MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

II SEMESTER M.TECH. (APPLIED COMPUTATIONAL FLUID DYNAMICS)

END SEMESTER EXAMINATIONS, MAY 2024

SUBJECT: INTRODUCTION TO FINITE ELEMENT ANALYSIS OF SOLIDS AND FLUIDS [AAE -5219]

REVISED CREDIT SYSTEM

(03/05/2024)

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitably assumed.

1A Figure 1 shows a truss structure with two uniform members made of the same material. The truss structure is constrained at two ends. The cross-sectional area of all the truss members is 0.01 m^2, and the Young's modulus of the material is 2.0E10 N/m^2. Using the finite element method, calculate All the nodal displacements. **(04)**

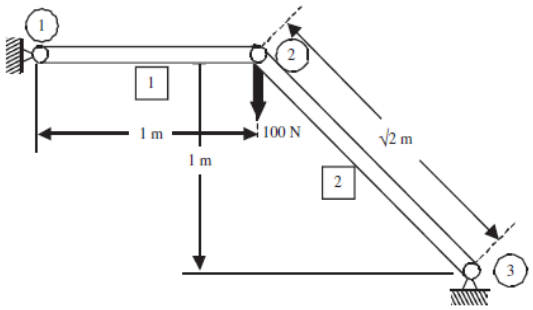

Figure 1

1B For the truss assembly shown in Figure 1, determine the reactions at the supports. **(03)**

1C For the truss assembly shown in Figure 1, determine the stresses in each element. **(03)**

2A Consider the cantilever beam as shown in Figure 2. The beam is fixed at one end, and it has a uniform cross-sectional area as shown. The beam undergoes static deflection by a downward load of P = 1000 N applied at the free end. The dimensions of the beam are shown in the figure and the beam is made of aluminium whose properties: are E= 69 Gpa, ν = 0.33. Determine the nodal dispalcemenet and rotation. **(04)**

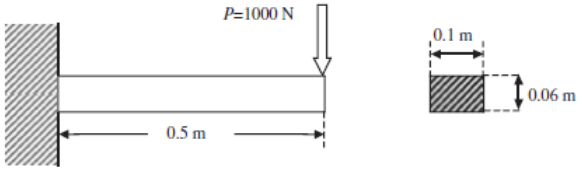

Figure 2

2B List the general steps involved in the finite element method. **(02)**

2C For the spring assemblages shown in Figure 3 determine the nodal displacements using the direct stiffness method. **(04)**

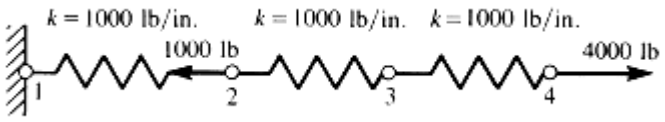

Figure 3

3A Consider a plane strain element as shown in Figure 4. Determine the stiffness matrix. Nodal displacements are given as **(05)**
u1 = 0.005 mm, u2 = 0.0 mm, u3 = 0.005 mm, v1 = 0.002 mm, v2 = 0.0 mm, and v3 = 0.0 mm.

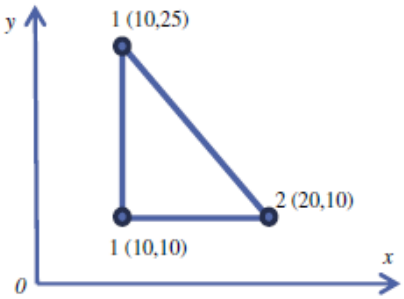

Figure 4

3B For the assembly shown in Figure 4, Calculate the stress components σ_x, σ_y, τ_{xy}. **(05)**

3C For the plane strain element shown in Figure 4 determine the σ_1, σ_2, and θ_p. **(03)**

4A For the beam assembly shown in Figure 5, determine the unknown displacements and rotations. **(05)**

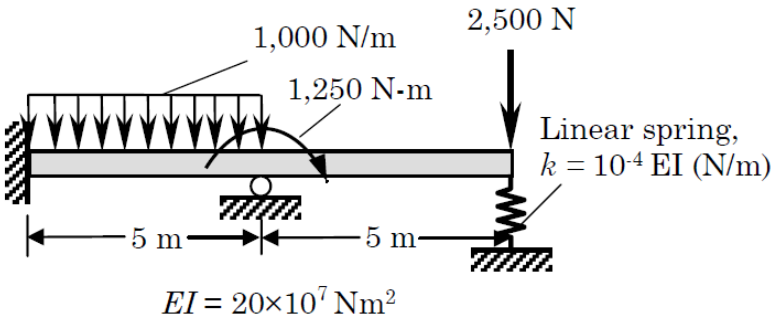

Figure 5

4B For the beam assembly shown in Figure 5, determine the reactions at the supports. **(03)**

5A For the beams shown in Figure 6, with an internal hinge, determine the deflection at the hinge. Let E = 210 GPa and I = $2X10^{-4}$ m^4. **(05)**

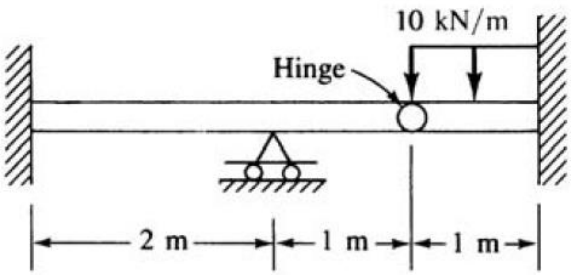

Figure 6

5B For the spring assemblages shown in Figure 7 determine the nodal displacements using the potential energy method. **(04)**

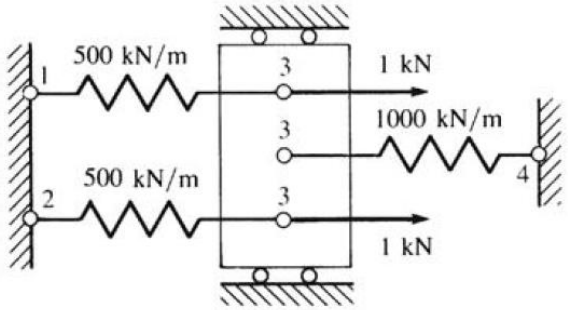

Figure 7