Name: Enrolment No:	UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

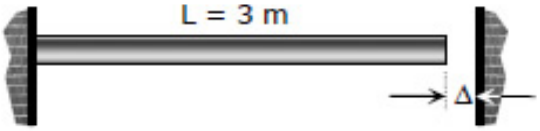
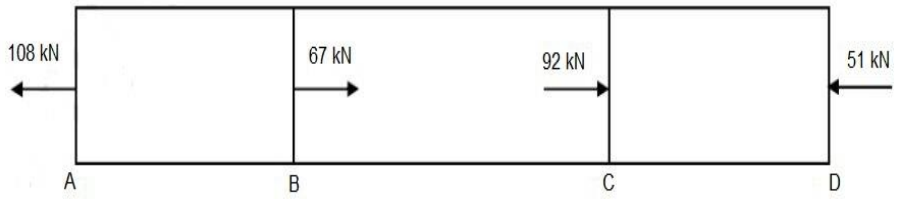
END Semester Examination, December 2021

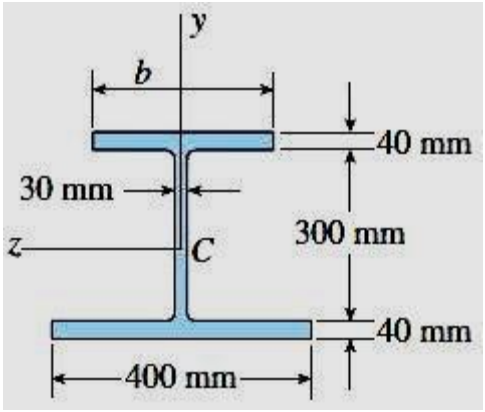
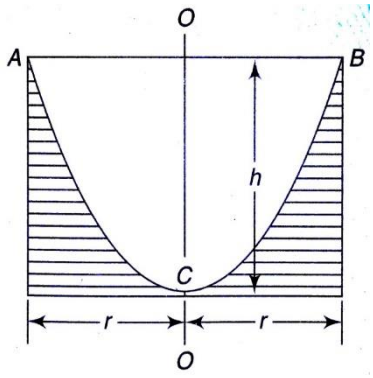
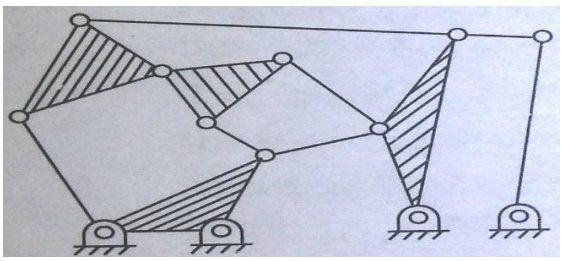
Program : M. Tech- Automation and Robotics Engineering **Semester** : I
Course : Mechanics for Automation and Robotics **Time** : 03 hrs
Course Code : ECEG 7014 **Nos. of page(s)** : 4 **Max. Marks** : 100

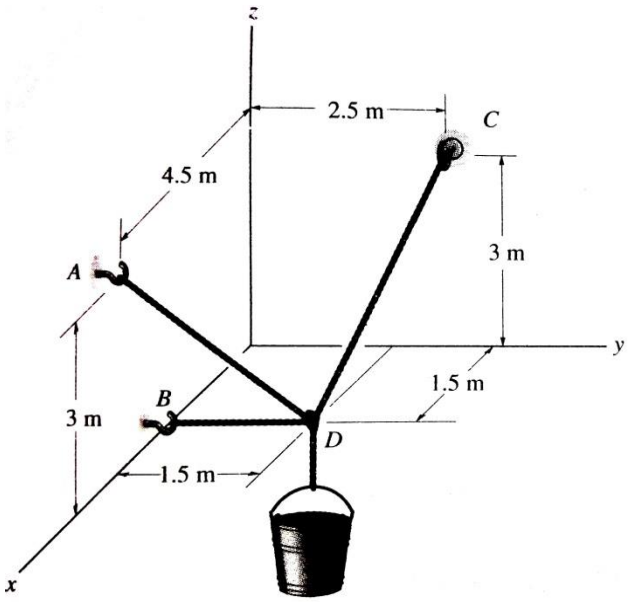
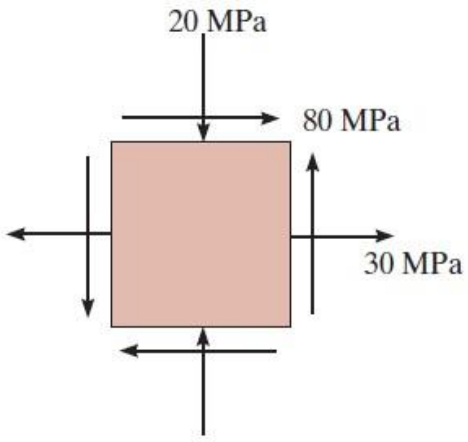
Instructions:

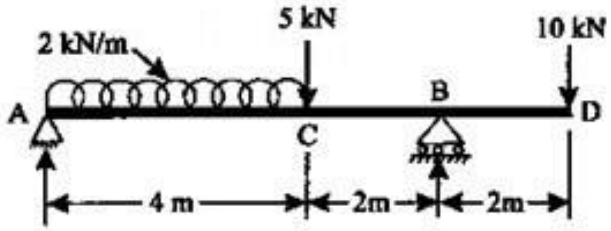
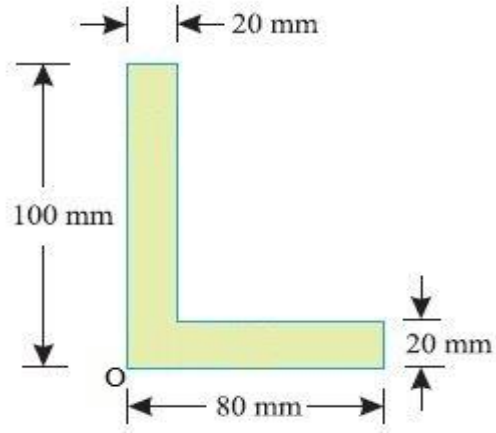
i. *There are three sections viz. Section A, Section B and Section C. Section A carries 20 marks, Section B carries 40 marks and Section C carries 40 marks*
ii. *Attempt all the questions in Section A, B and C*
iii. *Make appropriate assumptions wherever required*

SECTION A (5 x 4 = 20 Marks)

S. No.		Marks	CO
Q 1	What is a kinematic chain? Differentiate between locked chain, constrained chain and unconstrained chain.	4	CO5
Q 2	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 $\alpha = 18.0 \times 10^{-6}$ m / (m·°C) and E = 80 GPa. 	4	CO4
Q 3	What is a mechanism? Differentiate between structure and machine. Enumerate different kinematic pairs with mechanical constraint.	4	CO5
Q 4	A hollow circular steel shaft of external and internal diameters 200 mm and 120 mm respectively is used to transmit power at 200 rpm. The average torque is 7% less than the maximum torque. If the allowable shear stress in the material of shaft is 240 MPa, determine the power transmitted by the shaft.	4	CO4
Q 5	A uniform bar ABCD of cross-sectional area of 500 mm^2 is subjected to axial loads at its different cross-sections as shown in figure below. Determine the magnitude and nature of stress in the length segment BC. 	4	CO4

SECTION B (4 x 10 = 40 Marks)			
Q 6	A beam having a cross section in the form of an unsymmetrical wide-flange shape as shown in figure below is subjected to a negative bending moment acting about the z-axis. Determine the width of the top flange in order that the stresses at the top and bottom of the beam will be in the ratio 4:3.  **OR** A right circular cylindrical tank containing water spins about its vertical geometric axis OO at such speed that the free water surface is a parabaloid ACB as shown in figure below. Using theorem of Pappus and Guldinus, determine the depth of water in the tank when it comes to rest.  	**10**	**CO2**
Q 7	What is degree of freedom? Explain the Grubler's criteria to obtain the degree of freedom of any planer mechanism. For the linkage shown in figure below, determine the binary links, ternary links, total links and degree of freedom. 	**10**	**CO5**

Q 8	Three cables AD, BD and CD support a bucket as shown in figure below. If each cable can sustain a tension of 600 N, determine the greatest weight of the bucket that can be suspended without failure of the system.  	**10**	**CO1**
Q 9	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. Also, determine the normal and shear stresses on an oblique plane 40° clockwise to the plane of 20 MPa stress.  If Poisson's ratio for the shaft material is 0.3 and failure of the shaft is according to Maximum Strain Energy per unit volume theory, determine the yield strength of the material for a factor of safety 3.0.	**10**	**CO4**

SECTION C (2 x 20 = 40 Marks)			
Q 10	Draw the shear force and bending moment diagram of the beam hinged at A and roller supported at B as shown in figure below. Also, find the maximum value of the bending moment. Locate the points of contra-flexure if any.  Also, determine the slope and deflection at mid-point C. Take EI = 8.2 x 10^6 Nm^2. **OR** A double overhanging beam ABCDE has equal overhung AB and DE, each of 2 m on both sides. It is simply supported at B and D such that span BD is 6m and the total length of beam is 10 m. It carries two equal point loads each of 75 kN at the ends A and E together with third point load of 100kN at the mid-point C. In addition, it also carries a uniformly distributed load of 50 kN/m between the supports. Sketch the Shear Force and Bending Moment diagrams for this beam. Determine the location of point of contra-flexure, if any and the value of deflection at the mid-point of the beam either by Macaulay's method or by Area Moment method. Given E = 200 GPa and I = 72 x 10^{-6} m^4.	**20**	**CO3**
Q 11	The centroid of the L section shown in figure below is located at $\bar{x}$ = 25 mm and $\bar{y}$ = 35 mm with respect to origin O. Determine the moment of inertia about centroidal axes, orientation of principal axes with respect to centroidal axes and principal moments of inertia of the section.  	**20**	**CO2**