Code -

G. S. Mandal's

Maharashtra Institute of Technology, Aurangabad

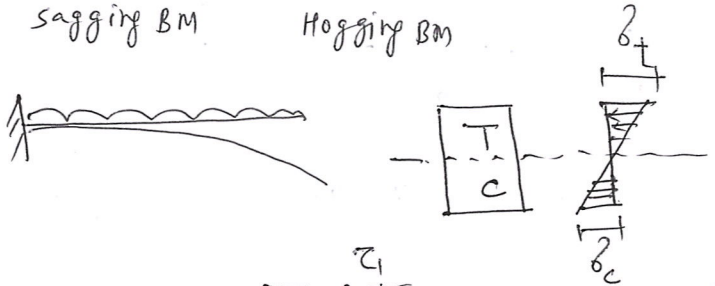
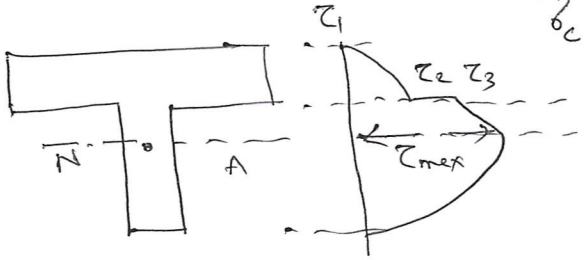
(An Autonomous Institute)

END SEMESTER EXAMINATION

Second Year B.Tech (Civil Engg.) – Feb/Mar-2023

Course Code : CED201 **Course Name : Strength of Material**

Duration : 2 Hrs **Max. Marks : 50** **Date :**

Q. No.	Solve/Answer the following questions	
	Answer/Solution	Stepwise Marking Scheme
1		
a)	The plane which carries only normal stresses on it is called as Principal plane	01
	The only normal stress acting on PP is called as principal stress	01
b)	The ratio of lateral strain to linear strain within elastic limit remains constant is called Poisson's ratio.	01
	It is denoted by μ. It is property of a given material. It is a unitless quantity	01.
c)	The net moment acting on left or right of the section which tends to bend the beam is called as B.M.	01
	It is obtained by taking ΣM_F @ the section under consideration. It's unit is KN.m.	01
	+ Sagging BM − Hogging BM	
d)		02
e)		02

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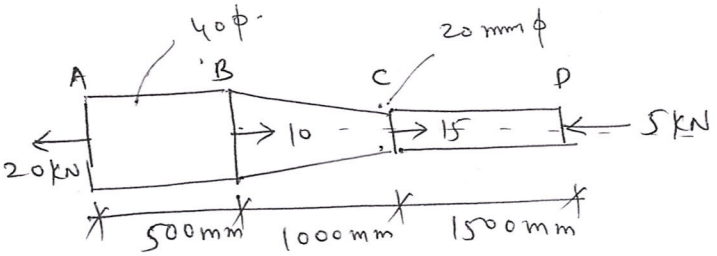
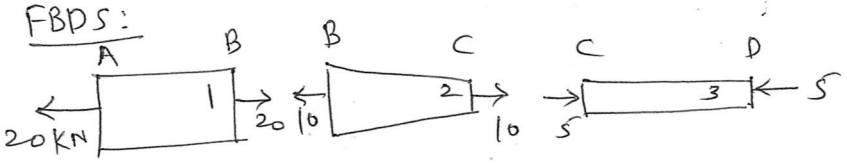
1f)	Impact load / falling load	02
g)	Whenever a body is loaded. some energy is stored in it, ~~strained~~ This energy is called strain energy. $S.E = \frac{\sigma^2}{2E} V$	01
	σ : stress in the member, V = volume. E: Young's modulus of the material	01
h)	Column is a vertical compression member. Whereas strut is an inclined compression member. Length of column is large than that of strut.	02
2		
	FBDS: 	03
	$\delta l_1 = \frac{Pl}{AE} = 20\times10^3\times500 / \frac{\pi}{4}(40)^2\times2\times10^5 = +0.04$ mm	01
	$\delta l_2 = +0.08$ mm	01
	$\delta l_3 = -0.119$ mm	01
	$\delta l = \delta l_1 + \delta l_2 - \delta l_3$	01
	$\boxed{\delta l = 0}$	01

