Please check that this question paper contains_9_ questions and _3_ printed pages within first ten minutes.

[Total No. of Questions: 09] [Total No. of Pages: 03]

Uni. Roll No. .....

Program: B.Tech. (Batch 2018 onward)
Semester: 5
Name of Subject: **Finite Element Method**
Subject Code: **PCME-110**
Paper ID: **16376**
Scientific calculator is Allowed

EVENING
30 DEC 2022

Detail of allowed codes/charts/tables etc. ...*not applicable*....
Time Allowed: 03 Hours **Max. Marks: 60**

NOTE:

1) Parts A and B are compulsory
2) Part-C has Two Questions Q8 and Q9. Both are compulsory, but with internal choice
3) Any missing data may be assumed appropriately

Part – A **[Marks: 02 each]**

Q1.

a) Explain the concept of FEM briefly and outline the procedure.

b) Explain the terms clearly; nodes, primary nodes, secondary nodes and internal nodes.

c) By direct stiffness matrix approach, determine stiffness matrix for a bar element.

d) To what does the term *degrees of freedom* refer?

e) Explain the term 'Shape Functions'. Why polynomial terms are preferred for shape functions in finite element method?

f) State and explain the principle of minimum potential energy.

Part – B **[Marks: 04 each]**

Q2. Explain the terms 'Plane stress' and 'Plane strain' problems. Give constitutive laws for these cases.

Q3. Derive the expressions for natural coordinates for a two noded element.

P.T.O.

Q4. Refer to Fig. 1. If displacement at point 1 is 0.003 mm and that at point 2 is -0.005 mm, determine the value of the displacement at point *P*.

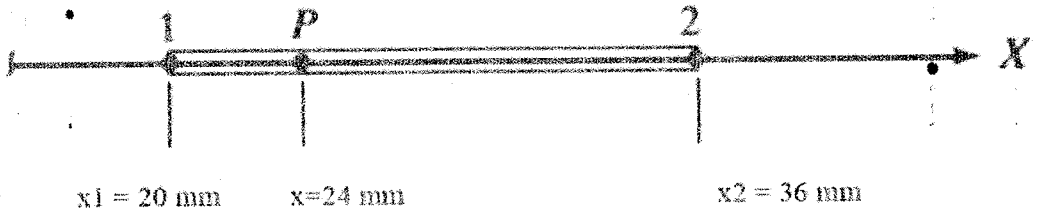

Fig. 1

Q5. For the triangle shown in Fig. 2, the interior point P at (2, 2) divides it into three areas, A1, A2, and A3, as shown. Determine A1/A, A2/A, and A3/A.

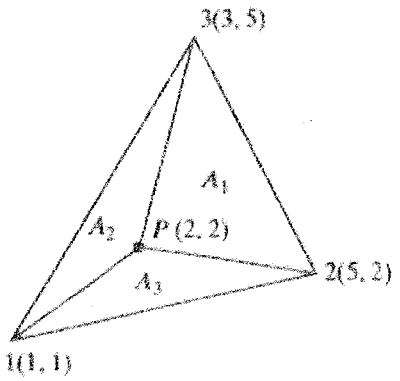

Fig. 2

Q6. With the help of a suitable example, explain how we can find shape functions using Lagrange polynomials.

Q7. Explain Pascal triangle in the context of two dimensional polynomial shape functions.

Part – C **[Marks: 12 each]**

Q8. For the spring assemblage shown in Fig. 3 obtain (a) the global stiffness matrix, (b) the displacements of nodes 3 and 4, (c) the reaction forces at nodes 1 and 2, and (d) the forces in each spring. A force of 25 kN is applied at node 4 in the x direction. The spring constants are given in the figure. Nodes 1 and 2.

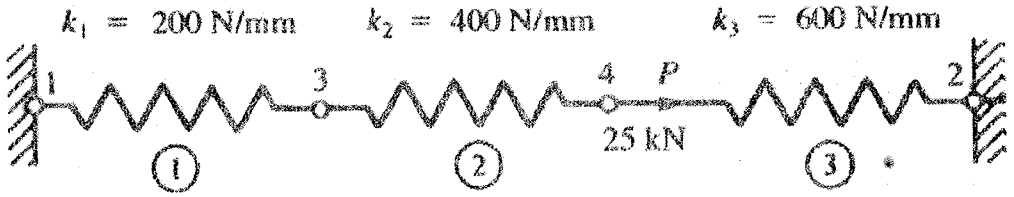

Fig. 3

P.T.O.

OR

Using minimum energy principle, determine the forces developed in the three bar truss shown in Fig. 4.

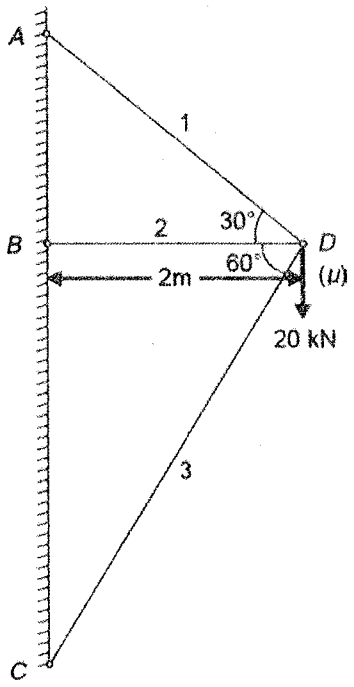

Fig. 4

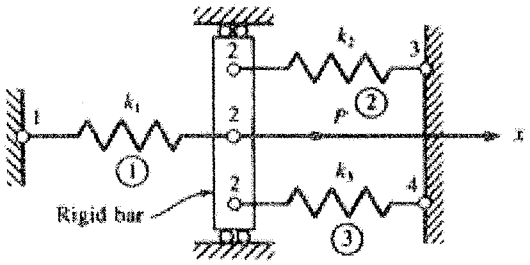

Fig. 5

Q9. Find the Global Stiffness Matrix for the spring system shown in Fig. 5.

OR

For the isoparametric quadrilateral elements shown in Fig. 6, determine (a) Cartesian coordinates of the point P which has local coordinates $\xi = 0.57735$ and $\eta = 0.57735$. (b) Local coordinates of the point Q which has Cartesian coordinates (7, 4).

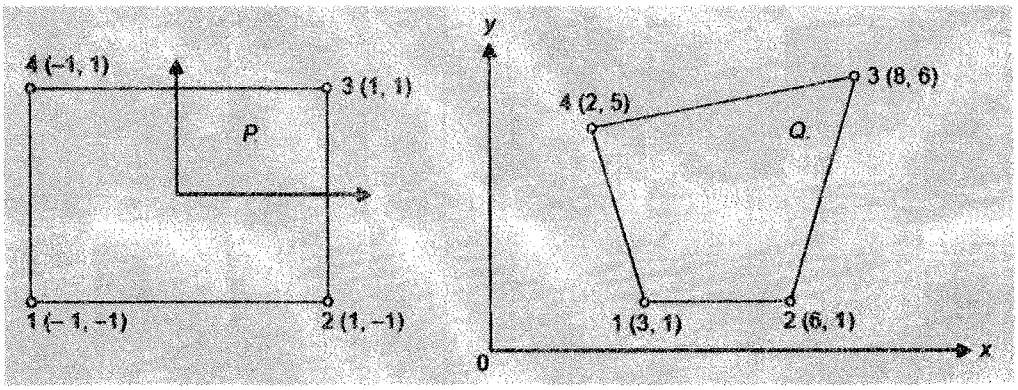

Fig. 6

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