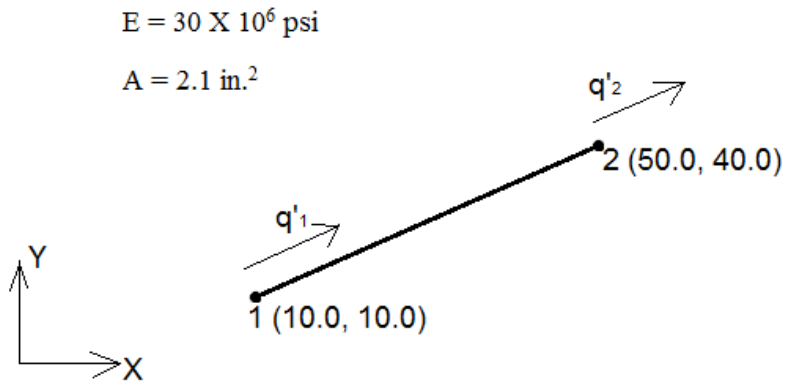
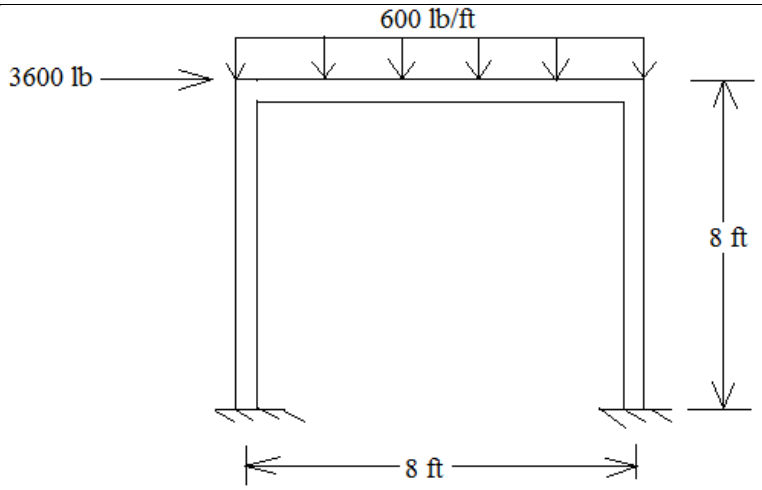
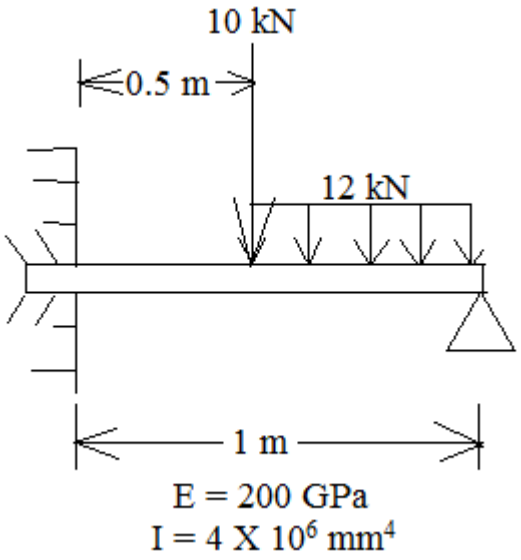
Name: **Enrolment No:**	UPES

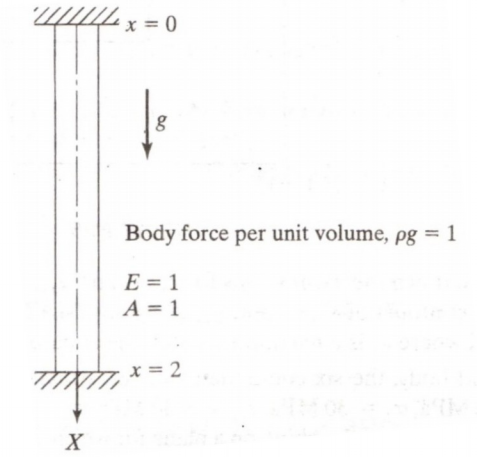
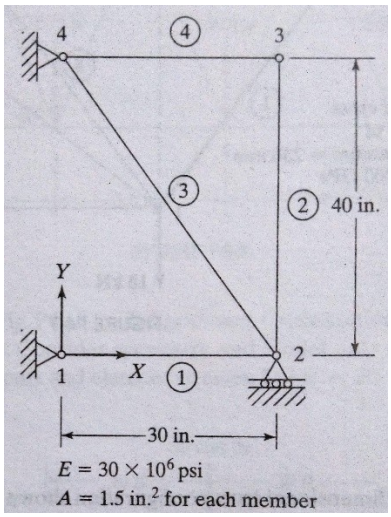
UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, December 2018

