SCHEME OF VALUATION

(15) 4021

REVISION-15

APPLIED MECHANICS AND STRENGTH OF MATERIALS

COURSECODE 4021

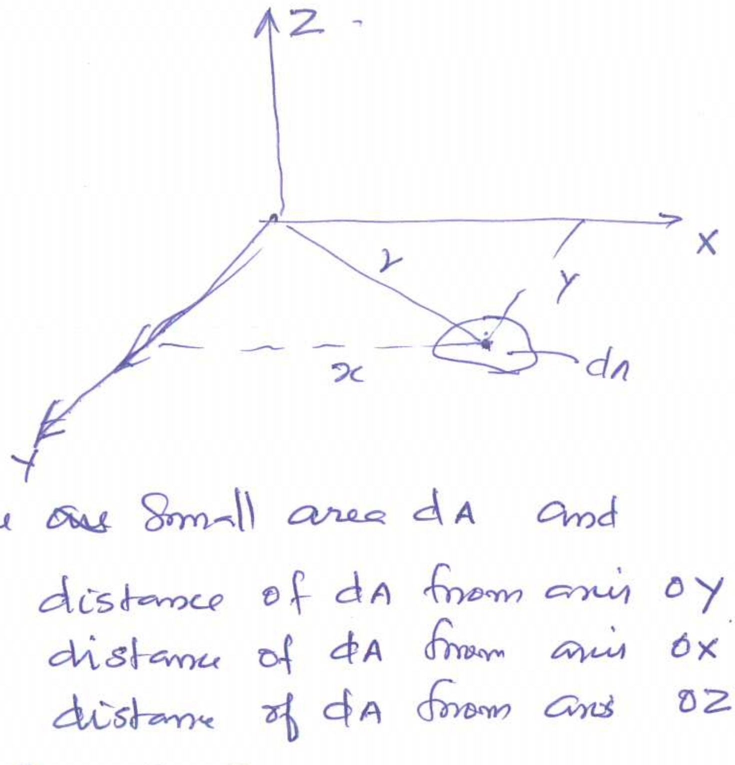
Q No.	SCORING INDICATORS	SPLIT UP SCORE	SUB TOTAL	TOTAL
	PART-A			
I (1)	Bulk modulus is defined as the ratio of direct stress to volumetric strain.	1x2		2
(2)	A bar made up of two or more bars of equal length but of different material rigidly fixed each other and behaving as one unit for extension or compression when subjected to axial tensile or compressive load is called composite bar.	1x2		2
3	Kinetic friction occurs when two objects are moving relative to each other. OR It is the friction experienced by a body, when it is in motion	1x2		2
4.	The maximum force, which a rivetted joint can withstand without failure is known as the strength of the joint	1x2		2
5	In an over hanging beam, the point at which the bending moment is zero after changing its sign from positive to negative or vice-versa.	1x2		2
	PART-B			
II (1)	Given $l = 2m = 2\times10^3 mm$. $A = 150 mm^2$ $P = 15 kN = 15\times10^3 N$. $\delta l = ?$, $E = 200 GPa = 200\times10^3 MPa$.	1		
	$\delta l = \frac{Pl}{A \cdot E}$, $\frac{15\times10^3 \times 2\times10^3}{150\times200\times10^3}$	formula 2 Ans - 3	1+2 +3	6.
	$\delta l = 1mm$.			

2. The maximum value of frictional force which comes in to play when a body just begins to slide over the surface of the other body is known as limiting friction. 3

The ratio of the limiting friction to the normal reaction between the two bodies, and is generally denoted by μ $\quad \mu = \frac{F}{R}$. 3 | 3+3 | 6.

