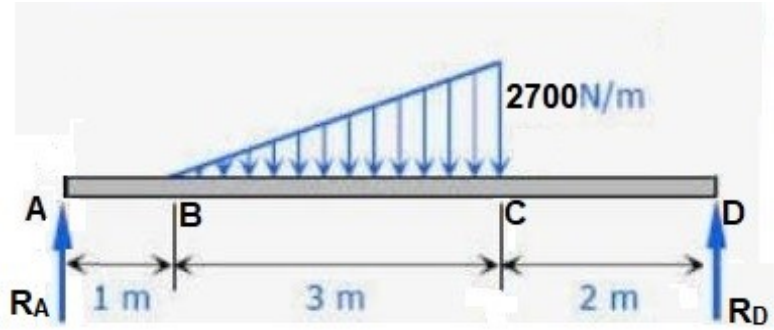
Name: **Enrolment No:**	UPES UNIVERSITY OF TOMORROW

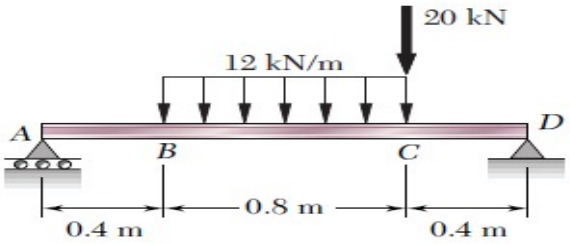
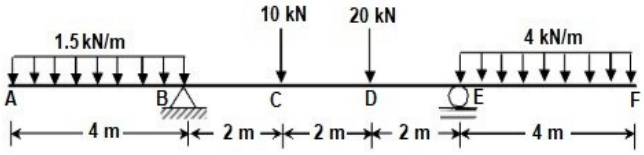
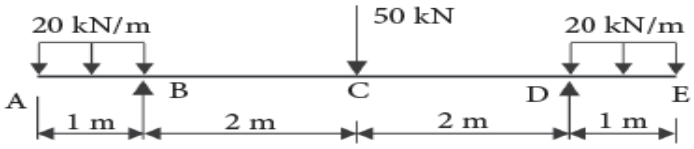
UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, May 2022

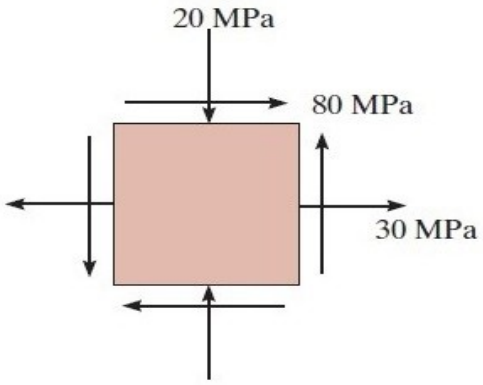
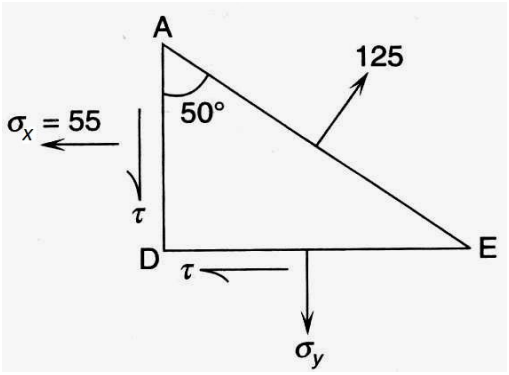
Course: Strength of Materials **Semester : IV**
Program: B. Tech. Mechatronics Engineering **Time : 03 hrs.**
Course Code: MECH 2018 **No. of Pages: 04** **Max. Marks : 100**

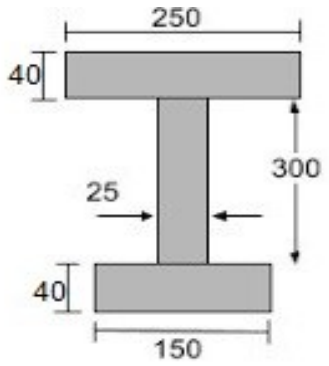
Instructions: Assume any missing data.

