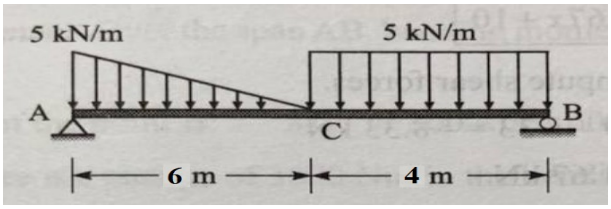
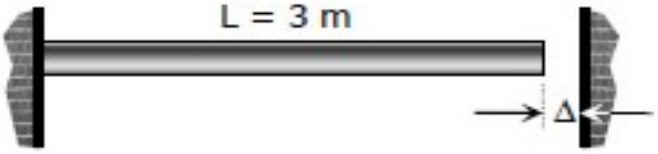
Name: **Enrolment No:**	UPES UNIVERSITY OF TOMORROW

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, May 2022

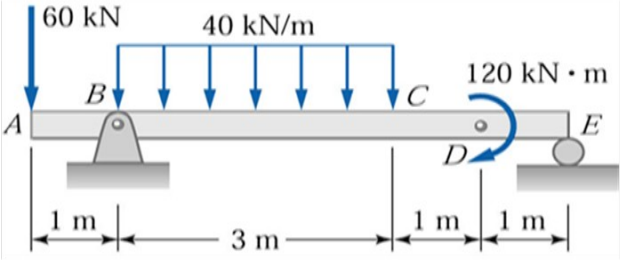
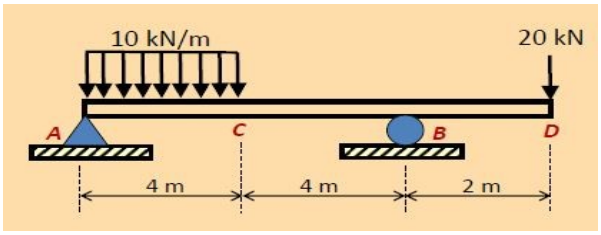
Course: Strength of Materials **Semester : IV**
Program: B. Tech. Automotive Design Engineering **Time : 03 hrs.**
Course Code: MECH 2018 **No. of Pages: 04** **Max. Marks : 100**

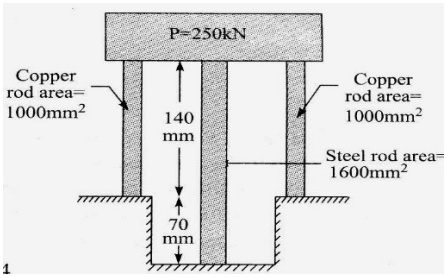
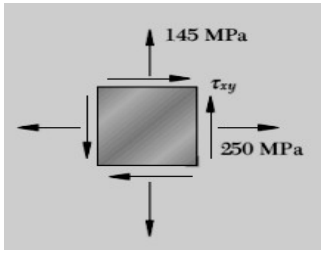
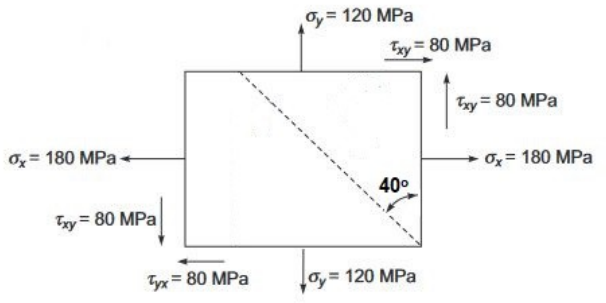
Instructions: Assume any missing data.

