Reg. No.										

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

VI SEMESTER B.TECH (MECHANICAL ENGINEERING)

END SEMESTER EXAMINATIONS, MAY 2016

SUBJECT: FINITE ELEMENT METHODS [MME 344]

REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ANY FIVE FULL** the questions.
- Missing data may be suitable assumed.

1A. Compute the values of the nodal displacements and nodal reaction forces of the 2-D truss system shown in Fig.1 applying the Direct Stiffness Method. Assume $A=1.5x10^{-4}$ m^2 and E = 210 GPa for all members.

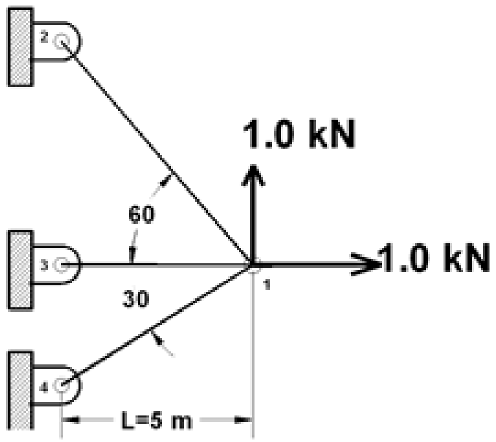


Fig.1

07

1B. For the three noded triangular plate element shown in Fig.2, compute the temperature at the point P, given the nodal temperatures are T_1= 120°C, T_2= 170°C and T_3=225°C.

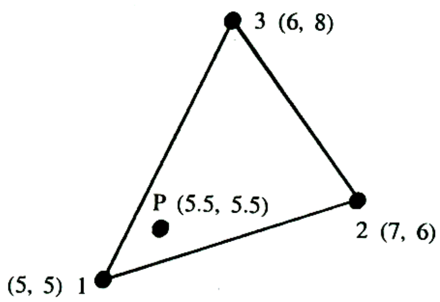


Fig.2

03

2A. Map side 1-2 of the Quadrilateral element shown in **Fig.3** to the corresponding side of an Iso-parametric element.

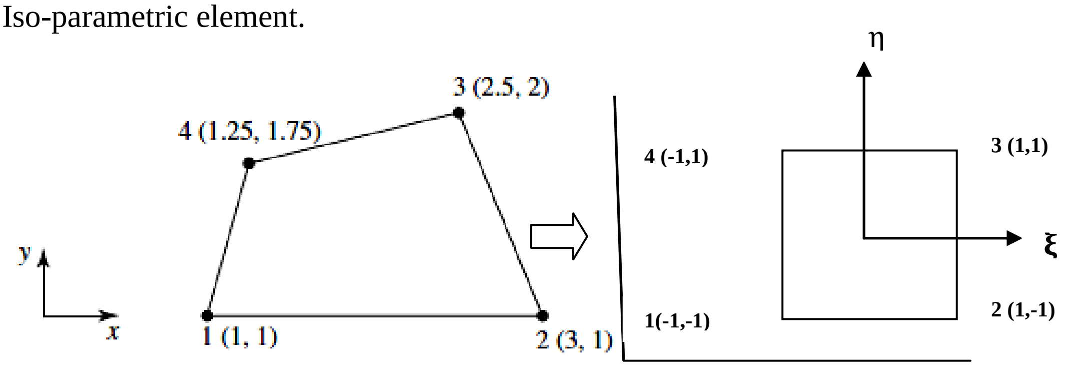
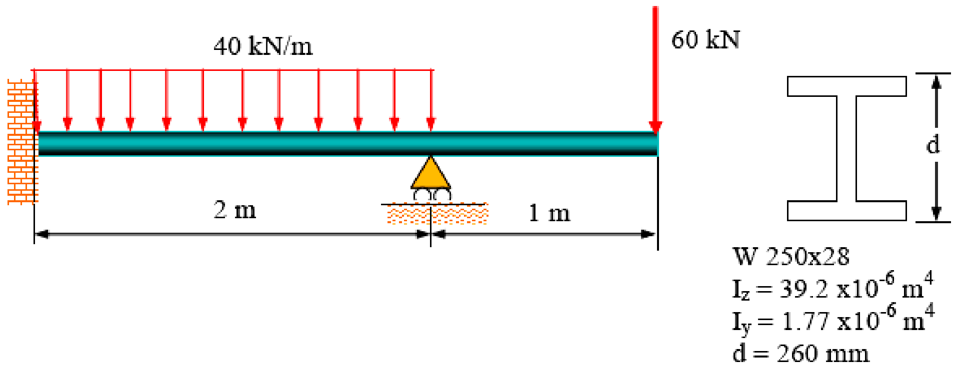
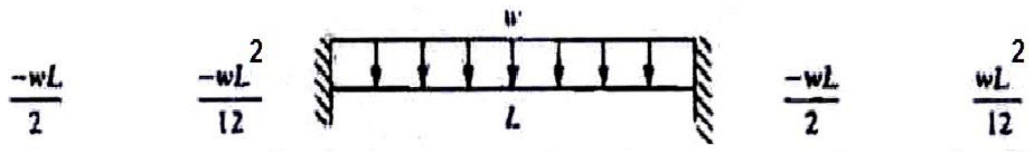