3. The theorem states that if I_{xx} and I_{yy} be the moment of Inertia of a plane section about two mutually perpendicular axis XX and YY in the plane of section, then the moment of Inertia of the section I_{zz} about ZZ is given by $I_{zz} = I_{xx} + I_{yy}$. 3

Proof



Let the ~~one~~ small area dA and

x – distance of dA from axis OY.
y – distance of dA from axis OX
r – distance of dA from axis OZ

Then $r^2 = x^2 + y^2$

MI of dA from OY – $dA \times y^2$

MI of dA from OX – $dA \times x^2$

Moment of Inertia of total area about xx axis

$$I_{xx} = \Sigma dA\, y^2$$

MI of total area about YY axis

$I_{YY} = \Sigma dA\, x^2$

MI of total area about ZZ axis

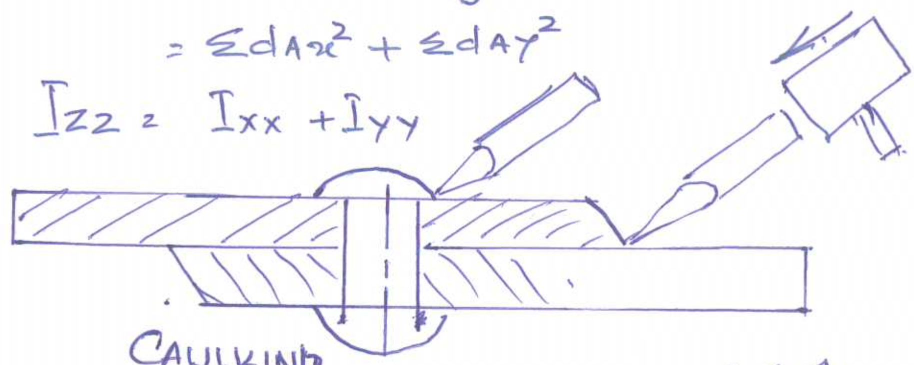
$I_{ZZ} = \Sigma dA\, r^2$

$= \Sigma dA (x^2 + y^2)$

$= \Sigma dA x^2 + \Sigma dA y^2$

$I_{ZZ} = I_{XX} + I_{YY}$ 3 | 3+3 | 6.

4.



CAULKING

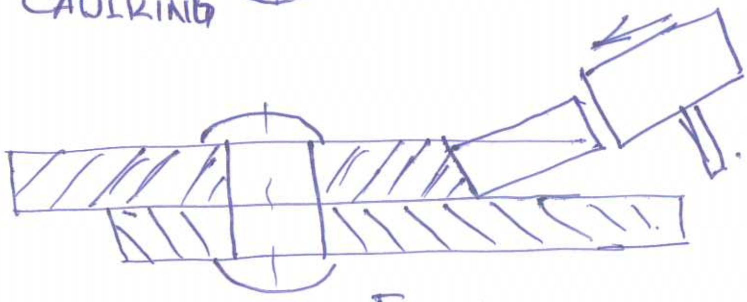


fig. 3

FULLERING.

To make the joints leak proof in pressure vessels a process is known as Caulking. For this a caulking tool is used

Exp. 3 | 3+3 | 6.

For fullering a fullering tool is used to get a clean finish.

5\. The stresses acting along the circumference of the cylinder is called circumferential or hoop stress 2

$\sigma_h = Pd/2t$ 1 | 2+1 +2+1 | 6.

The stresses acting along the length of the cylinder ie in longitudinal direction is called longitudinal stress 2

$\sigma_l = Pd/4t$ 1

b.	Springs are generally classified into ~~1. laminated spring~~ 1. leaf spring and Helical spring	2.		
	Helical springs are classified into two 1. Open Coil helical spring:- This ~~has~~ spring takes Compressive load and there is a large gap between the two Consecutive turns	2.	2+ 2+ 2	6.
	2. Closed Coil helical spring:- In this the wire is turned so closely that each turn is nearly right angle to the axis of the spring. This will take tensile load	2		
7.	If the member of the structure is vertical and both of its ends are fixed rigidly. While subjected to axial Compressive load the member is known as ~~the~~ Column.	3		
	If the member of the structure is not vertical and ~~or~~ one or both of its ends are hinged the bar is known as Strut	3	3+ 3	6.

PART C

UNIT - I

III (a)	When ever a body undergoes ~~an~~ axial or Compressive load, there is an axial deformation in the length of the body. The ratio of axial deformation (δl) to the original length is known as longitudinal strain	3	3+ 3	6
	When a body undergoes an axial load its length increases but its breadth and thickness decreases. The ratio of Changes in breadth or thickness or its breadth and thickness is known as lateral Strain	3		

III (b) Given $A_c = 2A_s$

$t_1 = 15°c$ $t_2 = 315°c$

$\therefore t = 315° - 15°c = 300°c$.

