Name:

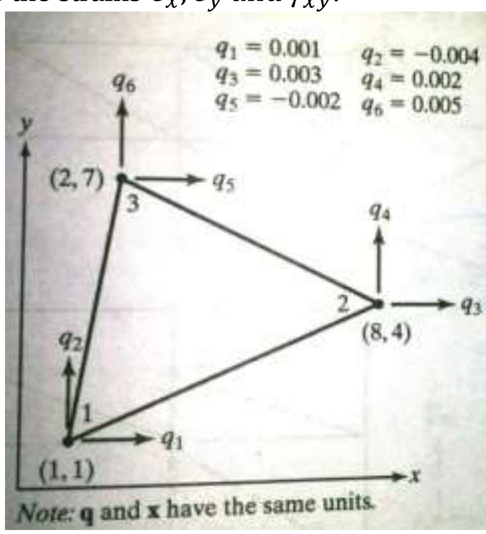
Enrolment No:

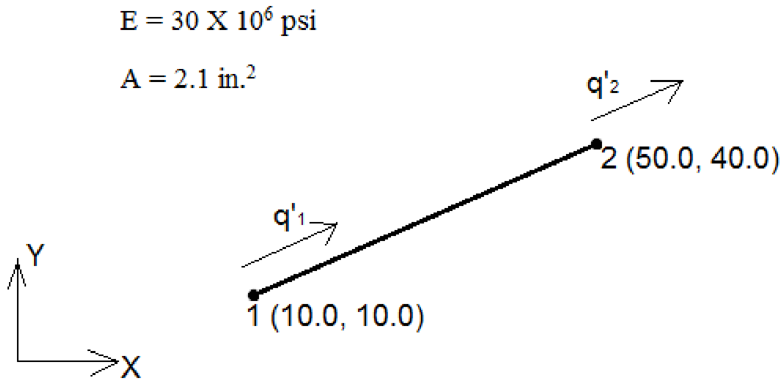
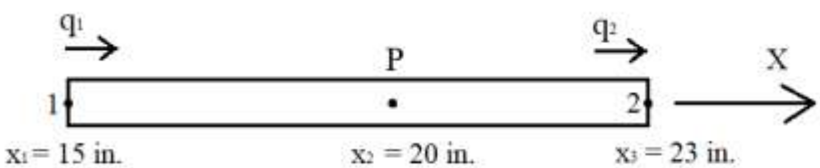
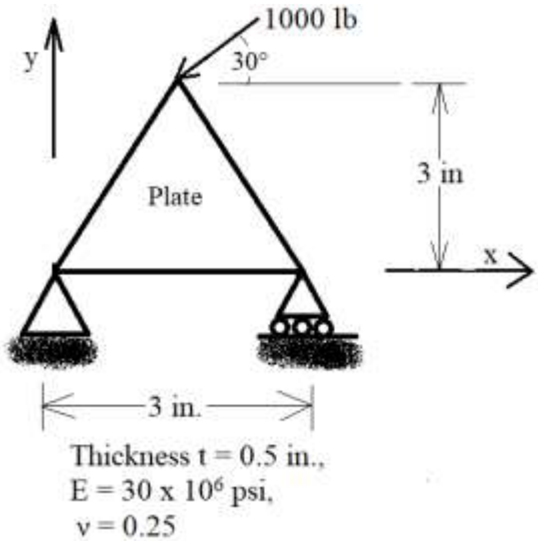
UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, December 2019

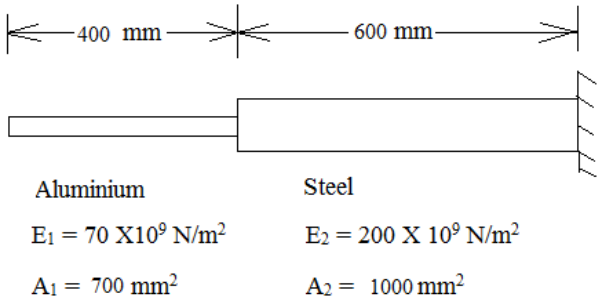
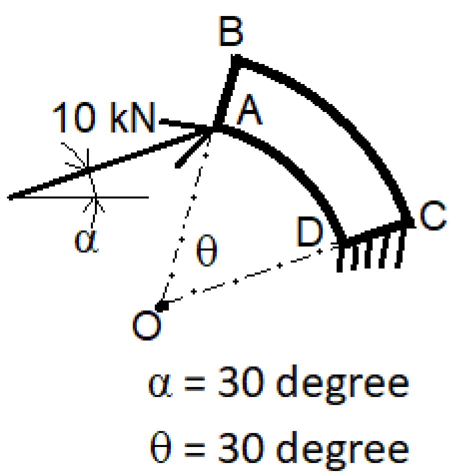
Course: Finite Element Analysis | **Semester: VII**
Program: B.Tech. Mechanical Engineering (Core & Specialization, International students)
Time 03 hrs. | **Max. Marks: 100**
Course Code: ASEG 483 | **Pages: 04**

