Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

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

Subject Code: 1720801 **Date: 09/12/2015**

Subject Name: Finite Element Methods

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)** Assume a simply supported beam of length L under uniformly distributed load. The governing equation of the beam is given as follows. **07**

$EI\frac{d^4v}{dx^4} - q_0 = 0$, where E is Youngôs Modulus, I is section inertia, v is displacement of the beam and q_o is UDL. Obtain the solution of the equation using Galerkinôs Method.

(b) Enlist properties of global stiffness matrix for a linear 1D element. Explain significance of node numbering and its effect on global stiffness matrix. **07**

Q.2 **(a)** Derive the stiffness matrix of a truss element using concept of strain energy. **07**

(b) Aluminium fin of rectangular cross-section is used to heat from surface whose temperature is maintained at 100° C. The ambient temperature is 20° C. The thermal conductivity of aluminium is 168 W/m ^{o}C. The natural convective heat transfer coefficient of surrounding air is 30 W/m^2 ^{o}C. The fin is 80 mm long, 5 mm wide and 1 mm thick. Determine the temperature distribution along the fin using 4 element finite element model. **07**

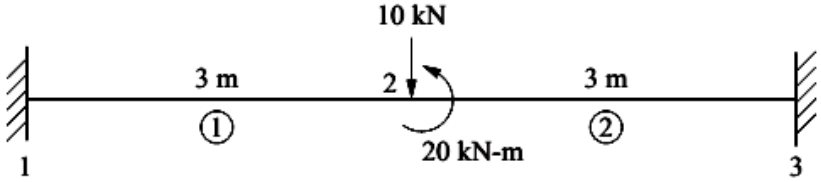
OR

(b) Consider a 1 mm diameter, 50 mm long aluminium pin-fin with insulated tip is used to enhance the heat transfer from a wall maintained at 300 ^{o}C. The governing equation of the phenomenon in general can be given as $k\frac{d^2T}{dx^2} = \frac{ph}{A}(T - T_\infty)$ where, k (thermal conductivity) is 200 W/m ^{o}C, p is perimeter, A is area of cross-section, h (convective heat transfer coefficient) is 20 W/m^2 ^{o}C, T_∞ (ambient temperature) is 30 ^{o}C. Following boundary conditions can be used. T(0) = Wall temperature = 300 ^{o}C, dT/dx(L) = 0 (for insulated tip). Estimate the temperature distribution in the fin using weighted residual method. Use second order polynomial trial function. **07**

Q.3 **(a)** Evaluate following integrals using 3 Gaussian points. Take $x_1 = x_3 = \pm 0.77459$, $x_2 = 0$, $w_1 = w_3 = 5/9$ and $w_2 = 8/9$. **07**

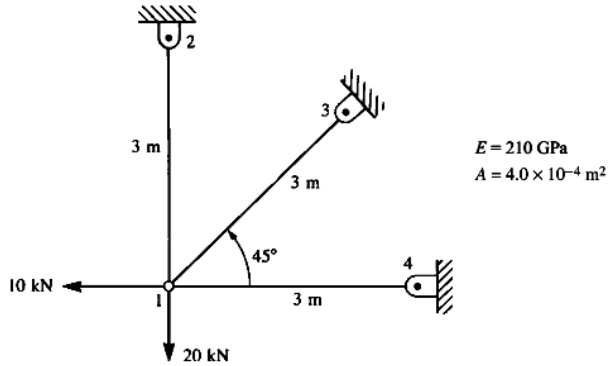
$$(1)\ I = \int_{-1}^{1}[x^2 + \cos(x/2)]dx \quad (2)\ I = \int_{-1}^{1}[3^x - x]dx$$

(b) For a beam shown in figure below, determine displacement and rotation of the centre of the beam using two beam element model. Beam has a constant section throughout its span with E = 210 GPa and I = 4 x 10^{-4} m^4 **07**



OR

Q.3 **(a)** For the truss shown in figure below, determine the displacement of the node 1. All elements have E = 210 GPa and A = 4 x 10^{-4} m^2. **07**



(b) Consider a four node quadrilateral element with following nodal coordinates: 1(0.5, 0), 2(0, -1), 3(1, 0) and 4(0, 1). Evaluate the Jacobian of the element at Gauss points. **07**

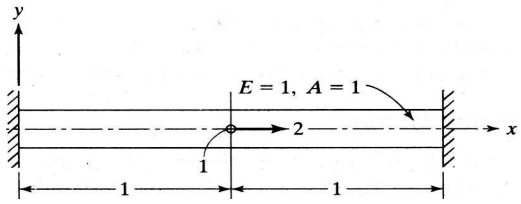
Q.4 **(a)** Consider a uniform rod of length L. Estimate natural frequencies of axial vibrations of the rod using two element model considering consistent mass matrix approach. **07**

(b) With suitable illustration and example, explain following terms in context to element formulation: Isoparametric, Subparametric and Superparametric **07**

OR

Q.4 **(a)** Develop strain-displacement matrix for a constant strain triangle. Why is it called a constant strain triangle? **07**

(b) Use Rayleigh-Ritz method to find displacement of the mid-point of the rod shown in figure below. **07**



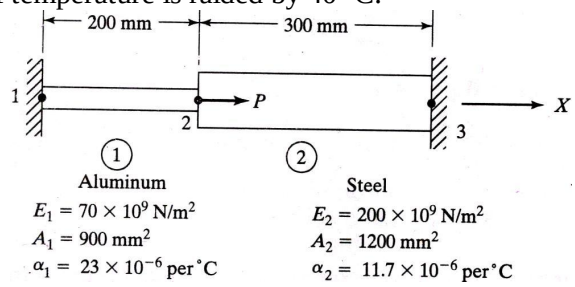
Q.5 **(a)** Explain geometric non-linearity and material-non linearity with suitable example. **07**

(b) Explain inverse iteration method for evaluating eigenvector in structural dynamics. **07**

OR

Q.5 **(a)** With the help of suitable example explain the term convergence in context to Finite Element Analysis. How can it be improved? **07**

(b) Consider the bar assembly shown below. Load P is 300 kN. Determine nodal displacement if temperature is raided by 40 ^{o}C. **07**



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