

Seat No.: _____

Enrolment No. _____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME SEMESTER II EXAMINATION – SUMMER 2017

Subject Code: 2720801

Date: 26/05/2017

Subject Name: Finite Element Methods

Time: 02:30 PM to 05:00 PM

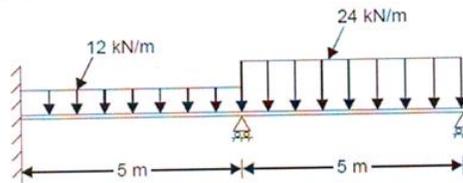
Total Marks: 70

Instructions:

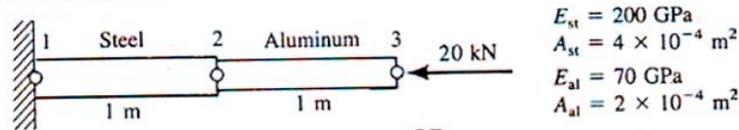
1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.

- Q.1** (a) Derive Jacobian matrix of Q4 (linear quadrilateral) element. 08
 (b) With the help of a neat sketch explain followings: 06
 (1) Hourglass phenomenon (2) Isoparametric Element (3) Subparametric Element

- Q.2** (a) For the beam loading shown in the figure, compute the deflection and slopes at supports. Assume beam with $I = 5 \times 10^6 \text{ mm}^4$. Beam material has $E = 200 \text{ GPa}$ and Poisson's ratio of 0.3. Use two beam elements for solution. 08



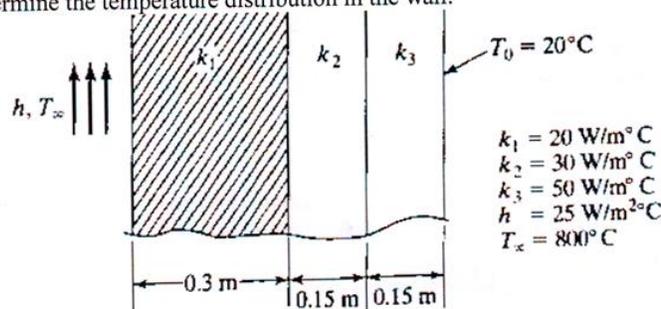
- (b) For the bar assemblages shown in Figures below, determine the nodal displacements, and element stresses. 06



OR

- (b) With the help of a neat sketch, explain degrees of freedom of Kirchoff and Mindlin plate elements and compare capabilities of the elements. 06

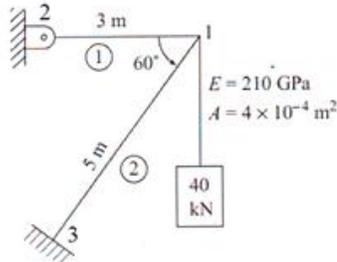
- Q.3** (a) Derive strain-displacement matrix of CST element. 07
 (b) A composite wall consist of three materials is shown in Figure below. The outer wall temperature is at 20°C . Convection heat transfer takes place on the inner surface of the wall. Determine the temperature distribution in the wall. 07



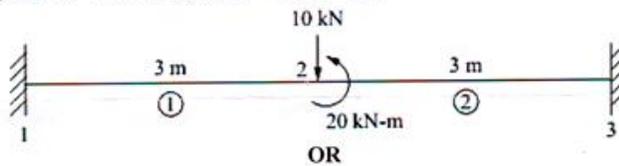
OR

- Q.3** (a) Determine mass matrices for 1-D bar element and Truss element. 07

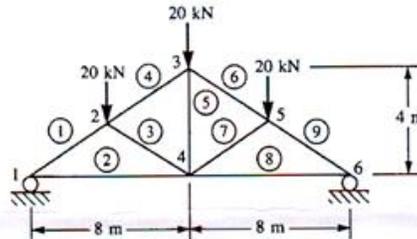
- (b) The structure shown in Figure below can be modelled as a truss. Determine stresses in each member. 07



- Q.4 (a) With suitable example, explain material and geometric non-linearity. 05
 (b) Determine displacement and rotation of node 2, for the beam shown in figure below. For all sections, take $E = 210 \text{ GPa}$, and $I = 4 \times 10^{-4} \text{ m}^4$. 09



- Q.4 (a) (1) Enlist properties of Eigenvectors. 02
 (2) Enlist methods to evaluate Eigenvalues and Eigenvectors and explain any one. 05
 (b) For a Q4 Element, coordinates of nodes are given as 1(0, 0), 2(2, 0), 3(2, 1) and 4(0, 1). Determine Jacobian matrix using One Gauss point and using Two Gauss point scheme. 07
- Q.5 (a) Consider a bar of uniform cross-section A , Length L made from a material with Elastic modulus E with density ρ . If rod is fixed at one end, determine natural frequency of its axial vibration using single element for Consistent and Lumped mass matrix. 06
 (b) For the truss shown in Figure below, determine element stiffness matrices and reduced global stiffness matrix using boundary conditions and symmetry about the vertical axis. Take $E = 210 \text{ GPa}$ and Area of cross section of each member as $10 \times 10^{-4} \text{ m}^2$. 08



OR

- Q.5 (a) Consider a simply supported beam subjected to uniformly distributed load q_0 along its span of length L . The governing equation and boundary conditions are as stated below. Determine displacement function using Galerkin's residual method. 07

$$EI \frac{d^4 v}{dx^4} - q_0 = 0 \text{ subjected to boundary conditions: } v(0) = v(L) = 0, \frac{d^2 v}{dx^2}(0) = \frac{d^2 v}{dx^2}(L) = 0$$

- (b) A simply supported beam of span L is loaded with UDL (w force/unit length). Using Rayleigh Ritz method, obtain displacement function. Assume two term trigonometric trial function. The potential energy of beam is given as: $\pi = \frac{1}{2} \int_0^L EI \left(\frac{d^2 y}{dx^2} \right)^2 dx - \int_0^L w y dx$ 07
