1. Explain the following terms
   a. Poisson’s Ratio
   b. Bulk Modulus
   c. Torsional Rigidity
   d. Polar Moment of Inertia
   e. Longitudinal stresses

2. (a) Draw stress-strain diagram of a ductile material & explain each point in brief. (10)

   (b) A steel bar is placed between two Cu bars each having the same area & length as the steel bar at 15 °C. At this stage they are rigidly connected together at the both ends. When the temp. is raised to 315 °C, the length of the bar increased by 1.5mm. Determine the original length & the final stresses in the bars.

   Take \( E_s = 2.1 \times 10^5 \) N/mm\(^2\), \( E_c = 1.0 \times 10^5 \) N/mm\(^2\) \( \alpha_s = 12 \times 10^{-6}/^\circ C \)
   \( \alpha_c = 17.5 \times 10^{-6}/^\circ C \)

3. (a) Define with neat sketches different types of load. Differentiate between a point load & a uniformly distributed loads. (10)

   (b) A simply supported beam of length 9m is carrying a uniformly distributed load of 10KN/m for a distance of 6m from the left end. Draw shear force & B.M. diagrams of the beam. (10)

4. (a) Drive the relation for a circular shaft when subjected to torsion as given below

   \[
   \frac{T}{J} = \frac{\tau}{R} = \frac{G \theta}{L}
   \]

   Where \( T = \) Torque transmitted \( \tau = \) Max. shear stress
   \( R = \) Radius of the shaft \( J = \) Polar Moment of Inertia
   \( G = \) Modulus of Rigidity \( L = \) Length of the shaft
   \( \theta = \) Angle of twist

4. (b) Two shafts of the same material are subjected to the same torque. If the first shaft is of solid circular section & the second shaft is of hollow section whose internal diameter is 2/3 of the outside diameter, compare the weights of the two shafts. (8)

5. (a) Prove that the max. shear stress in a rectangular section of a beam is 1.5 times the average stress. (10)

   (b) A simply supported beam carries a UDL of 40kN/m over the whole span. The section of the beam is rectangular having depth of 500mm. If the max. stress in the material of the beam not to exceed by 120N/mm\(^2\) & M.O.I of the section is \( 7 \times 10^8 \) mm\(^4\), find the length of the beam. (10)

6. (a) Drive an expression for the slope & deflection of a simply supported beam carrying a point load at the centre of the beam. (10)

   (b) A beam of rectangular section 200mm wide and 300mm deep is simply supported at its ends. It carries a UDL of 9 KN/m run over the entire span of 5m. If the value of \( E \) for the beam is \( 1 \times 10^4 \) N/mm\(^2\). Find the slope at the support & maximum deflection. (10)

7. (a) Explain the Rankine – Gordon formula is used to calculate the intensity of stress in short, intermediate and long column. (10)

   (b) A 1.5 m long column has a circular cross-section of 5cm diameter. One of the ends of the column is fixed in direction and position and other end is free. Taking FOS as 3, calculate the safe load using:

   (i) Rankine’s Formula, take yield stress, \( \sigma_c = 560 \) N/mm\(^2\) and \( a = 1/1600 \) for pinned ends.

   (ii) Euler’s formula, \( E = 1.2 \times 10^5 \) N/mm\(^2\) (10)