1

Total No. of Questions – [ 08 ]   Total No. of Printed Pages- 04

| G.R. No. | |
|---|---|

U218-154(ESE)

# DECEMBER 2018/ENDSEM

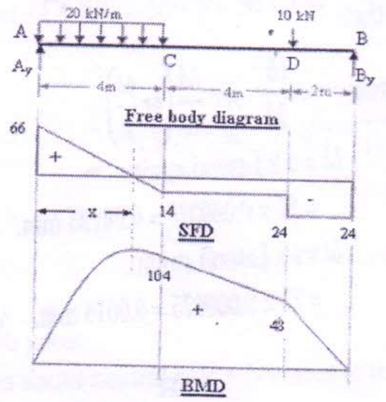
## S. Y. B. TECH. (MECHANICAL) (SEMESTER - I)

**COURSE NAME: STRENGTH OF MATERIALS**

**COURSE CODE: MEUA21174**

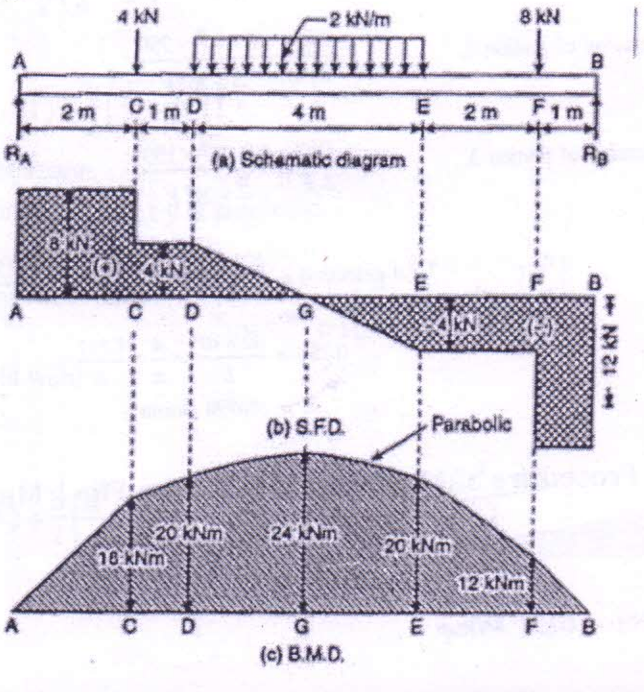
## SOLUTION-SET-1

Q.1) a) Draw the shear force and bending moment diagram. [6 Marks]




**OR**

b) [6 marks]



Q.2) a) [6 marks]

$$\therefore \quad \frac{\delta L}{L} = 0.00025.$$

$\therefore$ $\delta L$ (or change in length) $= 0.00025 \times L$

$$= 0.00025 \times 4000 = 1.0 \text{ mm. Ans.}$$

Using equation (2.3),

$$\text{Poisson's ratio} = \frac{\text{Lateral strain}}{\text{Longitudinal strain}}$$

$$0.3 = \frac{\text{Lateral strain}}{0.00025}$$

$\therefore$ Lateral strain $= 0.3 \times 0.00025 = 0.000075.$

We know that

$$\text{Lateral strain} = \frac{\delta b}{b} \text{ or } \frac{\delta d}{d}\left(\text{or } \frac{\delta t}{t}\right)$$

$$\therefore \quad \delta b = b \times \text{Lateral strain}$$

$$= 30 \times 0.000075 = 0.00225 \text{ mm. Ans.}$$

Similarly, $\delta t = t \times$ Lateral strain

$$= 20 \times 0.000075 = 0.0015 \text{ mm. Ans.}$$

**OR**

b) [6 marks]

***Solution:*** Extension of portion 1, $\dfrac{PL_1}{A_1E} = \dfrac{40 \times 10^3 \times 150}{\frac{\pi}{4} \times 25^2 E}$

Extension of portion 2, $\dfrac{PL_2}{A_2E} = \dfrac{40 \times 10^3 \times 250}{\frac{\pi}{4} \times 20^2 E}$

Extension of portion 3, $\dfrac{PL_3}{A_3E} = \dfrac{40 \times 10^3 \times 150}{\frac{\pi}{4} \times 25^2 E}$

$$\text{Total extension} = \frac{40 \times 10^3}{E} \times \frac{4}{\pi}\left\{\frac{150}{625} + \frac{250}{400} + \frac{150}{625}\right\}$$

$$0.280 = \frac{40 \times 10^3}{E} \times \frac{4}{\pi} \times \frac{1.112}{E}$$

$$E = 200990 \text{ N/mm}^2$$

Q.3) a) List- 2 Mark, Procedure of Mohr Circle-3 marks Fig-1 Mark [6 marks]

**OR**

b) Each Theory – 02 Marks [6 marks]

Q.4) a) [4 marks]

(i) **Maximum deflection :**

$$y = \frac{WL^3}{3EI}$$

Moment of inertia $I = \frac{bd^3}{12} = \frac{50 \times 150^3}{12} = 14.0625 \times 10^6$

Flexural rigidity $EI = 210 \times 14.0625 \times 10^6 = 2.953 \times 10^9 \text{ kN·mm}^2 = 2.953 \times 10^9 \times 10^{-6} =$ $2953.125 \text{ kN.m}^2$

$$\therefore y = \frac{10 \times 3^2}{3 \times 2953.125} = 0.01016 \text{ m} = 10.16 \text{ mm}$$