Course: Finite Element Analysis (ASEG 483) **Semester: VII**
Programme: B.Tech. Mechanical Engg.
Time: 03 hrs. **Max. Marks: 100**
Instructions: Assume any missing data. (Total pages = 4)

SECTION A

S. No.		Marks	CO
Q 1	Discuss how shape functions are selected. Describe the linear and quadratic shape functions for a bar element.	**4**	**CO2**
Q 2	Describe the various approaches for handling the boundary conditions during finite element analysis.	**4**	**CO2**
Q 3	Derive the transformation matrix **L** for converting the global coordinates into local coordinates.	**4**	**CO3**
Q 4	Consider the truss element shown in Fig. 1. The x-, y- coordinates of the two nodes are indicated in the figure. If **q** = $[1.5, 1.0, 2.1, 4.3]^T$ X 10^{-2} inch, determine the following: (a) the stress in the element, (b) the strain energy in the element.  Fig. 1: Figure for Q.4	**4**	**CO3**
Q 5	A portal frame is shown below in Fig. 2. Develop the global load vector for the horizontal member using only one finite element.	**4**	**CO4**

	 Fig. 2: Portal frame		
	SECTION B		
Q 6	Derive the **B** matrix for a constant strain triangle element. **OR** Derive the **B** matrix for a four node quadrilateral element.	**10**	**CO5**
Q 7	For the beam loading shown in Fig. 3, develop the relation **KQ** = **F**. Apply the boundary conditions also.  Fig. 3: Figure for Q.7	**10**	**CO4**
Q 8	Find the displacement at the mid-point of the rod shown in Fig. 4 using Galerkin's method.	**10**	**CO1**

	 Fig.4: Figure for Q. 8		
Q 9	Analyze the equilibrium equations for a three-dimensional body.	**10**	**CO1**
	SECTION-C		
Q 10	For the truss shown in Fig. 5, a horizontal load of P = 4000 lb is applied in the x-direction at node 2. (a) Write down the element stiffness matrix **k** for each element. (b) Assemble the **K** matrix. (c) Using the elimination approach, solve for **Q**. (d) Evaluate the stress in elements 2 and 3. (e) Determine the reaction force at node 2 in the y-direction.  Fig. 5: Truss	**20**	**CO3**
Q 11	a) A plate in the form of a sector is shown in Fig. 6. Inner radius (OD) of the plate is 30 cm and the outer radius (OC) of the plate is 35 cm. Perform the meshing of the plate using four CST elements and thus develop the mathematical model. You need not to assemble the element stiffness matrices	**20**	**CO5/ CO2/ CO1**

and element load vectors. The plate is fixed at end CD. Take E = 2 X 10^{11} N/ m^2.

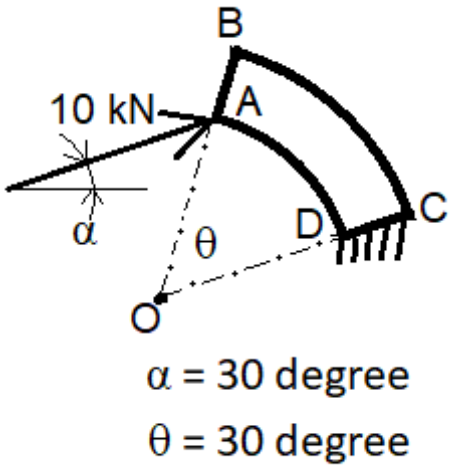


Fig. 6: A sector plate

OR

b) Determine the stresses in the 4 in. long bar in Fig. 7, using two linear (bar) elements. (Note: *x* in., *T* kips/in.)

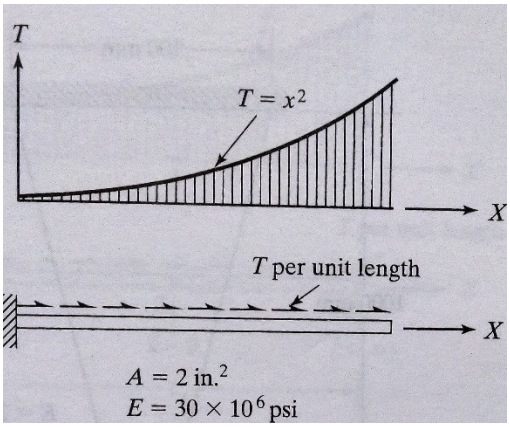


Fig. 7: Figure for Q 11 b