$\sigma_s A_s = \sigma_c A_c$

$\therefore \sigma_s = \frac{\sigma_c A_c}{A_s}$

$= \sigma_c \times \frac{2A_s}{A_s}$

$= 2\sigma_c$ 2

~~$\frac{\sigma_s}{E_s} = \frac{\sigma_c}{E_s}$~~ given $E_s = 2.1\times10^5$ N/mm^2

$E_c = 1\times10^5$ MPa. 1

$\frac{\sigma_s}{E_s} + \frac{\sigma_c}{E_c} = t(\alpha_c - \alpha_s)$ $\alpha_s = 1.2\times10^{-5}$

$\alpha_c = 1.75\times10^{-5}$ 2

$\frac{2\sigma_c}{2.1\times10^5} + \frac{\sigma_c}{1\times10^5} = 300(1.75\times10^{-5} - 1.2\times10^{-5})$

$\therefore \sigma_c = 84.51$ N/mm^2 4

$\sigma_s = 2\times84.51 = 169.02$ N/mm^2

~~2+~~ 1+2+4

2+1+2+4 = 9

IV (a) Young's Modulus :- It is the ratio of stress to strain $E = \frac{p}{e}$ 2

Modulus of rigidity :- It is the ratio of shear stress to shear strain. Nor $C = \frac{\tau}{\phi}$. 2

Volumetric strain :- It is the ratio of change in volume to the original volume. $\varepsilon_v = \frac{\delta V}{V}$ 2

2+2+2 = 6

IV (b) $l = 1.5\,m = 1.5\times10^{3}\,mm$.

$d = 20\,mm$ $\quad P = 100\,KN = 100\times10^{3}\,N$.

$E = 200\,GPa = 200\times10^{3}\,MPa$.

$$\delta l = \frac{PL}{AE}$$

$$= \frac{100\times10^{3}\times1.5\times10^{3}}{\frac{\pi\times20^{2}}{4}\times200\times10^{3}} = 2.38\,mm.$$ 4

Change in diameter δd, ? $\quad \frac{1}{m} = 0.32$

$$\frac{1}{m} = \frac{\text{lateral strain}}{\text{linear strain}}$$

$$\therefore \text{lateral strain} = \frac{0.32\times2.38}{1.5\times10^{3}}$$

$$\frac{\delta d}{d} = \frac{0.32\times2.38}{1.5\times10^{3}}$$

$$\therefore \delta d = \frac{0.32\times2.38\times20}{1.5\times10^{3}} = 0.01\,mm.$$ 5 | 4+5 | 9.

V ⓐ ① The force of friction acts in a direction opposite to that in which body tends to move.

~~② Till the limiting value is reached~~

② The magnitude of the force of friction is exactly equal to the force which tends to move the body

③ The magnitude of the limiting friction bears a constant ratio to the normal reaction between the two surfaces i.e. $\frac{F}{R}$ = Constant 2x3 | 6

V b

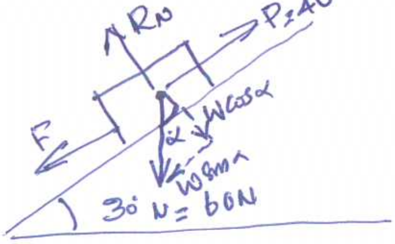


fig 2

Resolving along the plane

$$F + W\sin\alpha = P$$

ie $F + 60\sin 30^\circ = 40$

$\therefore F = 40 - 60\sin 30 = 10$ — F → 2

Resolving across the plane:

$$R_N = W\cos\alpha$$

ie $R_N = 60\cos 30$ — R_N → 2

$$F = \mu R_N$$

$$10 = \mu \cdot 60\cos 30^\circ$$ — 2+2+2 +3 — 9

$\therefore \mu = \frac{10}{60\cos 30} = 0.193$ — μ → 3

VI (a) $A_1 = 40 \times 50 = 2000\,mm^2$ — Area 3

$A_2 = \frac{1}{2} \times 40 \times 30 = 600\,mm^2$

$x_1 = \frac{50}{2} = 25$ $\quad x_2 = 50 + \frac{1}{3} \times 30 = 60\,mm$

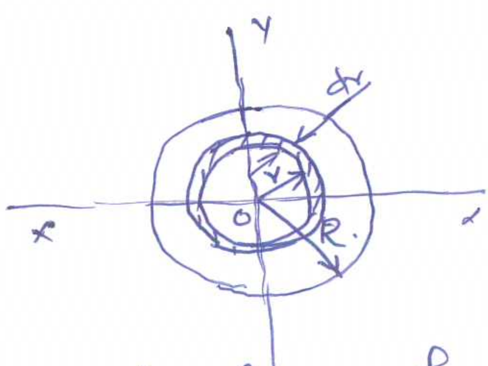
$y_1 = \frac{40}{2} = 20$ $\quad y_2 = 20$

