Scoring Indicators

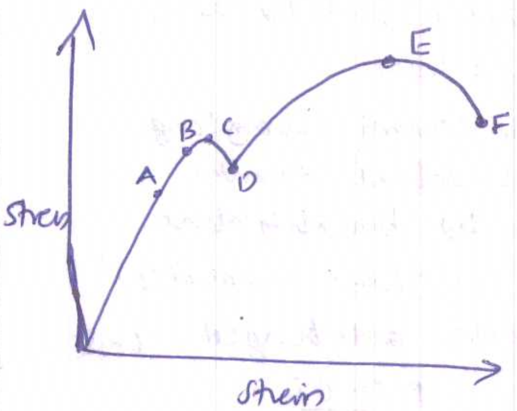
Code: TED (15) 4021

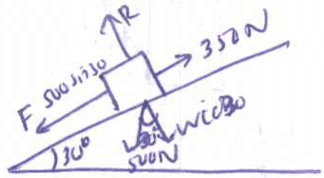
APPLIED MECHANICS AND STRENGTH OF MATERIALS

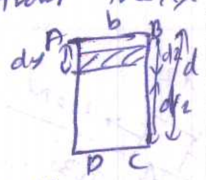
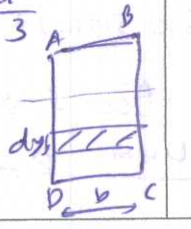
Q No.	Scoring Indicators	Split Score	Total Score
	PART A		
I.1	Hooks law states that when a material is loaded within its elastic limits the stress is directly proportional to the strain		2
I.2	$\mu = \frac{\text{Lateral strain}}{\text{Longitudinal strain}}$		2
I.3	The point at which the total area of the plane figure is assumed to be concentrated.		2
I.4	It is defined as the ratio between the strength of a riveted joint to strength of an unriveted joint or a solid plate.		2
I.5	(a) simply supported beam (d) fixed beam (b) cantilever beam (c) overhanging beam (e) continuous beam	Any 4	2
	PART B		
II.1	Given Load $P = 5KN = 5000N$ $\sigma = 100MPa = 100\times10^6$ $\sigma = \frac{P}{A}$ $A = \frac{P}{\sigma} = \frac{5000}{100\times10^6} = 5\times10^5$ $\Rightarrow \frac{\pi}{4}d^2 =$ $d = 7.9\times10^{-3}m$ $d = 0.0079m$		6
II.2	Given Data $P = 150\times10^3 N$ $L = 350mm$ $d = 25mm$ $A = \frac{\pi}{4}d^2 = \frac{\pi}{4}25^2$ $A = 490mm^2$ $\Delta l = \frac{PL}{AE} =$ $= \frac{150\times10^3\times350}{\frac{\pi}{4}\times25^2\times2\times10^5}$ $= 0.534mm$		6

II.3	(1) The force of friction always acts in a direction opposite to that in which body tends to move, if the force of friction would have been absent (ii) Till the limiting value is reached, the magnitude of friction is exactly = Force which tends to move the body (iii) The magnitude of the limiting friction bears a constant ratio to the normal reaction between the two surface of contact and this ratio is called coeff. of friction. (iv) The force of friction depends upon the roughness/smoothness of the surfaces. (v) The force of friction is independent of the area of contact between the two surfaces.		6
II.4	hoop stress (σh) The stress acting along the circumference of the cylinder is called circumferential or hoop stress longitudinal stress (σl) The stress acting along the length of the cylinder σh = hoop stress = $\frac{Pd}{2t}$ σl = longitudinal stress = $\frac{Pd}{4t}$		6

II.5	P=20KW, N=2000rpm. $P=\frac{2\pi NT}{60}$ $T=\frac{P\times60}{2\pi N}=\frac{20\times10^3\times60}{2\times\pi\times200}=$ $=954.9\ Nm$		6
II.6	Euler's theory of column Assumptions 1) The column is initially perfectly straight and the load is applied axially. 2) The cross section of the column is uniform throughout its length. 3) The column material is perfectly elastic, homogeneous and isotropic 4) The length of the column is very long as compared to its lateral dimensions 5) column will fail by buckling alone. 6) self weight of column is negligible.		6
II.7	(a) columns with both ends hinged $L=l$ $P=\frac{\pi^2 EI}{L^2}$ (b) column with one end fixed and other end free $P=\frac{\pi^2EI}{4l^2}$ $L=2l$ (c) column with both ends fixed $P=\frac{4\pi^2EI}{l^2}$ $L=l/2$ (d) column with one fixed & other end hinged $P=\frac{2\pi^2EI}{l^2}$		6 $L=l/\sqrt{2}$