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Q. No.	Solve/Answer the following questions	
2	Answer/Solution — OR — $A = 230 \times 300\ mm^2 = 69000\ mm^2$ $A_s = 8 \times \frac{\pi}{4}(16)^2 = 201 \times 8\ mm^2 = 1607.68\ mm^2$ $A_c = A - A_s = 67392.32\ mm^2$ $P = P_s + P_c$ $P = \sigma_s A_s + \sigma_c A_c$ $1000 \times 10^3 = \sigma_s \times 1.6 \times 10^3 + \sigma_c \times 67.39 \times 10^3 \rightarrow (1)$ Also $\frac{\sigma_s}{E_s} = \frac{\sigma_c}{E_c}$ $\frac{\sigma_s}{15E_c} = \frac{\sigma_c}{E_c}$ $\therefore \sigma_s = 15\sigma_c \rightarrow (2)$ put (2) in (1) $\therefore 1000 \times 10^3 = 15\sigma_c \times 1.6 \times 10^3 + \sigma_c \times 67.39 \times 10^3$ $\therefore \boxed{\sigma_c = 10.98\ N/mm^2}$ $\boxed{\sigma_s = 164.83\ N/mm^2}$	Stepwise Marking Scheme 01 01 01 01 01 01 01 01

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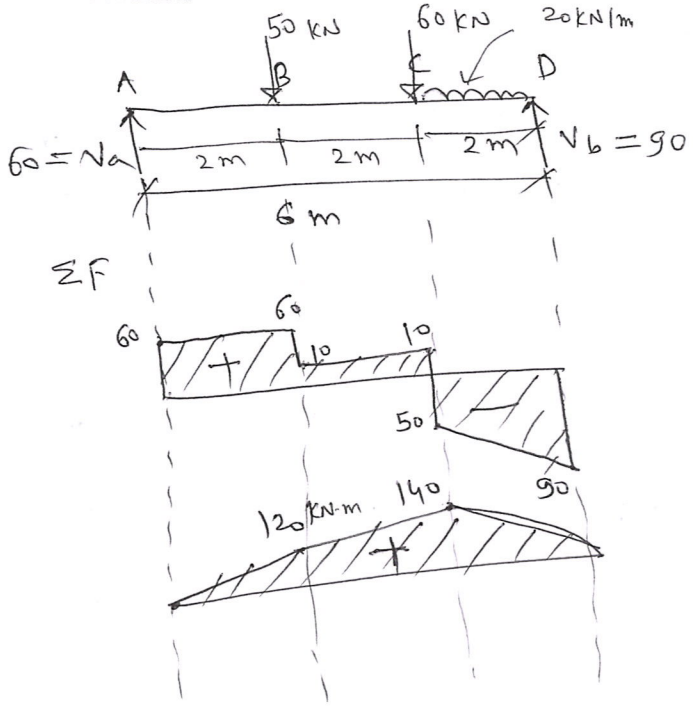
Q. No.	Solve/Answer the following questions	
3.	Answer/Solution	Stepwise Marking Scheme



02

02

$\Sigma F_y = 0 \quad V_a + V_b - 50 - 60 - 20 \times 2 = 0$

$V_a + V_b = 150 \rightarrow (1)$ 01

$\Sigma M @ A = 0, \quad 50 \times 2 + 60 \times 4 + (20 \times 2) \times 5 - 6V_b = 0$

