Name: **Enrolment No:**	UPES UNIVERSITY WITH A PURPOSE

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
Online End Semester Examination, January 2021

Course: Finite Element Methods for Fluid Dynamics **Semester: I**
Program: M. Tech CFD **Time: 03 hrs.**
Course Code: ASEG 7022 **Max. Marks: 100**
Pages: 03
Instructions: Make use of sketch/plots to elaborate your answer. All sections are compulsory

SECTION A (30 marks)

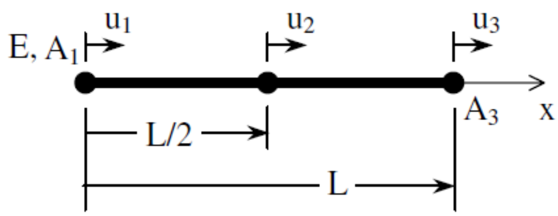
1. Each Question will carry 5 Marks
2. Instruction: Type your answers in the provided space

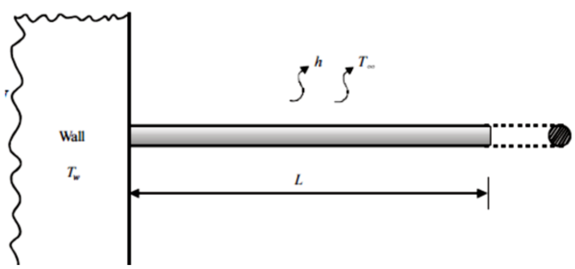
S. No.		**Marks**	**CO**
Q 1	Which relations are used in one dimensional finite element modeling? a) Stress-strain relation b) Strain-displacement relation c) Total potential energy d) Total potential energy; Stress-strain relation; Strain-displacement relation.	**[05]**	**CO2**
Q 2	Stiffness matrix represents a system of ________ a) Programming equations b) Iterative equations c) Linear equations d) Program CG SOLVING equations	**[05]**	**CO1**
Q 3	What are the basic unknowns on stiffness matrix method? a) Nodal displacements b) Vector displacements c) Load displacements d) Stress displacements	**[05]**	**CO1**
Q 4	Write the element stiffness matrix for a beam element. a) $K = \frac{2EI}{l}$ b) $K = \frac{2EI}{l}\begin{bmatrix} 2 & 1 \\ 1 & 2 \end{bmatrix}$ c) $K = \frac{2E}{l}\begin{bmatrix} 2 \\ 1 \end{bmatrix}$ d) $K = \frac{2E}{l}\begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}$	**[05]**	**CO2**
Q 5	Principal of minimum potential energy follows directly from the principal of ________ a) Elastic energy b) Virtual work energy c) Kinetic energy d) Potential energy	**[05]**	**CO3**

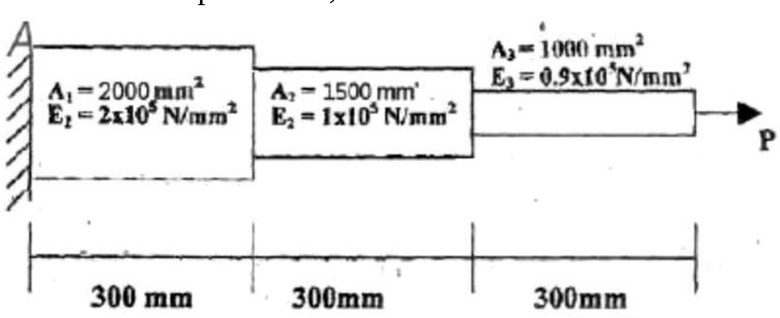
Q 6	Dimension of global stiffness matrix is _______ a) N X N, where N is no of nodes b) M X N, where M is no of rows and N is no of columns c) Linear d) Eliminated	**[05]**	**CO3**

SECTION B (50 marks)

1. **Each question will carry 10 marks**
2. **Instruction: Write short/brief notes, scan and upload the document**

Q 7	Solve the following equation using a two-parameter trial solution by the Rayleigh-Ritz method, $$\frac{dy}{dx} + y = 0, \qquad y(0) = 1$$	**[10]**	**CO2**
Q 8	Define the following terms with suitable sketches; (i) Shell element; (ii) Beam element; (iii) Truss element; (iv) 3D element	**[10]**	**CO3**
Q 9	Solve the differential equation for a physical problem expressed as $\frac{d^2y}{dx^2} + 100 = 0$ $0 \le x \le 10$ with boundary conditions as y(0)=0 and y(10)=0 using (i) Point collocation method (ii) Sub domain collocation method	**[10]**	**CO3**
Q 10	A 3 node rod element has a quadratic shape function matrix: $$N = \langle 1 - \frac{3x}{L} + \frac{2x^2}{L^2}, \frac{4x}{L} - \frac{4x^2}{L^2}, -\frac{x}{L} + \frac{2x^2}{L^2} \rangle$$ For L = 1 m, E = 200 × 10^9 Pa, $u_1 = 0, u_2 = 5 \times 10^{-6} m, u_2 = 15 \times 10^{-6} m$ Find: a. The displacement u at $x = 0.25\ m$. b. The strain as a function of x. c. The strain at $x = 0.25\ m$. d. The stress at $x = 0.25\ m$  	**[10]**	**CO4**

<table>
<tr><td>Q 11</td><td>Given the following stress tensor
$$\sigma = \begin{bmatrix} 10 & 20 & 30 \\ 20 & 40 & 50 \\ 30 & 50 & 60 \end{bmatrix}$$
I. What is the value of von Mises stress?
II. Propose two other stress tensor that will have the same von Mises stress?
III. Do all stress tensors having the same von Mises stress also have the same principle stresses?
IV. Do all stress tensors having the same principle stresses also have the same von Mises stress?</td><td>[10]</td><td>CO4</td></tr>
<tr><td colspan="4">SECTION-C (20 marks)
1. Question carries 20 Marks and has internal choice.
2. Instruction: Write long answer, scan and upload the document</td></tr>
<tr><td>Q 12</td><td>Consider a 1 mm diameter, 50 mm long aluminum pin fin as shown in the figure below that is used to enhance the heat transfer from a surface wall maintained at 300°C. The governing differential equation and the boundary conditions are given by,


$$k\frac{d^2T}{dx^2} = \frac{Ph}{A_c}(T - T_\infty); \qquad T(0) = T_w = 300^oC, \qquad \frac{dT}{dx}_{(L)} = 0$$
Let k = 200W/m/°C for aluminum, h = 20 W/m^2°C, T_∞ = 30°C. Estimate the temperature distribution in the fin at 10 equal points using the Galerkin residual method using an appropriate polynomial trial function.
OR
Consider the bar shown in figure axial force P = 30KN is applied as shown.
Determine the nodal displacement, stresses in each element and reaction forces.

</td><td>[20]</td><td>CO5</td></tr>
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