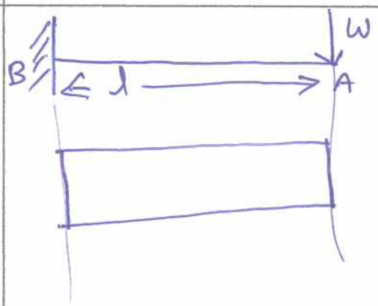
SET 2

Scoring Indicators

COURSE NAME: STRENGTH OF MATERIAL

COURSE CODE: 3021 **QID: 2110220178**

Q. No.	Scoring Indicators	Split Score	Sub Total	Total Score
	PART A			**9**
I. 1	No unit	1	1	1
I. 2	ductility	1	1	1
I. 3	Modulus of elasticity, Young's modulus	1	1	1
I. 4	Overhanging beam	1	1	1
I. 5	sagging	1	1	1
I. 6	Section modulus	1	1	1
I. 7	Strut	1	1	1
I. 8	$\frac{2\pi NT}{60}$	1	1	1
I. 9	Shell	1	1	1
	PART B			**24**
II. 01	When a body is subjected to two equal and opposite forces which are acting tangentially across the resisting section, as result of which the body tends to shear off. The shear strain is defined to be the ratio of the horizontal displacement to the height of the block	1.5x2=3	3	3
II. 02	Poisson's ratio being defined as the ratio of lateral strain to longitudinal strain and bulk modulus K as the ratio of direct stress to volumetric strain	1.5x2=3	3	3
II. 03	Ultimate strength or tensile strength or ultimate tensile strength is the capacity of the material to withstand tensile loads. Factor of safety can be defined as the ratio of ultimate strength to the design strength. It is a constant factor that	1.5x2=3	3	3

	is considered for designing of machine components or structure beyond its working strength.			
II. 04	Change in length = PL/AE P= $20x10^3$ N L = 2000 mm d= 20 mm A = 200 mm^2 E= $200x10^3$ MPa Change in length = 1 mm	Equation =1 Answer =2	3	3
II. 05	Point load, Uniform distributed load, uniform varying load with sketches	Types=2 Figure = 1	3	3
II. 06	Shear force definition Bending moment definition	1.5 1.5	3	3
II. 07	 $SF_A = W$ $SF_B = W$	SFD –2 mark SF values –1 mark	3	3
II. 08	1.Material of the beam is homogeneous. 2.Beam is initially straight and unstressed 3.transverse section which are plane before bending should be plane after bending 4.bending stresses are within elastic limit 5.each layer of the beam is free to expand and contract. 6.the radius of curvature of beam is large compared to cross sectional dimensions.	6x0.5 = 3	3	3
II. 09	The ratio of mean coil diameter to the wire diameter is called spring index C. Load required for unit deflection of the spring is called spring index	1.5x2=3	3	3
II. 10	Thin shell definition. Failures- hoop and longitudinal	1+2=3	3	3
				42

