(3 Hours) **[Total marks- 80]**

N.B. :
1. Question No **1** is **compulsory**
2. Attempt any **Three** questions from the remaining five questions.
3. Assume any **suitable data** if necessary with justification.
4. Figures to the right indicate full marks.

Q1. Attempt any **four** of the following questions.

(a) Derive the expression of Flexural formula in bending **05**

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

(b) Derive the relation for strain energy stored in a beam due to bending. **05**

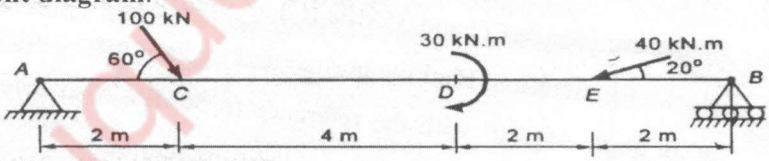
(c) Define longitudinal strain, lateral strain, shear strain, modulus of rigidity and poisson's ratio. **05**

(d) Draw SFD and BMD for a simply supported beam of length L carrying uniformly distributed load over the entire span.. **05**

(e) A steam pipe line measures 20 m at a temperature of 20°C. The steam pipe carries superheated steam at a temperature of 300°C. If 80% of the possible expansion of the pipe is prevented from taking place, find the stress induced in the material of the pipe having $E = 210 \times 10^3$ N/mm^2. **05**

Q2. **(a)** A steel bar is placed between two copper bars of same area and same length with their ends rigidly connected. The temperature of the assembly is maintained at 30°C. On rising the temperature to 150°C, it was found that length of unit is increased by 5 mm. Determine the original length and stresses in bars. Given Es = 200 GPa, Ec = 100 GPa, $\alpha_s = 12 \times 10^6$/°C, $\alpha_c = 17 \times 10^6$/°C. **10**

(b) For the beam loaded as shown in figure, **Draw Shear Force and Bending Moment diagram**. **10**



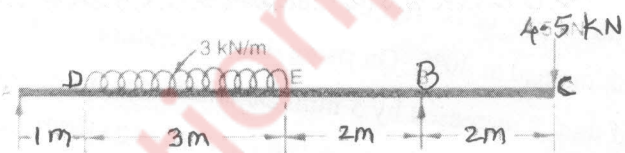
Q3. **(a)** A cast iron bracket, subjected to bending, has a cross section of I – Section with unequal flanges. The top flange has the dimension of 250 x 50 mm, the web is 250 x 50 mm and the bottom flange is 150 x 50 mm. If the maximum compressive stress is not to exceed 20MN/mm^2, what is the bending moment, the section can take? If the section is subjected to 80 KN, draw the stress distribution over the depth of the section. **10**

(b) A beam has T-shaped cross section of a beam having flange of 150 x 50 mm and web of 150 x 50 mm, is subjected to a sagging bending moment of 3400 Nm such that the beam bends in y-y plane. Plot stress distribution across the section. **10**

Q4. **(a)** The power transmitted by a solid circular shaft is 75 KW at 200 rpm. considering maximum shear stress allowed as 70 N/mm^2. Determine the diameter of the shaft such that maximum torque transmitted in each revolution exceeds mean torque by 30%. What would be the percentage saving in weight of the shaft if it is replaced be a hollow shaft with internal diameter as 0.7 times the external diameter. **10**

(b) A hollow circular column having external and internal diameters of 320 mm and 240 mm respectively carries a vertical load of 80 KN at the outer edge of the column. Calculate the maximum and minimum intensities of stress in the section. **10**

Q5. **(a)** A simply supported beam is subjected to the loads as shown in fig, Determine maximum deflection between A and B. Also find deflection at C. Take E = 2 x 10^5 N/mm^2 and I = 13.5x10^{-6}. **10**



(b) At a point in a strained material, the stresses on two mutually perpendicular planes are 50MPa (T) and 35MPa (C) accompanied by shear stress of 25MPa in clockwise direction. Find the normal and shear stress acting on a plane which is at an angle of 120° with the reference to 50MPa.Also determine the principal stresses, maximum shear stress and their orientation **10**

6. **(a)** Determine the section of a cast iron hollow cylindrical column 3 m long with both ends firmly built in if it carries an axial force of 800 KN. The ratio of internal to external diameter is 5/8. Take factor of safety as 4, yield stress σ_c = 550 N/mm^2 and rankine constant α = 1/1600. **10**

(b) An unknown weight falls through a height of 10 mm on a collar rigidly attached to the lower end of a vertical bar 5 m long and 600 mm^2 in section. If the maximum extension of the rod is to be 2 mm, what is the corresponding stress and magnitude of the unknown weight? Take E = 2 x 10^5 N/mm^2. **10**