times 0.0523$ $= 13.18$ N. (–ve) *(iv) Consider force $F_4 = 228\,N$.* Horizontal and vertical components are Angle made by F_4 with horizontal axis $OX' = 90 - 9 = 81°$. ∴ Horizontal component, $Fx_4 = F_4 \cos 81° = 228 \times 0.1564$ $= 35.66$ N (–ve) Vertical component, $Fy_4 = F_4 \sin 81° = 228 \times 0.9877$ $= 225.2$ N. (–ve) Now algebraic sum of horizontal components is given by, $\Sigma H = Fx_1 - Fx_2 - Fx_3 - Fx_4$ $= 102.4 - 63.44 - 251.64 - 35.66$ $= -248.32$ N. Similarly, the algebraic sum of vertical components is given by, $\Sigma V = 18.06 = 142.50 + 13.18 - 225.2$ $= -77.82$ N. ∴ $R = \sqrt{(\Sigma H)^2 + (\Sigma V)^2}$ $= \sqrt{(248.32)^2 + (77.82)^2} = 260.2$ N. Ans.	1 1 1 1 2	7	7

	The direction of resultant is given by $\therefore \quad \tan\theta = \frac{\Sigma V}{\Sigma H} = \frac{77.82}{248.32} = 0.3134$ $\therefore \quad \theta = \tan^{-1} 0.3134 = 17.4°$. **Ans.**	1		
III.2	 Using Lami's theorem at C $\frac{15}{\text{sin of } \angle BCA} = \frac{T_1}{\text{sin of } \angle ACE} = \frac{T_2}{\text{sin of } \angle ACE}$ But $\angle BCA = 45° + 30° = 75°$ $\angle ACE = 180° - 30° = 150°$ $\angle BCE = 180° - 45° = 135°$ $\therefore \quad \frac{15}{\sin 75°} = \frac{T_1}{\sin 150°} = \frac{T_2}{\sin 135°}$ $\therefore \quad T_1 = \frac{15 \times \sin 150°}{\sin 75°}$ = **7.76 N. Ans.** and $T_2 = \frac{15 \times \sin 135°}{\sin 75°}$ = **10.98 N. Ans.** (OR May be solved by applying equilibrium condition at C)	2 2 1 1 1	7	7
III.3	Reactions : $R_B = 4.5kN$, $R_C = 1.5kN$ Member forces: F_{AB}= 5.196kN (compressive) F_{BC}= 2.598kN (tensile) F_{AC} = 3kN (compressive)	1 2 2 2	7	7
III.4	Force F= μR will be acting towards right Resolving forces along the plane $\mu R = 80 \cos 20$ ----------------------(1) Resolving forces normal to the plane R -100 – 80 sin 20 =0 R= 127.36 kN Substitute in eqn (1) Coefficient of friction = 0.59	2 2 1 2	7	7
III.5	Applying equilibrium conditions: $\Sigma V = 0$ $R_A + R_B$ = 50+40 +(10 x 4) $R_A + R_B$ = 130--------------(1) ΣM_A=0 (50 x 2) + (40x 6) + (10 x 4 x4) +10 – (R_B x 10) = 0 R_B= 51kN Substitute in eqn(1) R_A = 79kN	1 2 2 2	7	7

III.6	When the forces in a few members of a truss are to be determined, then the method of section is mostly used. This method is very quick as it does not involve the solution of other joints of the truss. In this method, a section line is passed through the members, in which forces are to be determined as shown in [redacted]. The section line should be drawn in such a way that it does not cut more than three members in which the forces are unknown. The part of the truss, on any one side of the section line, is treated as a free body in equilibrium under the action of external forces on that part and forces in the members cut by the section line. The unknown forces in the members are then determined by using equations of equilibrium as $\Sigma F_x = 0,\ \Sigma F_y = 0$ and $\Sigma M = 0$.  (a) Given truss (b) Left part (c) Right part [redacted] If the magnitude of the forces, in the members cut by a section line, is positive then the assumed direction is correct. If magnitude of a force is negative, then reverse the direction of that force.		7	7
III.7	$a_1 = 10 \times 30 = 300\ mm^2,\ x_1 = 5$ mm, $y_1 = 15$ $a_2 = 40 \times 10 = 400\ mm^2,\ x_2 = 10 + 20 = 30$ mm, $y_2 = 5$ mm $a_3 = 10 \times 20 = 200\ mm^2,\ x_3 = 5$ mm, $y_3 = -10$ mm $a_4 = 10 \times 10 = 100\ mm^2,\ x_4 = 45$ mm, $y_4 = 10 + 5 = 15$ mm	3	7	7
	$\bar{x} = \frac{a_1x_1 + a_2x_2 + a_3x_3 + a_4x_4}{(a_1 + a_2 + a_3 + a_4)} = \frac{1500 + 12000 + 1000 + 4500}{1000}$ $= 1.5 + 12 + 1 + 4.5 = 19$ mm. **Ans.**	2		
	$\bar{y} = \frac{a_1y_1 + a_2y_2 + a_3y_3 + a_4y_4}{(a_1 + a_2 + a_3 + a_4)} = \frac{4500 + 2000 - 2000 + 1500}{1000}$ $= 4.5 + 2 - 2 + 1.5 = 6$ mm. **Ans.**]	2		
III.8	$a_1 = 2500mm^2$ $y_1 = 10mm,\ x_1 = 62.5mm$ $a_2 = 4600\ mm^2$		7	7
	$y_2 = 135$ mm, $x_2 = 10$ mm	1		
	$\bar{y} = \frac{a_1y_1 + a_2y_2}{a_1 + a2}$ $= 91$ mm	1		
	$\bar{x} = \frac{a_1x_1 + a_2x_2}{a_1 + a2}$ $= 28.49$ mm	1		
	$I_{GXX} = (IG_{1XX} + a_1h_1^2) + (IG_{2xx} + a_2h_2^2)$ $= 45.66 \times 10^6\ mm^4$	2		
	$I_{GYY} = (IG_{1YY} + a_1h_1^2) + IG_{2YY} + a_2h_2^2)$ $= 78.72 \times 10^5\ mm^4$	2		
III.9	The figure is symmetrical about X axis. Hence centroid lies on X axis		7	7
	$\therefore\ \ \bar{y} = 0$. The value of $\bar{x}$ is given by $\bar{x} = \frac{a_1x_1 + a_2x_2}{a_1 - a_2}$	2		
	But $a_1 = \frac{\pi}{4} \times 100^2 = 7853.98\ mm^2,\ x_1 = \frac{100}{2} = 50$ mm	1		

