



## P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belgaum)

**Third Semester, B.E. - Civil Engineering**

**Semester End Examination; Dec - 2016/Jan - 2017**

**Strength of Materials**

*Time: 3 hrs*

*Max. Marks: 100*

*Note: i) Answer FIVE full questions, selecting at least ONE full question from each unit.  
ii) Missing data, if any, may be assumed suitably and clearly mentioned.*

### UNIT - I

- 1 a. Define stress, strain, upper and lower yield stress, breaking stress. 4
- b. Derive expression for change in length ' $\delta l$ ' of a bar of varying diameter from  $d_1$  to  $d_2$  and length  $l$ . 8
- c. A mild steel specimen tested under tension test and following results were obtained,
- |   |          |   |
|---|----------|---|
| i) Diameter of specimen                                   | 20 mm    |   |
| ii) Length of specimen                                    | 0.2 m    |   |
| iii) Extension under a load of 10 kN is                   | 0.032 mm |   |
| iv) Load at yield point is 82 kN at C (lower yield point) |          |   |
| v) Maximum load is  | 133 kN   | 8 |
| vi) Length of specimen after failure is                   | 0.252 m  |   |
| vii) Diameter of neck is                                  | 12.6 mm  |   |
- Calculate;
- I) Young's modulus      II) Yield stress      III) Ultimate stress      IV) % Elongation  
V) % Reduction in area      VI) Working stress, if factor of safety is 2.
- 2 a. List and define elastic constants with equations. 5
- b. Derive relationship between E and K [Young's modulus and Bulk modulus]. 7
- c. A steel rail is 30 m long at a temperature of 20°C. Estimate the elongation when the temperature increases to 80°C. 8
- Calculate the thermal stress developed in the rail if,
- i) No expansion joint is provided
- ii) A gap of 10 mm is provided for expansion,  $E = 200 \text{ GPa}$ ,  $\alpha = 12 \times 10^{-6}/^\circ\text{C}$ .

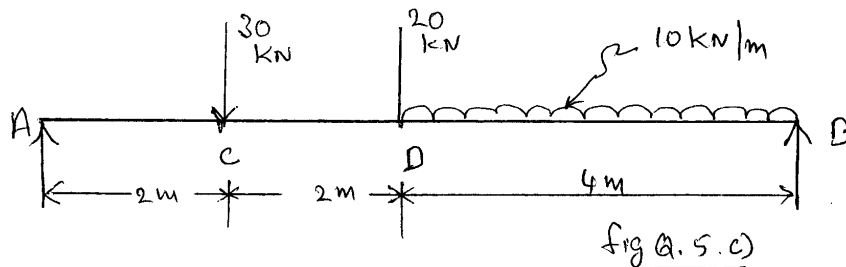
### UNIT - II

- 3 a. Define principal stress and principal planes (directions). 4
- b. In a two dimensional stress system (2D stress system), Derive expression for normal and tangential component of stresses on a given plane. 8

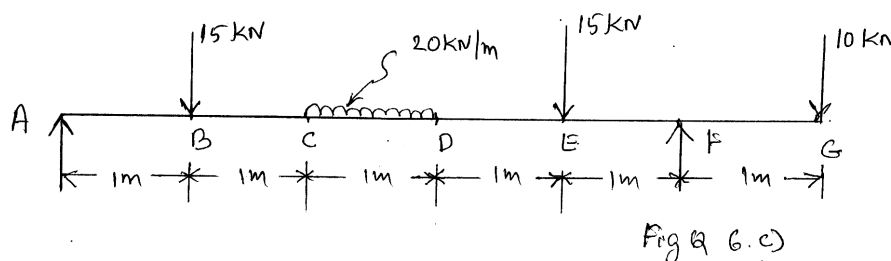
- c. At a certain point in piece of elastic material there are normal tensile stresses  $f_x = 120 \text{ MPa}$ ,  $f_y = 60 \text{ MPa}$ . In addition there is a positive shearing stress (Left up right down)  $q = 80 \text{ MPa}$ . Determine;
- i) The magnitude and directions of the principal stresses
  - ii) The magnitude and direction of the maximum shearing stress
  - iii) The normal and shearing stress on a plane inclined at  $30^\circ$  to the direction of  $120 \text{ MPa}$ .
- 4 a. Derive an expression for circumferential stress ( $f_1$ ) and longitudinal stress ( $f_2$ ) in the case of thin cylinder.
- b. Derive expressions for change in diameter, change in length and change in volume of a thin cylinder.
- c. A thick cylinder of  $400 \text{ mm}$  material diameter and  $100 \text{ mm}$  thickness contains a fluid at a pressure of  $80 \text{ N/mm}^2$ . Find the maximum and minimum hoop stresses across the section. Also sketch the radial and hoop stress distribution across the section.

