Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME - SEMESTER– II(Old course) • EXAMINATION (Remedial) – WINTER- 2015

Subject Code: 1720901 **Date: 09/12/2015**

Subject Name: Finite Element Method

Time:2:30 pm to 5:00 pm **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** The bar shown in Fig. 1 is axially loaded at a temperature of 30° C. Determine the nodal displacements and elemental stresses if the temperature of the bar is raised to 50° C. Take: E= 200 GPa and Ŭ=12x10^{-6} per° C. **10**

(b) What is a constant strain triangular element? State its properties and applications. **04**

Q.2 **(a)** For the arrangement of spring-mass system shown in Fig. 2, derive the potential energy equation and find the nodal displacement using minimum potential energy approach. **07**

(b) (i) State the advantages and limitations of Finite Element analysis. **07**

(ii) The coordinates of the nodes i, j and k of a CST element are (1,2), (5, 3) and (4, 6) respectively. At the interior point P, the x-coordinate is 3.3 and the shape function N_1 is 0.3. Determine the y-coordinate at the point P.

OR

(b) (i) State the advantages of isoparametric formulation. Explain sub-parametric and super-parametric elements. **07**

(ii) For the CST element having coordinates at (0, 0), (2, 5) and (4, 0.5), obtain the shape functions and the intensity of pressure at a point with coordinates (2, 1.5). The nodal values of pressures at nodes 1, 2 and 3 are 60 N/m^2, 50 N/m^2 and 70 N/m^2 respectively.

Q.3 **(a)** The thin plate of uniform thickness 20 mm is shown in Fig. 3. In addition to the self-weight, the plate is subjected to a point load of 400N at mid-depth. The Young's modulus E = 2 × 10^5 N/mm^2 and density ɟ = 8 gm/cc. Analyze the plate after modeling it with two elements and find the stresses in each element. **10**

(b) Derive the shape function for a quadratic bar element using Lagrangian method. **04**

OR

Q.3 **(a)** A tapered bar is loaded axially as shown in Fig. 4. Model the problem with four elements and find the nodal displacements. **10**

Given: A_1=2400 mm^2, A_2=600 mm^2, L=300 mm, E=70 GPA, P=20 kN

(b) What do you mean by symmetric problem? Explain, with example, the application of FEM to the solution of following symmetric problems. **04**

(i) Axisymmetry and (ii) Rotational symmetry.

Q.4 **(a)** For the three-element truss shown in Fig. 5, calculate the x and y displacements at node 1 and the stress in each element. **10**

Given: E =200 N/mm^2 and A= 250 mm^2 for all elements.

The lengths of the elements are shown in the figure.

(b) Prepare the finite element model of the following problems specifying the boundary conditions, type of element, and meshing. **04**

(i) a long hollow cylinder subjected to internal pressure.

(ii) a steel flywheel rotating at 3000 rpm.

OR

Q.4 **(a)** Consider the bar shown in Fig. 6 made of steel having E=200 GPa. An axial load P=200 kN is applied as shown. Using the penalty approach for handling the boundary conditions, determine the: **10**

(i) nodal displacements, and (ii) stress in each element.

Note that the displacement at free end is more than 3.5 mm , if constraint on right end side is not present.

(b) Prepare the finite element model of the following problems specifying the boundary conditions, type of element, and meshing. **04**

(i) an octagonal pipe subjected to internal pressure.

(ii) Belleville spring.

Q.5 **(a)** A cantilever beam of 10 m length is subjected to uniformly distributed load as shown in Fig. 7. Model using a single element and calculate the deflection at the free end of the beam using FEM if E = 200 Gpa, A=500 mm^2 and I = 2500 cm^4. **09**

(b) Derive the stiffness matrix for a 2D frame Element. **05**

OR

Q.5 **(a)** Determine the angle of twist in degrees at the step and the maximum shear stress in each section for the stepped circular bar shown in Fig. 8. **08**

Given: G = 77 GPa.

(b) (i) How can the bandwidth of a matrix be minimized? Explain with illustrative examples. **06**

(ii) Sketch Linear and Quadratic tetrahedral elements.