	$a_2 = -\left(\frac{\pi}{4} \times 50^2\right) = -1963.5\ \text{mm}^2, x_2 = 100 - 25 = 75$ mı $\therefore \quad \bar{x} = \frac{7853.98 \times 50 - 1963.5 \times 75}{7853.98 - 1963.5} = 41.67$ mm Hence centroid is at (41.67 mm, 0). **Ans.]**	1 3		
III.10	 $a_1 = \frac{1}{2} \times 60 \times 80 = 2400\ \text{cm}^2$ $a_2 = \pi r^2 = 176.715\ \text{cm}^2$ $x_1 = \frac{2}{3} \times 60 = 40$ cm $x_2 = 30$ cm $y_1 = \frac{2}{3} \times 80 = 53.333$ cm $y_2 = 50$ cm $\bar{x} = \frac{a_1 x_1 - a_2 x_2}{a_1 - a_2}$  $= \frac{2400 \times 40 - 176.715 \times 30}{2400 - 176.715} = 40.795$ cm $\bar{y} = \frac{a_1 y_1 - a_2 y_2}{a_1 - a_2}$ $= \frac{2400 \times 53.33 - 176.715 \times 50}{2400 - 176.715}$ $\bar{y} = 53.598$ cm $I_{G_{XX}} = (I_{G_{1XX}} + A_1 h_1^2) - (I_{G_{2XX}} + A_2 h_2^2)$ $= (\frac{60 \times 80^3}{36} + \frac{1}{2} \times 60 \times 80 \times (0.265)^2) - (\frac{\pi \times 15^4}{64} + \pi \times \left[\frac{15}{2}\right]^2 \times (3.598)^2)$ $= (853333.333 + 168.54) - (2485.049 + 2287.677)$ $= 853304.5\ \text{cm}^4$ $I_{G_{YY}} = (I_{G_{1YY}} + A_1 h_1^2) - (I_{G_{2YY}} + A_2 h_2^2)$ $= 458438.85\ \text{cm}^4$	1 1 1 2 2	7	7

III.11	$\therefore$ Area of rod, $A = \frac{\pi}{4}(25)^2 = 490.87 \text{ mm}^2$ Tensile load, $P = 50 \text{ kN} = 50 \times 1000 = 50{,}000 \text{ N}$ Extension of rod, $dL = 0.3 \text{ mm}$ Length of rod, $L = 250 \text{ mm}$ Stress (σ) is given by $\sigma = \frac{P}{A} = \frac{50{,}000}{490.87} = 101.86 \text{ N/mm}^2.$ Strain (e) is given by . $e = \frac{dL}{L} = \frac{0.3}{250} = 0.0012.$ the Young's Modulus (E) is obtained, as $E = \frac{\text{Stress}}{\text{Strain}} = \frac{101.86 \text{ N/mm}^2}{0.0012} = 84883.33 \text{ N/mm}^2$ $= \mathbf{84883.33 \times 10^6 \text{ N/m}^2}$. **Ans.**	2 2 3	7	7
III.12	Length, $L = 30$ cm ; Breadth, $b = 4$ cm ; and Depth, $d = 4$ cm. $\therefore$ Area of cross-section, $A = b \times d = 4 \times 4$ $= 16 \text{ cm}^2 = 16 \times 100 = 1600 \text{ mm}^2$ Axial compressive load, $P = 400 \text{ kN} = 400 \times 1000 \text{ N}$ Decrease in length, $\delta L = 0.075 \text{ cm}$ Increase in breadth, $\delta b = 0.003 \text{ cm}$ Longitudinal strain $= \frac{\delta L}{L} = \frac{0.075}{30} = 0.0025$ Lateral strain $= \frac{\delta b}{b} = \frac{0.003}{4} = 0.00075.$ Using equation (13.3), Poisson's ratio $= \frac{\text{Lateral strain}}{\text{Longitudinal strain}} = \frac{0.00075}{0.0025} = 0.3.$ Longitudinal strain $= \frac{\text{Stress}}{E} = \frac{P}{A \times E}$ $0.0025 = \frac{400000}{1600 \times E}$ $E = \frac{400000}{1600 \times 0.0025} = \mathbf{1 \times 10^5 \text{ N/mm}^2}.$	1 1 3 2	7	7