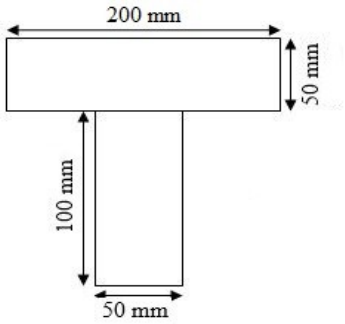
SECTION A
(5Qx4M=20Marks)

S. No.		Marks	CO
Q 1	Enumerate the basic assumptions of Torsion Theory.	**4**	**CO3**
Q 2	Determine the support reactions on the loaded beam shown in the figure below. 	**4**	**CO1**
Q 3	A bronze bar 3 m long with a cross sectional area of 320 mm^2 is placed between two rigid walls as shown in figure below. At a temperature of -20°C, the gap is Δ = 2.5 mm. Find the temperature at which the compressive stress in the bar will be 35 MPa. Given that α = 18.0 × 10^{-6} m / (m·°C) and E = 80 GPa. 	**4**	**CO1**
Q 4	Define shear force and bending moment acting at a cross-section of a loaded beam.	**4**	**CO2**
Q 5	A cylindrical specimen of 36 mm diameter was subjected to a pull of 90 kN during a tension test. The extension on a gauge length of 200 mm was measured to be 0.089 mm and the change in diameter was measured to be 0.0046 mm. Determine modulus of elasticity and Poisson's ratio for the material of the specimen.	**4**	**CO1**

SECTION B

	(4Qx10M= 40 Marks)		
Q 6	Determine the slope and deflection at point C of the single overhanging beam hinged at A, roller supported at E and loaded as shown in figure below. Take EI = 6 x 10^5 Nm^2.  **OR** Determine the slope and deflection at point C of the single overhanging beam hinged at A, roller supported at B and carrying a point load of 20 kN at the free end D, uniformly distributed load of 10 kN/m intensity between A and C as shown in figure below. Take EI = 1.2 x 10^5 Nm^2.  	**10**	**CO2**
Q 7	A thin spherical shell of internal diameter of 70 cm is initially filled with a fluid at atmospheric pressure. Some additional volume of fluid is then pumped into the shell to raise the pressure to 8 MPa above atmospheric. If yield strength of the material is 350 MPa and a factor of safety of 5 is employed, then determine the minimum wall thickness of the shell and volume of the fluid pumped. Modulus of elasticity and Poisson's ratio of the shell material is 220 GPa and 0.3 respectively. The bulk modulus of the fluid is 2.1 GPa. Neglect the effect of radial stresses.	**10**	**CO4**
Q 8	A solid alloy shaft of 50 mm diameter is coupled in series with a hollow steel shaft of same external diameter. Determine the internal diameter of the hollow steel shaft if the angle of twist per unit length in hollow shaft is 75% of that of the solid alloy shaft. Also, determine the speed at which the compound shaft must be driven to transmit 200 kW, if the limiting shear stresses are 55 MPa and 75 MPa in alloy and steel respectively. Take G_{steel} = 2.2 $G_{alloy.}$	**10**	**CO3**

Q 9	Two copper rods and one steel rod together support a load 250 kN as shown in figure. Determine the stresses developed in the copper and steel rods. Take E_{steel} = 200 GPa and E_{copper} = 100 GPa.  	**10**	**CO1**
	SECTION-C **(2Qx20M=40 Marks)**		
Q 10	For the state of plane stress shown below, determine (a) the largest value of τ_{xy} for which the major principal stress is equal to 300 MPa, (b) the minor principal stress, maximum shear stress and principal planes.  Construct the Mohr's stress circle for this plane stress condition showing the above results and determine graphically the normal and shear stresses on an oblique plane making an angle of 35° clockwise to the plane of σ_x. **OR** For the state of plane stress shown below, determine (a) principal stresses, (b) the principal planes, and (c) maximum shear stress.  Construct the Mohr's stress circle for this plane stress condition showing the above results and determine graphically the normal and shear stresses on an oblique plane making an angle of 40°	**20**	**CO4**

	counter-clockwise to the plane of σ_x.		
Q 11	A beam with T cross-section as shown in figure below is subjected to a maximum bending moment of 105 kN-m. The shear force at this cross-section is 85 kN. Determine the maximum tensile and compressive bending stresses induced in the beam. Also, determine the shear stress developed at the mid surface of the flange and at the neutral axis.  	**20**	**CO3**