III. a	$d = 25mm$, $L = 1000mm$ $\mu = \frac{\varepsilon_c}{\varepsilon} = 0.25 = \left(\frac{1}{4}\right)$ $E = 2\times10^5 N/mm^2$ $V = A\times l = \frac{\pi}{4}25^2\times1000$ $= 7853981.6 \ mm^3$ $G = \frac{E}{2(1+\mu)} = \frac{2\times10^5}{2(1+0.25)} = 0.8\times10^5 N/mm^2$ $K = \frac{E}{3(1-2\mu)} = \frac{2\times10^5}{3(1-2\times0.25)} = 1.33\times10^5 N/mm^2$ $K = \frac{\sigma}{\varepsilon_V} \Rightarrow \varepsilon_V = \frac{\sigma}{K} = \frac{100}{1.33\times10^5} = 7.5\times10^{-4}$ $\delta V = V\times\varepsilon_V =$ $= \underline{\underline{5890}} \ mm^3$		9
III. b	Stress - Strain Dia of Mild Steel  A→ Proportionality limit D→ lower yeild point B→ Elastic limit E→ Ultimate point C→ Upper yeild point F→ Breaking point.		6
IV. a	$l = 200mm$, $A_s = 20\times8 = 160mm^2$, $A_a = 20\times6\times2 = 240mm^2$ $t = 50°C$ $E_s = 200GPa = 200\times10^3 N/mm^2$ $E_a = 80GPa = 80\times10^3 N/mm^2$ $\alpha_s = 12\times10^{-6}$ per °C $\alpha_A = 24\times10^{-6}$ per °C $\sigma_s\times A_s = \sigma_A\times A_a \Rightarrow \sigma_s = 1.5\sigma_a$		

	$\frac{\sigma_S}{E_S}+\frac{\sigma_G}{E_G}=t(\alpha_G-\alpha_S) \Rightarrow \sigma_G = 30\,N/mm^2$ $\sigma_S = 1.5\times 30 = 45\,N/mm^2$		9
IV. b	1) Yangs Modulus $E = \frac{\text{Linear stress}}{\text{Linear strain}}$, N/mm^2 2) Modulus of Rigidity $G = \frac{\text{Shear stress}}{\text{Shear strain}}$. N/mm^2 3) Bulk modulus $K = \frac{\text{Pressure in mutually for direction}}{\text{Volumetric strain}}$		6
V. a	 $W=500N$ $P=350N$ $\theta=30°$ x direction $500\sin30+F=350$ $500\sin30+\mu R=350$ — (1) y direction $R=433N$ sub in (1) weight $\mu = 023$		9

V. b	<u>Parallel</u> If the MI of a plane area about an axis in the plane of area thrgh the CG of the plane area be represented by I_G then the MI of the given plane area about a parallel axis AB in the plane of area at a distance h from the CG of the area is given by $I_{AB} = I_G + Ah^2$ <u>Perpendicular</u> If I_{xx} & I_{yy} be the MI of the plane section about two ⊥r axis XX & YY, then the MI about ZZ is I_{ZZ} ⊥r to the plane is given by (passing thrgh the intersection of XX & YY) $I_{ZZ} = I_{xx} + I_{yy}$		6
VI. a	<u>passing thrgh CG</u> width = b depth = d Consider a rectangular element strip of thickness dy at a distance y from the XX axis  Area = $dA = b \times dy$ MI = by^2dy $I_{xx} = \int_{-d/2}^{d/2} by^2dy = \frac{bd^3}{12}$ $I_{yy} = \frac{bd^3}{12}$ <u>Base</u> $I_{cd} = \int_0^d by^2dy = b\int_0^d y^2dy = \frac{bd^3}{3}$  $I_{AD} = \frac{db^3}{3}$		9