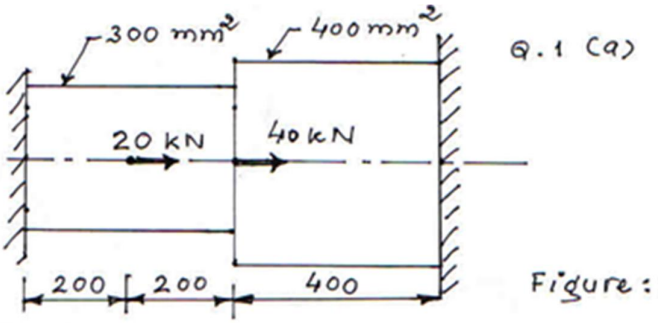

Figure : 1

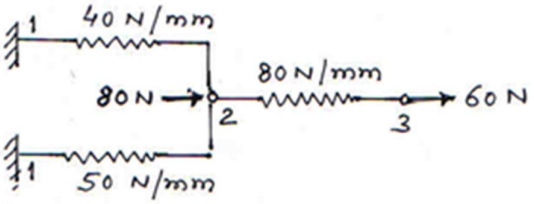

Figure : 2

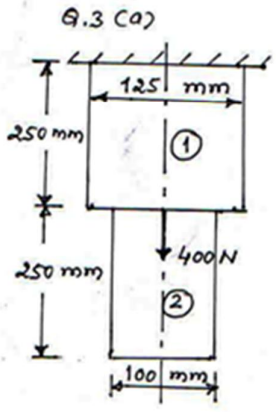

Figure : 3

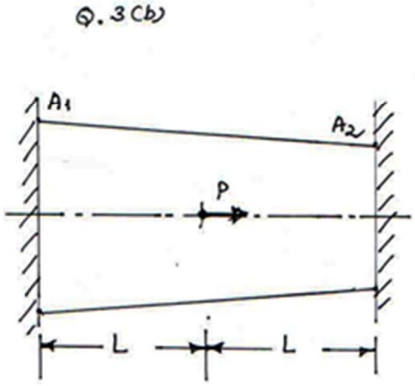

Figure : 4

Q.4(a)

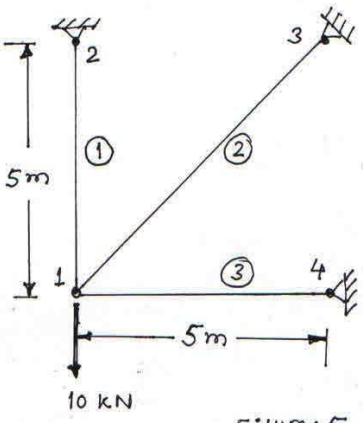

Figure: 5

Q.4(a) OR

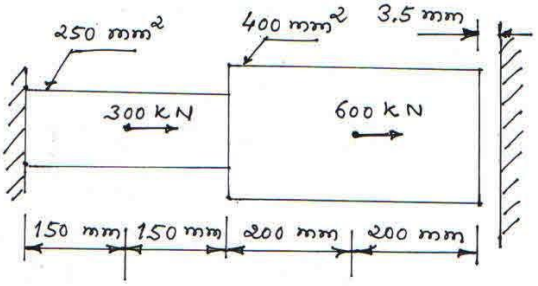

Figure: 6

Q.5(a)

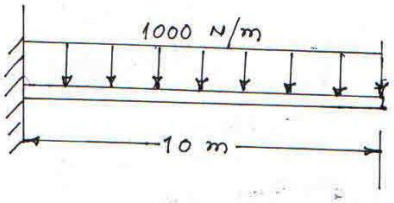

Figure: 7

Q.5(a) OR

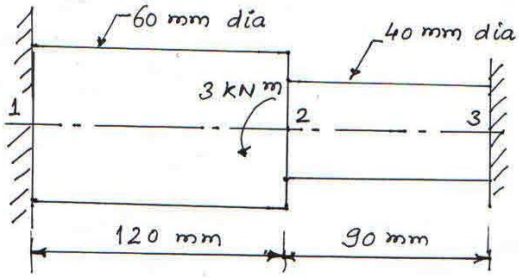

Figure: 8

****