Fig.3 **03**

2B. A rolled steel beam and loading is shown in the **Fig 4.** Given, E = 200 GPa. (a) Solve for the nodal displacements and slopes and (b) Calculate the reaction forces and moments .





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3A. Generate shape functions for a 2-D planar triangular element with mid-side nodes using Lagrangian interpolation function. **03**

3B. Apply Iso-parametric approach to develop the element stiffness matrix [K] for a 4 noded linear quadrilateral element. **07**

4A. Using the **Principle of Minimum Potential Energy**, derive the following stiffness matrix formula for a general structural element

$$[K] = \iiint_V [B^T][D][B]\,dV$$

07

4B. Show that the thermal load vector induced due to thermal expansion in an arbitrarily oriented linear truss element subjected to uniform temperature rise ΔT is given by,

$$\begin{Bmatrix} f_{1x}^t \\ f_{1y}^t \\ f_{2x}^t \\ f_{2y}^t \end{Bmatrix} = AE\alpha\Delta T \begin{Bmatrix} -C \\ -S \\ +C \\ +S \end{Bmatrix}$$

03

5A. From the first principles of **Minimum Total Potential Energy** concept, obtain the element displacements of the spring assemblage shown in **Fig.5** , if δ = 20 mm.

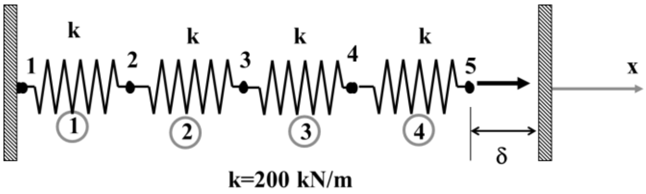

Fig. 5

05

5B. Using Galerkin weighted residual method, obtain the element stiffness matrix for an uniaxial linear truss element. **05**

6A. Compute the element stiffness matrix for the Constant Strain Triangle (CST) given in **Fig.6** below: Determine the nodal displacements and support reactions. Dimensions are in m. Assume plane stress condition. Given that thickness of the element is 25 mm, Poisson's ratio μ =0.25 and E= 200 GPa.

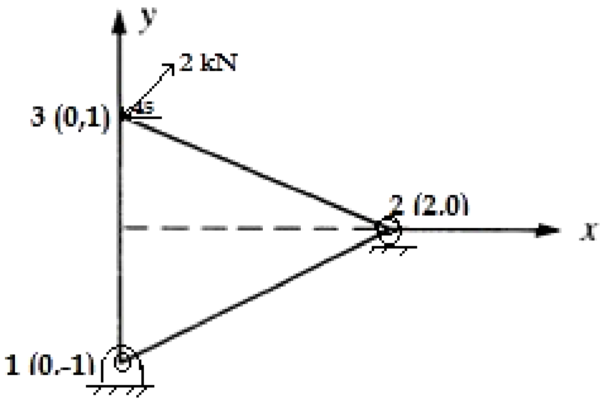

Fig. 6 **08**

6B. Explain with neat sketches to bring out the salient differences between Sub-parametric and Super- Parametric elements. Bring out the relative advantages. **02**