VI. b	(i) Sliding friction The opposite force that comes into play when one body is actually sliding over the surface of the other body. (ii) Rolling friction When objects such as a wheel, sphere or cylinder rolls over a surface, the force of friction that comes into play is called rolling friction iii) Pivot friction Due to axial thrust, which is conveyed to the bearing by the rotating shaft, rubbing takes place between the contacting surface. This is called pivot bearing.		6
VII. a	$n=2,\ t=20^{mm},\ d=25\ mm,\ p=100mm$ $\sigma_s=80N/mm^2\quad \sigma_b=160N/mm^2\quad \sigma_t=100N/mm^2$ $P_s=2\times\frac{\pi}{4}d^2\times\sigma_s\times n=157079.63N$ $P_b=\sigma_b\times t\times d\times n=160000N$ $P_t=\sigma_t(p-d)t=150000N$ $\therefore$ strength $=$ Least of $P_s, P_b, P_t = 150000N$ Unriveted $=\sigma_t\times p\times t=P=20{,}0000N$ $\eta=\dfrac{\text{Least of } P_s P_b P_t}{\sigma_t p t}=\dfrac{150000}{200000}=\underline{75\%}$		9
VII b	1) Permanent joint 2) 100% strength. 3) Leak proof 4) No change in cross-sectional area 5) High load carrying capacity 6) Various shapes can be joined 7) Dissimilar joining is also possible		6

VIII. a	$P = \frac{2\pi N T}{60} \Rightarrow T = \frac{60 \times 150 \times 10^3}{2 \times \pi \times 180}$ $T = 7957.7\ Nm$ $T = \frac{\pi}{16} \tau d^3$ $\tau = \frac{16 \times T}{\pi d^3} = \frac{16 \times 79577}{\pi \times 160^3} = 9.89\ N/mm^2$ or $\tau = 9.89\ MPa$ ~~$\tau = 25 \times 10^5\ N/m^2 = 0.2\ MPa$~~		9
VIII. b	$d = 500mm$ $p = 2\ N/mm^2$ $\sigma_h = 100\ N/mm^2$ $t = \frac{pd}{2\sigma_h} = \frac{2 \times 500}{2 \times 100} = 5mm$		6
IX. a	$d = 12mm,\ n = 10,\ D = 120mm,\ W = 200N,\ G = 8 \times 10^4\ N/mm^2$ (a) $\delta = \frac{64 W R^3 n}{C d^4} = \frac{64 \times 200 \times 60^3 \times 10}{8 \times 10^4 \times 12^4} =$ $= 16.66\ mm$ (b) $\tau = \frac{16 W R}{\pi d^3} = \frac{16 \times 200 \times 10}{\pi \times 12^3} = 5.89\ N/mm^2$ (c) $S = \frac{W}{\delta} = \frac{200}{16.66} = 12\ N/mm$		9

IX. b	(i) Short column Slenderness ratio less than 32 or length to diameter ratio less than 8, length to diameter ratio 8 to 10. (ii) Medium column Slenderness ratio lies between 32 & 120 or length to diameter ratio more than 30. (iii) Long column Slenderness ratio more than 120 or length to diameter ratio more than 30		6
X. a	$l = 6m = 6\times10^3 mm$ $\quad L = l = 60\times10^3 mm$ $d = 40mm$ $t = 5mm$ $D = d+2t = 40+2\times5 = 50mm$ $E = 2\times10^5 N/mm^2$ $I = \frac{\pi}{4}(D^4-d^4) = \frac{\pi}{64}(50^4-40^4)$ $= 18.11\times10^4 mm^4$ $P = \frac{\pi^2 EI}{L^2} = \frac{\pi^2\times2\times10^5\times18.11\times10^4}{(6\times10^3)^2}$ $= 9930N$ Safe load $= \frac{\text{crippling load}}{FS} = \frac{9930}{3} = 3310N$		9

Xb	open coiled * The wire are coiled such that there is a gap between the two consecutive turns	closed coil spring * The wire are very closely coiled such that there is no gap b/w the two cons turns		6
	* Helix angle is greater than 10°	* Helix angle less than 10°		
	* Both torsional & bending stress are significant	* only torsional stress are predominant.		