SECTION A
(5Qx4M=20Marks)

S. No.		Marks	CO
Q 1	Enumerate the basic assumptions of Torsion Theory.	**4**	**CO3**
Q 2	A steel rod 30 mm diameter and 300 mm long is subjected to a tensile force P acting axially. The temperature of the rod is then raised through 80 °C and the total extension measured as 0.35mm. Calculate the value of P. Take modulus of elasticity of steel E_s = 200GN/m^2 and α_s =12 x 10^{-6} per °C.	**4**	**CO1**
Q 3	Determine the support reactions R_A and R_B on the loaded beam shown in the figure below. 	**4**	**CO1**
Q 4	A metal block is subjected to a tensile normal stress of 60 MPa and a compressive normal stress of 40 MPa in x and y directions respectively. Using generalized Hooke's law, determine normal strain in x direction. Take elastic modulus E = 150 GPa and Poisson's ratio v = 0.27 for the material of block.	**4**	**CO4**
Q 5	A material has modulus of elasticity E = 200 GPa. If the bulk modulus of the material K = 160 GPa, determine the Poisson's ratio and shear modulus of the material.	**4**	**CO1**

SECTION B (4Qx10M= 40 Marks)			
Q 6	For the beam and loading shown in figure below, determine the deflection of the mid-point. Take EI = 8.3 x 10^5 Nm^2.  	**10**	**CO2**
Q 7	A thin cylindrical shell of 1 m internal diameter, 3 m length and wall thickness of 1.2 cm is filled with a fluid at atmospheric pressure. What intensity of pressure will be developed, if 175 cm^3 more fluid is pumped into it? Also, calculate the circumferential stress and change in diameter at that pressure. The modulus of elasticity of shell material is 200 GPa and bulk modulus of fluid is 2.1 GPa. Take Poisson's ratio for the material of shell as 0.3.	**10**	**CO4**
Q 8	A shaft is required to transmit 245 kW power at 240 rpm. The maximum torque is 50% more than the mean torque. The shear stress in the shaft is not to exceed 40 N/mm^2 and the twist 1º per meter length. Taking G = 80 kN/mm^2, determine the diameter required if, (a) the shaft is solid and (b) the shaft is hollow with external diameter twice the internal diameter.	**10**	**CO3**
Q 9	A double overhanging beam hinged at B and roller supported at E is loaded as shown in figure below. Draw shear force and bending moment diagrams by indicating the principal values at all the points and position of point of contra-flexure. Also, determine the maximum bending moment on the beam.  **OR** A double overhanging beam roller supported at B and D is loaded as shown in figure below. Draw shear force and bending moment diagrams by indicating the principal values at all the points and position of point of contra-flexure. Also, determine the maximum bending moment on the beam.  	**10**	**CO2**

	SECTION-C **(2Qx20M=40 Marks)**		
Q 10	The state of stress for a steel component is shown in figure below. Determine the magnitudes of principal stresses, maximum shear stress and position of 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 55° counter clockwise to the plane of 30 MPa stress. **OR** An oblique plane in a strained material subjected to two dimensional stress system transmits a normal tensile stress of 55 MPa along with an unknown shear stress as shown in figure. The maximum principal stress in the material is 125 MPa tension acting on plane inclined at 50^0 with the plane of 55 MPa stress. Determine analytically: (a) Second principal stress, (b) Maximum shear stress, and (c) Directions of principal planes.  Construct Mohr's stress circle to show all above and determine, graphically the normal and shear stresses on an oblique plane making an angle of 25° counter clockwise to the plane of σ_x.	**20**	**CO4**
Q 11	An unequal I-beam with cross-section as shown in figure below is	**20**	**CO3**

	subjected to a maximum bending moment of +25 kN-m. The shear force at this cross-section is 40 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 upper flange and at the neutral axis.  Dimensions are in mm.		