BIRLA INSTITUTE OF TECHONOLOGY AND SCIENCE, PILANI

First Semester (2016-2017), Comprehensive Examination

Course: Finite Element Analysis (CE G619)

Date: 3rd Dec. 2016 (Room:6105) Max. Marks: 70 Duration: 2:00PM-5:00PM

Q.1. Find the approximate solution of the differential equation given below by,

(i) Collocation method, take the collocation point as 0.5

(ii)Least Square method

(iii) Galerkin method

(iv) Ritz method

$$\frac{d^2u}{dx^2} - u = x \ , 0 \leq x \leq 1, \quad u(0) = 0 \quad \text{and} \quad \left.\frac{du}{dx}\right|_{x=1} = 3.0$$

Approximate the solution by taking, $u = c_1\phi_1 + \phi_0$, with $\phi_1 = x(1 - 0.5x)$, and $\phi_0 = 3x$. Further find the exact solution of the differential equation and report the value of u at $x = 1$ for all five cases. [15]

Q.2. Take the differential equation of Q.1, *i.e.* $\frac{d^2u}{dx^2} - u = x, 0 \leq x \leq 1, \quad u(0) = 0 \quad \text{and} \quad \left.\frac{du}{dx}\right|_{x=1} = 3.0$. Do not take the approximating functions given in Q.1. Solve this equation by developing the finite element model applying Modified Galerkin Method taking one linear element. [8]

Q.3. A plate(1m×1m×0.01m) as shown in **Fig.1** is subjected to a distributed load on the right-side edge. The plate is divided by two linear triangular elements. Derive the elemental equilibrium equations for both the elements applying finite element model. To derive these, first derive the governing differential equations used for this kind of analysis. Find the weak form of the derived governing differential equations. After this considering the linear triangular elements derive the elemental equilibrium equations for both the elements. [20]

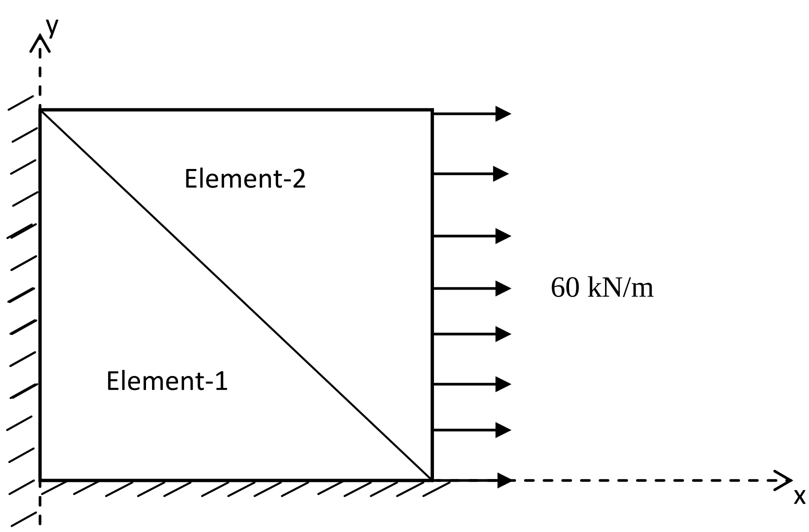

Fig.1 Plate subjected to distributed load on the right-side edge

Q.4. A two noded beam element is shown in **Fig.2**. Find the elemental equilibrium equations for this element by finite element model using Timoshenko beam theory. To do this first derive the governing differential equations of beam bending. Find the weak form of the derived governing differential equations. Now, taking this element derive the elemental equilibrium equation. During approximating the solutions use the natural coordinate system(ξ). Use reduced integration to evaluate the co-efficient matrix. [20]

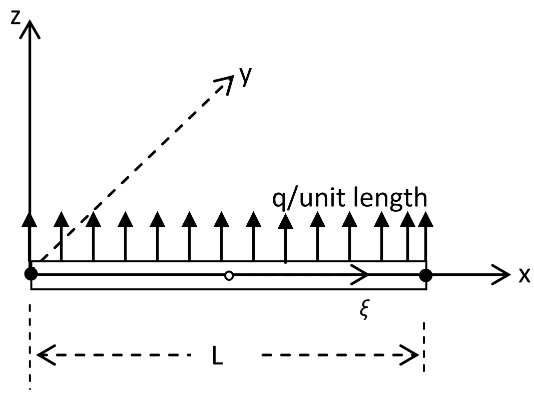

Fig.2 Beam element with uniformly distributed load

Q.5. Derive the interpolation functions to be used in the following special element(**Fig.3**) using Lagrange basis polynomial with respect to the natural coordinate system. [7]

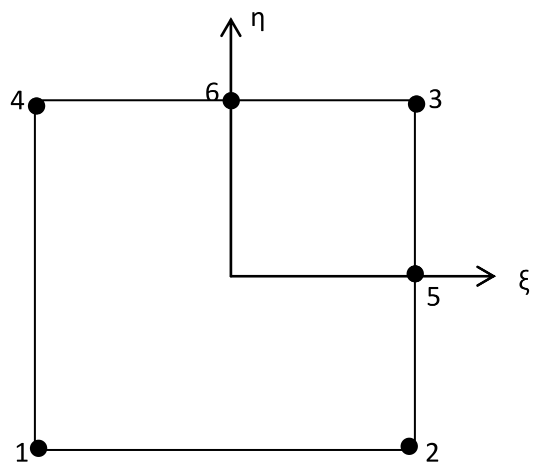

Fig.3 Special element