$$\bar{x} = \frac{A_1 x_1 + A_2 x_2}{A_1 + A_2}$$ — $\bar{x}$ → 3 — 3+3+1

$$= \frac{2000 \times 25 + 600 \times 60}{2000 + 600} = 33.08\,mm$$ — 7

$\bar{y} = 20\,mm$ — $\bar{y}$ → 1

VI (b) Consider a circular section of radius R with centre O



Consider an elementary circular ring of radius "r" and thickness "dr"

Area of elementary ring = $2\pi r \cdot dr$.

MI of the circular section about an axis $\perp^r$ to xx and yy axis passing through O'

$$= \text{Area of ring} \times \text{radius}^2$$

$$= 2\pi r \cdot dr \times r^2$$

$$\therefore \text{Polar MI } I_{zz} = \int_0^R 2\pi r^3 \cdot dr.$$

$$= 2\pi \left[\frac{r^4}{4}\right]_0^R.$$

$$= \frac{\pi}{2}\left[R^4 - 0\right]$$

$$= \frac{\pi R^4}{2} \quad \text{Put } R = D/2$$

$$\therefore I_{zz} = \frac{\pi D^4}{32}$$

According to perpendicular axis theorem.

$$I_{zz} = I_{xx} + I_{yy}.$$

But $I_{xx} = I_{yy}$ $\quad \therefore I_{zz} = 2I_{xx}$ or $2I_{yy}$

$$\therefore I_{xx} = \frac{I_{zz}}{2} = \frac{\frac{\pi D^4}{32}}{2} = \frac{\pi D^4}{64}.$$ 8.

UNIT III

VII (a) ① The material of the shaft is uniform throughout.

② The shaft is of circular cross section remains circular after loading

③ The ~~planee~~ plane of section of a shaft normal to its axis before loading remains plane after application of torque.

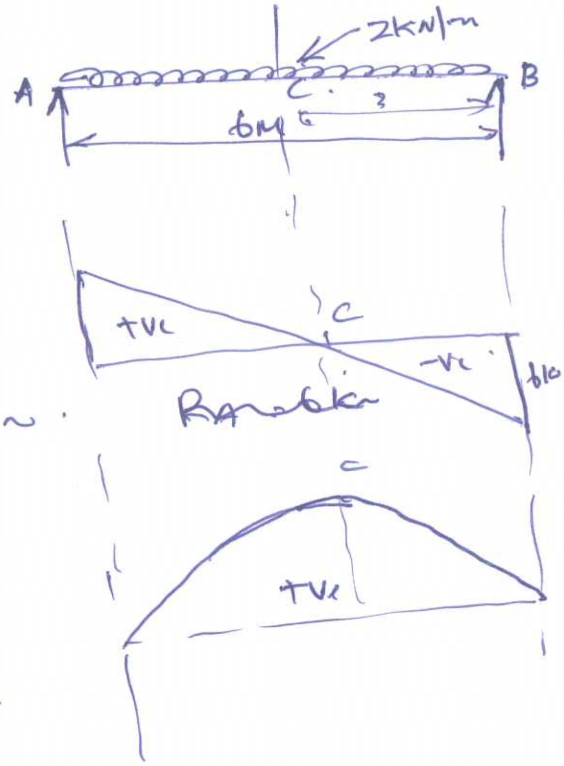
④ The twist along the length of shaft is uniform throughout