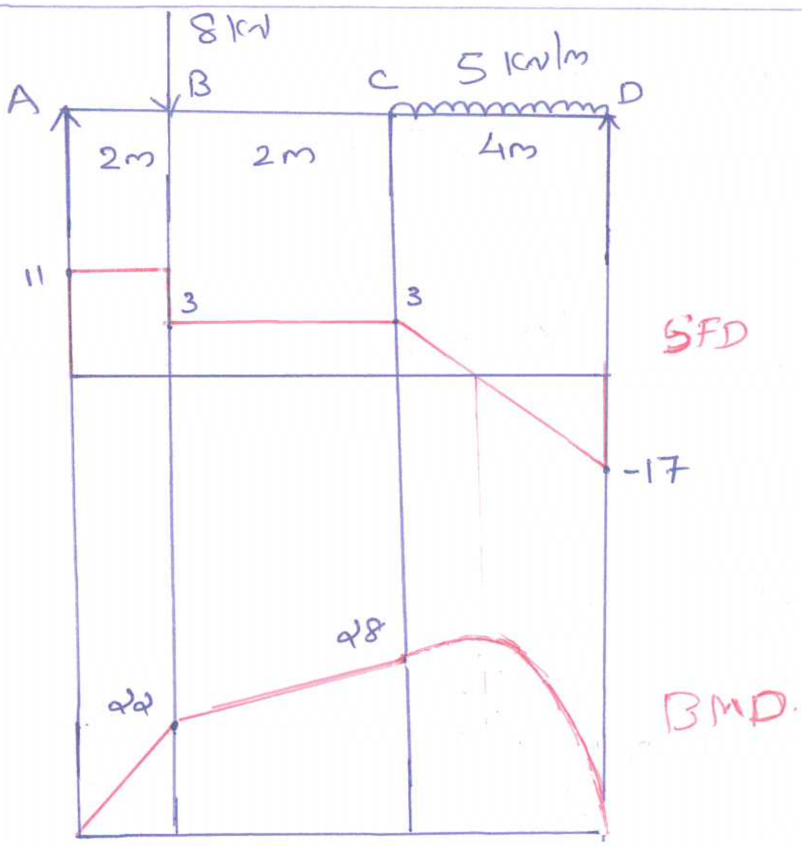
III	1.	$A_s = \frac{\pi}{4} \times 20^2 = 314.16\,mm^2$	1	
		$A_c = \frac{\pi}{4} \times 20^2 = 314.16\,mm^2$		
		$P = \sigma_s A_s + \sigma_c A_c$	2	
		$= \sigma_s \times 314.16 + \sigma_c \times 314.16$		
		$20 \times 10^3 = 314.16\,[\sigma_s + \sigma_c]$		
		$\sigma_s + \sigma_c = 63.66$ —— (1)		
		$(\Delta l)_{steel} = (\Delta l)_{Copper}$	2	7
		$\frac{\sigma_s L_s}{E_s} = \frac{\sigma_c L_c}{E_c}$		
		$\frac{\sigma_s \times 2000}{2.05 \times 10^5} = \frac{\sigma_c \times 1500}{1.1 \times 10^5}$		
		$\sigma_s = 1.39\,\sigma_c$ —— (2)		
		(2) in (1)		
		$2.39\,\sigma_c = 63.66$ $\sigma_c = 26.64\,N/mm^2$	2	
		$\sigma_s = 37.02\,N/mm^2$		
	2.	(i) $\sigma = \alpha T E$		
		$= 12 \times 10^{-6} \times 45 \times 2 \times 10^5$	2	
		$= 108\,N/mm^2$		
		(2) $\boxed{\Delta l = \alpha T L - \delta}$ (Actual expansion prevented)		
		$= 12 \times 10^{-6} \times 45 \times 20 \times 10^3 - 5.8$	2	
		$= 5\,mm$		
		$Strain = \frac{\Delta l}{l} = \frac{5}{20 \times 10^3} = 2.5 \times 10^{-4}$	1	

Stress = $\varepsilon \times E$

$= 2.5 \times 10^{-4} \times 2 \times 10^{5}$ 2 7

$=$ 50 N/mm²

3.



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$R_A + R_D = 8 + 20 = 28$ kN 1

$\Sigma M_A = 0$

$R_A \times 0 + 8 \times 2 + 20 \times 6 - R_D \times 8 = 0$

$R_D = 17$ kN $R_A = 11$ kN

Shear force

$SF_A = 11$ kN

$SF_B = 11 - 8 = 3$ kN 2

$SF_C = 3$ kN

$SF_D = 3 - 5 \times 4 = -17$ kN

Bending Moment.