(ii) **Maximum stress :**

Maximum bending moment $M = WL = 10 \times 3 = 30 \text{ kN·m}$

using bending formula

$$\frac{M}{I} = \frac{f}{y} \qquad \therefore f = \frac{M}{I} \times y = \frac{30 \times 10^6}{14.0625 \times 10^6} \times 75 = 160 \text{ N/mm}^2$$

**OR**

b) [4 marks]

where $A\bar{y}$ = Moment of area of two parts

= Moment of flange area about neutral axis + Moment of the shaded area of web about neutral axis

$$= B\left(\frac{D}{2} - \frac{d}{2}\right) \times \frac{1}{2}\left(\frac{D}{2} + \frac{d}{2}\right) + b\left(\frac{d}{2} - y\right) \times \frac{1}{2}\left(\frac{d}{2} + y\right)$$

$$A\bar{y} = \frac{B}{8}(D^2 - d^2) + \frac{b}{2}\left(\frac{d^2}{4} - y^2\right)$$

Shear stress in the web

$$\tau = \frac{S}{bI}\left[\frac{B}{8}(D^2 - d^2) + \frac{b}{2}\left(\frac{d^2}{4} - y^2\right)\right] \qquad \text{...(iii)}$$

Observations from above equation.

Equation (iii) shows the variation τ w.r.t y is parabolic.

At neutral axis, shear stress is maximum

$$y = 0, \qquad \tau_{max} = \frac{S}{bI}\left[\frac{B}{8}(D^2 - d^2) + \frac{bd^2}{8}\right]$$

At the junction of flange and web,

$$y = \frac{d}{2}$$

$$\tau = \frac{S}{bI}\left[\frac{B}{8}(D^2 - d^2) + \frac{b}{2}\left(\frac{d^2}{4} - \frac{d^2}{4}\right)\right] \qquad \therefore \quad \tau = \frac{SB(D^2 - d^2)}{8bI} \qquad \text{...(iv)}$$

Q. 5) a) $\sigma = \frac{P}{A} = \frac{60 \times 10^3}{400\pi}$ , $\boxed{\sigma = 47.76\ N/mm^2}$ — 02 marks

[6 marks]

stretch $e = \frac{\delta l}{l} = \frac{\sigma}{E}$ , $\delta l = l \times \frac{\sigma}{E} = \frac{47.746}{2 \times 10^5} \times 500$

$\boxed{\delta l = 1.19 mm}$ — 02 marks

Strain energy absorbed $U = \frac{\sigma^2}{2E} \times V = \frac{47.476^2}{2 \times 2 \times 10^5} \times 2 \times 10^6 \pi$

$\boxed{U = 35.81\ N\text{-}m}$ — 02 marks

b)

[4 marks]

Slope dy/dx= $1/EI(-wx^3/6 + wL^3/6)$

Deflection Y= $1/EI(-wx^4/24 + wL^3x/6 - wL^4/8)$

Max Deflection = $-wL^4/8EI$

c) for cantilever beam

[4 marks]

1) at x=0, y=Ymax, slope=slope max

2) at x=L, y=0 and slope =0

For simply supported beam

1) at x=0, y=0 , slope=slope max

2) at x=L/2, y= Ymax and slope =0

**OR**

Q.6) a)

[6 marks]

extension in rod $\delta l = l \times \frac{\sigma}{E}$ , $1.5 = \frac{\sigma}{2 \times 10^5} \times 3000$

$\boxed{\sigma = 100\ N/mm^2}$ — 03 marks

suddenly applied load

$\sigma = 2 \times \frac{P}{A}$ , $100 = 2 \times \frac{P}{1000}$ , $\boxed{P = 50 KN}$ — 02 marks

b)

[4 marks]

Slope $\frac{dy}{dx} = \frac{1}{EI}\left[\frac{wLx^2}{4} - \frac{wL^3}{24} - \frac{wx^3}{6}\right]$ — 01

Deflection $Y = \frac{1}{EI}\left[\frac{wLx^3}{12} - \frac{wL^3}{24}x - \frac{wx^4}{24}\right]$ — 01

$Y_{max} = \frac{-5wL^4}{384EI}$ at $x = L/2$ — 02

c)

[4 marks]

Procedure – 02 Marks

Equation / example – 01 Mark

fig – 01

Q.7) a) [6 marks]

Assumption (at least 04) — 2 marks

$T_H = \tau (0.116 D^3)$ —— 01 mark

$D = 1.19 d_s$, $d = 0.95 d_s$ — 01 mark

$\frac{W_H}{W_S} = 0.514$ —— 2 mark

b) [4 marks]

Boundary condⁿ, $x = 0,\ y = 0 \Rightarrow C_1 = 0$

$x = L,\ y = 0 \Rightarrow C_2 =$ } 2 mark

$$P = \frac{\pi^2 E I}{L^2}$$ —— 2 mark

c) [4 marks]

Buckling Load $= 2105.3$ N —— 2 mark

safe load $= 701.8$ N —— 2 mark

**OR**

Q.8) a) [6 marks]

Boundary condⁿ $x = 0,\ y = 0,\ C_1 = -\frac{HL}{P}$ — 01

$x = 0,\ \frac{dy}{dx} = 0\quad C_2 = \frac{H}{P}\sqrt{\frac{EI}{P}}$ — 01

$$P = \frac{2\pi^2 E I}{L^2}$$ —— 04 marks

b) [4 marks]

Diameter Based on shear stress $D = 58.74$ mm — 2 mark

— " — " — Angle of twist $D = 48.64$ mm — 01 M

Ans $= 58.74$ —— 01 M

c) [4 marks]

$\frac{T}{J} = \frac{G\theta}{L} = \frac{\tau}{r}$ — 3 mark, fig — 01 mark

***END***