5	Maximum shear stress developed under torsion does not exceed the value of its elastic limit.	Any four	$4 \times 1\frac{1}{2} = 6$
VII (b)	$t = 12\,mm$ $d = 22\,mm$ $p = 70\,mm$.		
	$\tau = 60\,MPa$ $\sigma_b = 160\,MPa$ $\sigma_t = 90\,MPa$.		
	Shearing strength $P_s = n \times \frac{\pi d^2}{4} \times \tau$		
	$= \frac{2 \times \pi \times 22^2}{4} \times 60 =$		
	$= 45593\,N$	2	2+ 2+ 2+ 1+ 2 = 9
	Crushing strength $P_b = n \times d \times t \times \sigma_b$.		
	$= 2 \times 22 \times 12 \times 160$		
	$= 84480\,N$.	2	
	Tearing strength $P_t = (p - d)t \times \sigma_t$		
	$= (70 - 22)12 \times 90$		
	$= 51840\,N$	2	
	Strength of the riveted joint = least of P_s, P_b, P_t.		
	$= 45593\,N$	1	
	Efficiency of the joint $= \frac{\text{Strength of joint}}{\text{Strength of unriveted plate}}$		
	$= \frac{45593}{70 \times 12 \times 90} \times 100$		
	$= 60.3\%$.	2	

VIII (a)	Throat:- perpendicular distance between the face and root of the weld.	2	
	Size of weld:- The minimum length of the leg of a weld is called size of the weld	3x2= 2	2x3 =6
	Toe:- Point formed by the intersection of leg and face.	2	
(b)	$d = 800mm$ $H = 100m$ Weight of water $w = 9810\ N/m^3$ $\sigma_h = 20 N/mm^2$ $P = wH$ $= 9810 \times 100$ $= 981000\ N/m^2$ $\therefore P = 0.981\ MPa.$ $\sigma_h = \frac{Pd}{2t}$ $\therefore t = \frac{Pd}{2\sigma_h} = \frac{0.981 \times 800}{2 \times 20} = 19.62mm$ $t = 20mm.$		
	UNIT. IV		
IX a	$\frac{M}{I} = \frac{\sigma}{Y} = \frac{E}{R}$ M - Maximum Bending moment in N-m I - Moment of Inertia in M^4 σ - Bending stress in N/m^2 Y - distance from neutral axis in m. E - Young's Modulus in N/m^2 R - Radius of Curvature in - M.	3 2	3+2 =5

IX b

$R_A + R_B = 6 \times 2 = 12 KN$



Taking moment about A

$R_B \times 6 = 2 \times 6 \times \frac{6}{2}$

$6 R_B = 36$

$R_B = \frac{36}{6} = 6 kN$

$R_A = 6 kN$

~~BM~~ SF at B = −6KN

SF at C = −6 + 3×2 = 0 k.

SF at A = +6 k.

BM at B = 0

BM at A = 0

Maximum Bending moment is at C.

Max: Bending Moment = $\frac{wl^2}{8}$ kN-m

$\frac{2 \times 6^2}{8} = \frac{72}{8} = 9$ kN-m

fig 4 | Calculat 4 | 4+4 +2 =10 | 2

X (a). d = 10mm n = 8 D = 100 ∴ R = 50

W = 200 N. C = 8.4×10^4 MPa.

$\tau = \frac{16WR}{\pi d^3} = \frac{16 \times 200 \times 50}{\pi \times 10^3}$

$= 50.93 N/mm^2$ 4 4+4 =8

$\delta = \frac{64 W R^3 n}{C d^4} = \frac{64 \times 200 \times 50^3 \times 8}{8.4 \times 10^4 \times 10^4}$

$= 15.23 mm$ 4

$\bar{X}$ (b)	$L = 2.3\,m = 2.3\times10^3\,mm$.		
	$d_o = 40\,mm$ $\quad d_i = 35\,mm$.		
	$E = 205\times10^3\,N/mm^2$		
	Both end hinged $L = l$	2	2+2 +3
	Crippling load $P = \dfrac{\pi^2 E I}{L^2}$		=7
	$I = \dfrac{\pi}{64}(d_o^4 - d_i^4)$		
	$= \dfrac{\pi}{64}(40^4 - 35^4)$		
	$= \underline{52001.94\,mm^4}$	2	
	$P = \dfrac{\pi^2 \times 205\times10^3 \times 52001.947}{(2.3\times10^3)^2}$		
	$= \underline{\underline{19889.2\,N}}$	3	
	$= \underline{19.889\,kN}$		