$BM_A = 0$ $\quad$ $BM_D = 0$

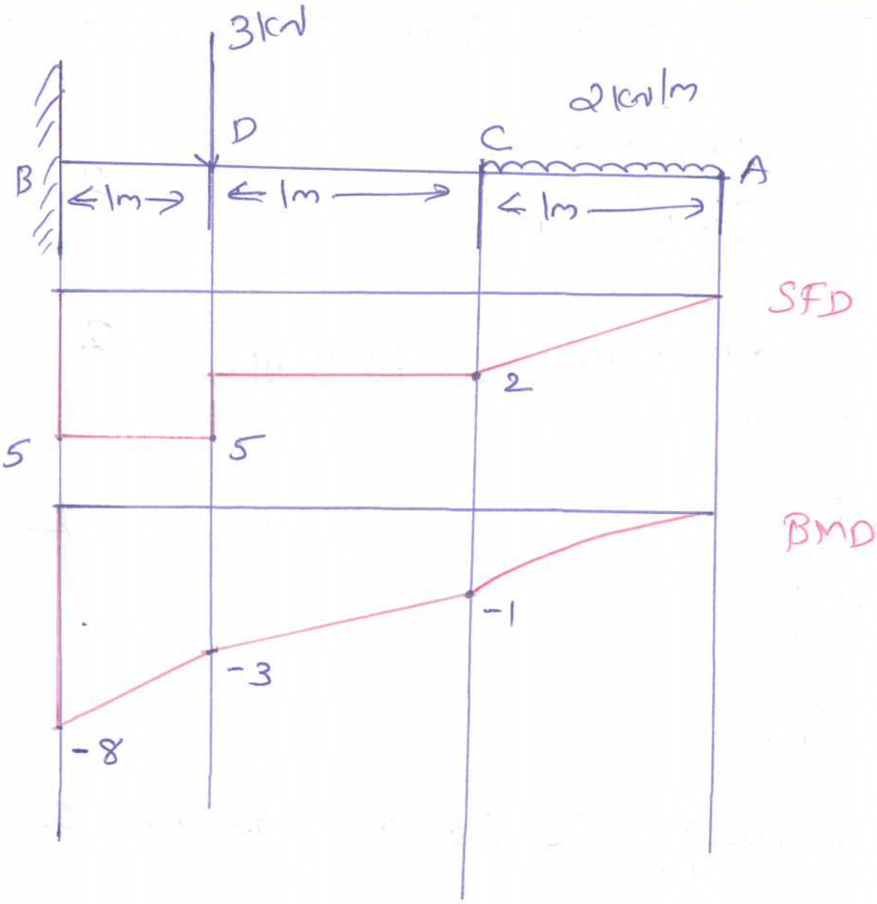
~~BMB~~ $BM_B = 11 \times 2 = 22$ kNm

$BM_C = 11 \times 4 - 8 \times 2$

$= 44 - 16 = 28$ kNm

2 $\quad$ 7

4.



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Shearforce

$SF_A = 0$

$SF_C = 2$ kN

$SF_D = 2 + 3 = 5$ kN

$SF_B = 5$ kN

Bending Moment

$BM_A = 0$

$BM_C = -2 \times 1 \times 0.5$

$= -1$ kNm

$BM_D = -2 \times 1 \times 1.5$

$= -3$ kNm

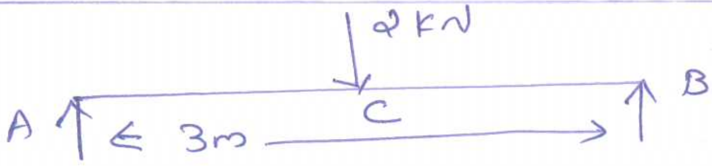
$BM_B = -2 \times 1 \times 2.5 - 3 \times 1$

$= -8$ kNm.

Shearforce - 2

Bending Moment - 3

5.