$100 + 240 + 200 = 6V_b$

$\therefore V_b = 540/6 = \underline{90\ kN}$ 01

SF: $F_a = 60, \quad F_b = 60 - 50 = 10$

$F_{c(L)} = 10, \quad F_{c(R)} = 10 - 60 = -50$ 01

$F_d = 60 - 50 - 60 - 40 = -90$

BM $M_a = M_d = 0, \quad M_b = 60 \times 2 = 120$

$M_c = 60 \times 4 - 50 \times 2 = 240 - 100 = 140$ 01

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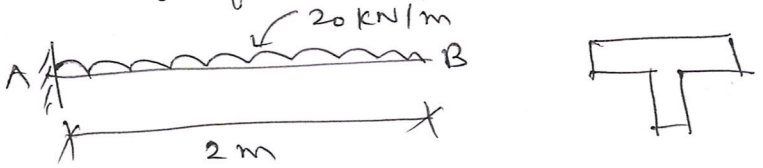
Q. No.	Solve/Answer the following questions	
	Answer/Solution	Stepwise Marking Scheme
3.	— OR —	
	Any four assumption — $4 \times \frac{1}{2} = 02$	02
	Derivation of eqn $\frac{dF}{dx} = w$	02
	Figure	01
	Derivation of eqn $-F = \frac{dM}{dx}$	02
	Meaning of each eqn	01
4.		
	$M_{max} = \frac{wl^2}{2} = \frac{20 \times 2^2}{2} = 40$ KN.m	01
	$\bar{x} = 100$ mm , $\bar{y} = 46.42$ mm from top of the flange	02
	$I_{xx} = 1.81 \times 10^7$ mm^4	02
	$\frac{M}{I} = \frac{\sigma}{y}$	01
	$\therefore \sigma_b = 102.58$ MPa (tensile)	02
	— OR —	
	Diagram of beam section (FBD)	02
	Derivation of equation $E = \frac{y}{R}$	01
	Derivation of $\frac{\sigma}{y} = \frac{E}{R}$	02
	Derivation of eqn $\frac{M}{I} = \frac{E}{R}$	02
	Final eqn	01

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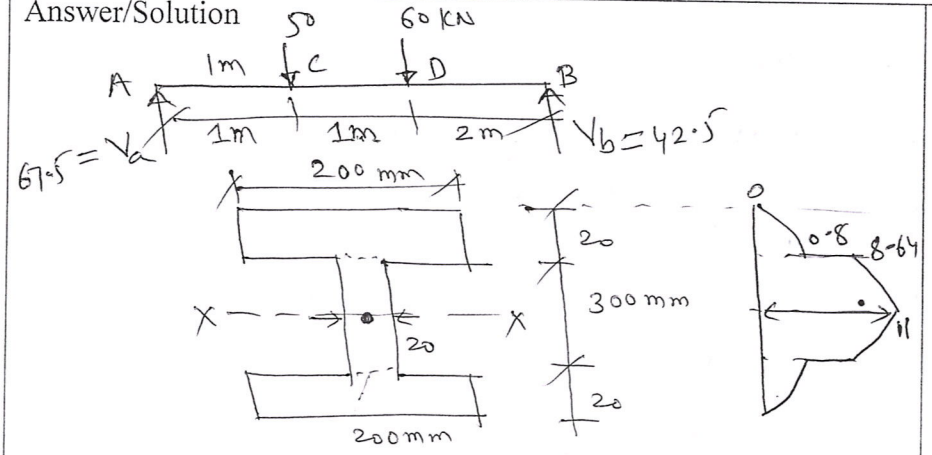
Duration : 2 Hrs **Max. Marks : 50** **Date :**

Q. No.	Solve/Answer the following questions	
5.	Answer/Solution	Stepwise Marking Scheme



01

$\bar{X} = 100\ mm, \quad \bar{Y} = \frac{340}{2} = 170\ mm$ from top 02

$$I_{xx} = \frac{BD^3}{12} - 2 \times \frac{bd^3}{12}$$

$$= \frac{200 \times 340^3}{12} - \left\{ \frac{2 \times 90 \times 300^3}{12} \right\}$$

$I_{xx} = 6.55 \times 10^8 - 4.05 \times 10^8 = 2.5 \times 10^8$ mm^4 02

$F_{max} = 67.5\ kN$ 01

$\tau_1 = 0$

$$\tau_2 = \frac{S A \bar{Y}}{I b} = \frac{67.5 \times 10^3 \times (200 \times 20) \times 160}{2.5 \times 10^8 \times 200}$$