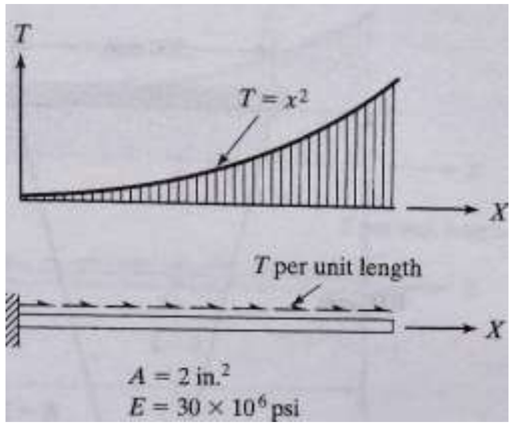
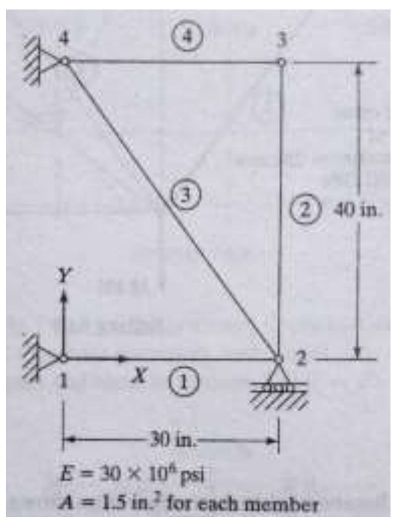
Instructions: Assume any missing data.

SECTION A

S. No.		Marks	CO
Q 1	For the triangular element shown in Figure 1, obtain the strain-displacement relation matrix **B** and determine the strains ϵ_x, ϵ_y and γ_{xy}.  Fig. 1: A triangular element	**5**	**CO1**
Q 2	Discuss the Hermite shape functions for a beam element.	**5**	**CO1**
Q 3	Consider the truss element shown in Figure 2. The x-, y- coordinates of the two nodes are indicated in the figure. If **q** = $[1.5, 1.0, 2.1, 4.3]^T \times 10^{-2}$ inch, determine the following: (a) the stress in the element, (b) the strain energy in the element.	**5**	**CO1**

	 Fig. 2: Figure for Q.3		
Q 4	Consider the bar in Figure 3. Cross-sectional area $A_e = 1.2$ in.^{2}, and Young's modulus $E = 30 \times 10^6$ psi. If $q_1 = 0.02$ in. and $q_2 = 0.025$ in., determine the following: (a) The displacement at point P, (b) The strain ϵ and stress σ, (c) The element stiffness matrix, and (d) The strain energy in the element.  Fig. 3: Bar	**5**	**CO1**
SECTION B			
Q 5	Derive the expression for mass matrix for a quadratic bar element.	**10**	**CO2**
Q 6	For the two-dimensional isosceles triangular plate shown in Figure 4, determine the nodal displacements.  Fig. 4: A 2D loaded plate	**10**	**CO3/ CO2**

	OR Develop the formulation for stiffness matrix for a four-node quadrilateral element.		
Q 7	Determine the natural frequencies and mode shapes for steel bar shown in Figure 5.  Fig. 5: A stepped bar	**10**	**CO3**
Q 8	Discuss the equilibrium equations for a three-dimensional body occupying a volume V and having a surface S.	**10**	**CO1**
SECTION-C			
Q 9	(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 determine the **B** matrices and element load vectors. Determine the stiffness matrix for any one element. Specify the order of assembled global stiffness matrix. The plate is fixed at end CD. Specify the boundary conditions. Take E = 2 x 10^{11} N/m^2, $\nu = 0.3$ and thickness of plate, t = 1 cm.  Fig. 6: A sector plate (Q. 9a) **OR**	**20**	**CO4**

	(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. 9b		
Q 10	For the truss shown in Fig. 8, 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. 8: Truss	**20**	**CO3**