**UNIT - III**

- 5 a. Define bending moment, shear force, BMD and SFD.
- b. Derive relationship between intensity of uniformly distributed load  $w$ , shear force  $F$  and bending moment  $M$ .
- c. Draw BMD and SFD for the beam shown in Fig. Q. 5(c).

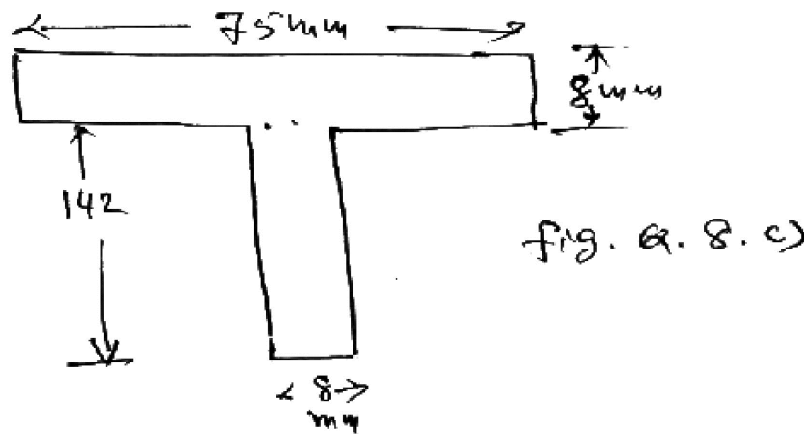


- 6 a. Define point of contra flexure, bending moment (Hogging and sagging bending moment) and shear force (positive and negative shear force).
- b. For a simply supported beam carrying uniformly distributed load  $w/m$  over entire span  $l$ , Show that maximum B.M,  $M_{\max} = \frac{wl^2}{8}$  at  $x = \frac{l}{2}$  from either support.
- c. Draw BMD and SFD for the beam shown in Fig. Q 6(c). Find the point of contra flexure and maximum bending moment.



## UNIT - IV

- 7 a. State assumptions made while deriving (Bernoulli) bending equation. 3  
 b. Derive bending equation (Bernoulli equation) with usual notations. 7  
 c. A wooden beam 10 m long 360 mm deep and 300 mm wide is simply supported and loaded with a uniformly distributed load. Find the safe total load. Factor of safety = 6, maximum shear intensity of the material is = 60 MPa. 10
- 8 a. Draw shear stress variation diagram for various standard sections (including triangle, rhombus and T - Section). 3  
 b. Show that maximum shear stress is 1.5 times average shear stress for a rectangular section. 7  
 c. A T-Section beam shown in Fig. Q 8(c) is subjected to a shear force of 9 kN at a section. Determine the amount of maximum intensity of shear stress and draw the distribution of shear stress across the depth of the section. 10



## UNIT - V

- 9 a. State assumptions made while deriving deflection equation. 3  
 b. Derive deflection equation with usual notations. 7  
 c. A simply supported beam has a span of 6 m. It carries two concentrated loads of 40 kN and 10 kN at distance of 2 m and 4 m from left hand support. Find the deflection under the 40 kN load and the position and magnitude of maximum deflection.  $E = 200 \text{ GPa}$  and  $I = 40 \times 10^{-6} \text{ m}^4$ . 10
- 10 a. Derive torque equation with usual notations. 7  
 b. State assumptions made while deriving torque equation. 3  
 c. Calculate the dimensions of a hollow steel shaft to transmit 600 kW at a speed of 120 r.p.m. the maximum torque being 1.12 times the mean (12% extra). The internal diameter of the shaft is 60% of the outside diameter and the greatest intensity of shear stress in the steel is limited to  $28 \text{ MN/m}^2$ . 10