$= 0.8.64\ N/mm^2$

$$\tau_3 = \frac{67.5 \times 10^3 \times 200 \times 20 \times 160}{2.5 \times 10^8 \times 20} = 8.64$$ 01

$$\tau_4 = \frac{67.5 \times 10^3}{2.5 \times 10^8 \times 20} \left[4000 \times 160 + 3000 \times 75 \right]$$

$\tau_{max} = \tau_4 = 11.67\ N/mm^2$ 01

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Q. No.	Solve/Answer the following questions	
	Answer/Solution	
5	— OR —	Stepwise Marking Scheme
	$P = 375$ kW	
	$= 375 \times 10^6$ N·mm/s	
	$N = 210$ r.p.m	01
	$\tau_{permissible} = 50$ N/mm^2	
	$\theta_{permissible} = 1^0$	
	$= 1 \times \frac{\pi}{180}$ radians	
	$\theta = 0.017453$ radians	
	$\therefore P = \frac{2\pi NT}{60}$	01
	$375 \times 10^6 = \frac{2 \times \pi \times 210 \times T}{60}$	
	$T = 1.7 \times 10^7$ N·mm	01
	Case I — diam. based on max. shear stress	
	$\therefore \frac{T}{I_p} = \frac{G\theta}{l} = \frac{\tau}{r}$	01
	$\therefore \frac{T}{I_p} = \frac{\tau}{r}$ i.e. $\frac{1.7 \times 10^7}{2 \times \frac{\pi}{64}(d)^4} = \frac{50}{d/2}$	
	$\therefore$ $d = 120$ mm	02

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Q. No.	Solve/Answer the following questions	
	Answer/Solution	Stepwise Marking Scheme

Case 2 diam. based on limiting value of α

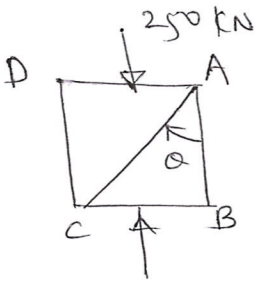
$$\therefore \frac{I}{I_p} = \frac{G\alpha}{l}$$ 01

$$\frac{1.7\times10^7}{\frac{\pi}{32}d^4} = \frac{80\times10^3\times0.0174}{3000}$$

$$d = 139 \text{ mm}$$ 01

∴ Adopt larger value of d, ie $\boxed{d = 140 \text{ mm}}$

6



$$\beta = \frac{P}{A} = \frac{250\times10^3}{(150)^2} = 11.11 \text{ MPa}$$ 01

$\alpha = 0^\circ$ $\beta_n = \beta\cos^2\alpha = 011.11\times1$ 01

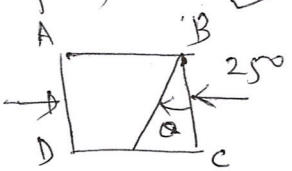
$\boxed{\beta_n = -011.11\ \beta_t = 0}$ $\beta_t = \beta/2 \sin 2\alpha = 0$ 01

$= 55\times0 = 0$ 01

$\alpha = 90^\circ$ (ie. along plane AB

$\beta_n = +00.0$ MPa (compr.) 02

$\beta_t = 0$



$\theta = 45^\circ$, $\beta_n = \beta\cos^2\alpha$

$= 11.11\cos^2 45 = -5.55$ $\beta_t = 5.5\sin 90 =$ 5.55 02

Plane BC — PP

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	Answer/Solution	Stepwise Marking Scheme

6 B)

$L = 4m$

$l_{ef} = 4m = 4000\ mm$ — 01

$P_E = \frac{\pi^2 EI}{l_{ef}^2}$ — 01

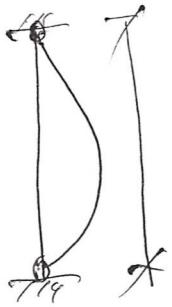
$I = \frac{\pi}{64}[D^4 - d^4]$ — 01

$= \frac{\pi}{64}[150^4 - 90^4]$

$I = 2.16 \times 10^7\ mm^4$ — 01

$\therefore P_E = \frac{\pi^2 \times 200 \times 10^3 \times 2.16 \times 10^7}{(4000)^2}$

$= 340.23\ kN$ — 02



02

— X — X —

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