$\frac{\sigma}{y} = \frac{M}{I}$ — 1

$y = \frac{d}{2} = \frac{80}{2} = 40\,mm$

$I = \frac{bd^3}{12} = \frac{80 \times 80^3}{12} = 3413333.33\,mm^4$ — 2

$M = \frac{Wl}{4} = 2 \times 10^3 \times 3000$

$= \underline{6 \times 10^6\ N \cdot mm}$ — 2

$\sigma = \frac{My}{I} = \frac{6 \times 10^6 \times 40}{3413333.33} = \underline{70.31\,N/mm^2}$ — 2

Total: 7

6. $y = \frac{Wl^3}{48EI}$ — 1

$W = 3 \times 10^3\ N$

$l = 5 \times 10^3\ mm$

$I = \frac{bd^3}{12} = \frac{100 \times 250^3}{12} = \underline{130208333.3\,mm^4}$ — 2

$E = 1 \times 10^4\ N/mm^2$

$y = \frac{3 \times 10^3 \times (5 \times 10^3)^3}{48 \times 1 \times 10^4 \times 130208333.3} = \underline{6\,mm}$ — 3

Total: 7

7. Derivation $\frac{\sigma}{y} = \frac{M}{I} = \frac{E}{R}$ — 1 mark

Figure — 3 mark

$\frac{\sigma}{y} = \frac{E}{R}$

$\frac{E}{R} = \frac{M}{I}$ — 3 mark

8.

$D_o = 38\,mm$

$D_i = 38 - 5 = 33\,mm.$

$l = 2300\,mm$

$L_e = \frac{l}{2} = \frac{2300}{2} = 1150\,mm$ — 1

$P = \frac{\sigma_c \cdot A}{1 + a\left(\frac{L_e}{k}\right)^2}$ — 1

$A = \frac{\pi}{4}(38^2 - 33^2) = 278.82\,mm^2$ — 1

$I = \frac{\pi}{64}(38^4 - 33^4) = 44140.11\,mm^4$ — 1

$k = \sqrt{I/A} = 12.58\,mm$ — 1

$P = \frac{335 \times 278.82}{1 + \frac{1}{7500} \times \left(\frac{1150}{12.58}\right)^2} = 44267.6\,N = 44.23\,kN$ — 2

Total: 7

9.

Derive $\frac{T}{J} = \frac{\tau}{R} = \frac{G\theta}{L}$

Figure — 1 mark

$\frac{\tau}{R} = \frac{G\theta}{L}$ — 3 mark

$\frac{T}{J} = \tau/R$ — 3 mark

10.

$\sigma_c = \frac{pd}{2t}$ $\quad \sigma_l = \frac{pd}{4t}$ — 2

$t = \frac{pd}{2\sigma_c} = \frac{2 \times 1000}{2 \times 40}$ — 2

$= 25\,mmm$

$t = \frac{pd}{4\sigma_l} = \frac{2 \times 1000}{4 \times 30} = 16.67\,mm$ — 3

Wall thickness = 25 mm

11.	$\delta = \frac{64WR^3n}{Gd^4}$	1	
	$\tau = \frac{16WR}{\pi d^3}$	1	
	$80 = \frac{16 \times 200 \times R}{\pi \times 6^3}$	2	7
	$R = 16.96 = \underline{17mm}$		
	$n = \frac{8Gd^4}{64WR^3}$	3	
	$= \frac{11 \times 84 \times 6^4 \times 10^3}{64 \times 200 \times 17^3} = 19.04 \approx \underline{20}$		
12.	$P = 200 \times 10^3 W \quad N = 80 rpm$		
	$T = \frac{60 \times P}{2\pi N} = \frac{60 \times 200 \times 10^3}{2 \times \pi \times 80}$	3	
	$= \underline{23873.24 \times 10^3} Nmm$		
	$d_0 = \sqrt[3]{\frac{16T}{\pi\tau(1-K^4)}}$		7
	$= \sqrt[3]{\frac{16 \times 23873.24 \times 10^3}{\pi \times 60 \times (1-0.6^4)}}$	4	
	$= \underline{132.54mm}$		
	$d_i = \underline{79.52 mm}$		