Please check that this question paper contains 09 questions and 03 printed pages within first ten minutes.

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[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

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.

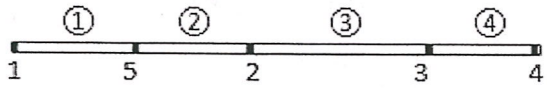
a) List four common types of finite elements.

b) Differentiate between BAR and TRUSS elements in FEM.

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

d) List typical areas of engineering where the finite element method is applied.

e) Find the bandwidth NBW for the one-dimensional model whose nodes are numbered as shown in the figure.



f) Define shape function. What are the characteristics of shape function?

Part – B **[Marks: 04 each]**

Q2. Solve the following equations with Gaussian elimination method.

$x - 2y + 6z = 0$; $2x + 2y + 3z = 3$; $-x + 3y = 2$.

Q3. List and briefly describe the general steps of the finite element method.

Q4. Given that $N = [\xi, 1-\xi^2]$, find $\int_{-1}^{1} N d\xi$, & $\int_{-1}^{1} N^T N d\xi$.

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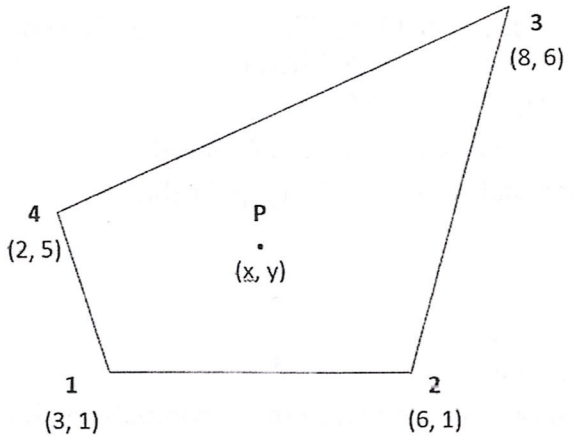
Q5. Write and explain the **D** matrix showing relationship between stresses and strains.

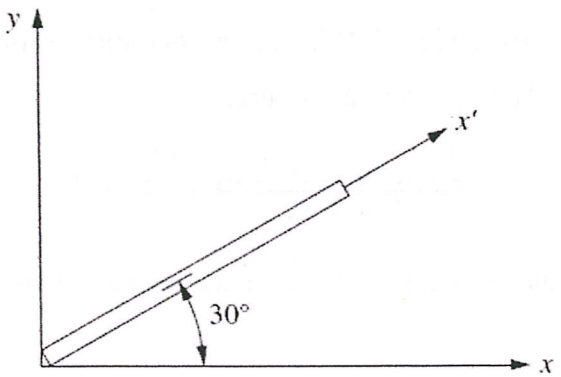
Q6. In a plane strain condition $\sigma_x = 150$ MPa, $\sigma_y = -100$ MPa, $E = 2 \times 10^5$ MPa, $\mu = 0.25$. Find the stresses in z-direction and strain in x & y direction.

Q7. For isometric quadrilateral element, determine the Cartesian co-ordinate of a point P; which has co-ordinate $\xi = 0.57735$, $\eta = 0.57735$.



Part – C **[Marks: 12 each]**

Q8. For the bar element shown in the figure, evaluate the global stiffness matrix with respect to the x – y coordinate system. Let the bar's cross-sectional area equal 6×10^{-4} m^2, length equal 1.2 m, and modulus of elasticity equal 2×10^{11} Pa. The angle the bar makes with the x axis is 30°.



OR

Determine the Jacobian for the $(x, y) - (\xi, \eta)$ transformation for the element shown in the figure. Also, find the area of the triangle.

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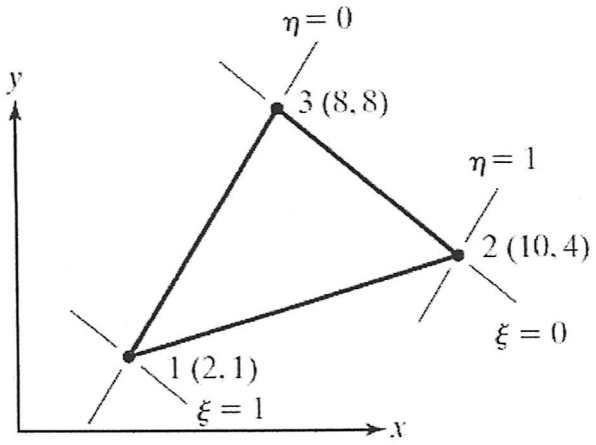

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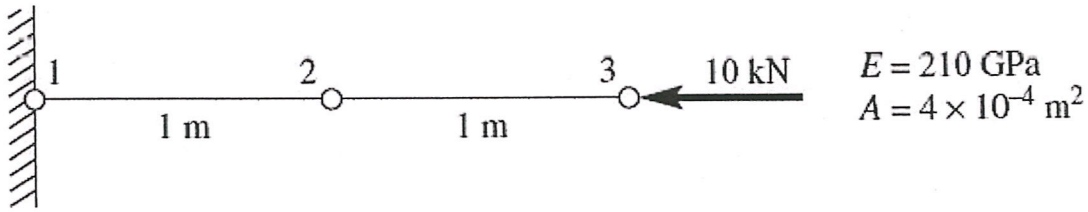
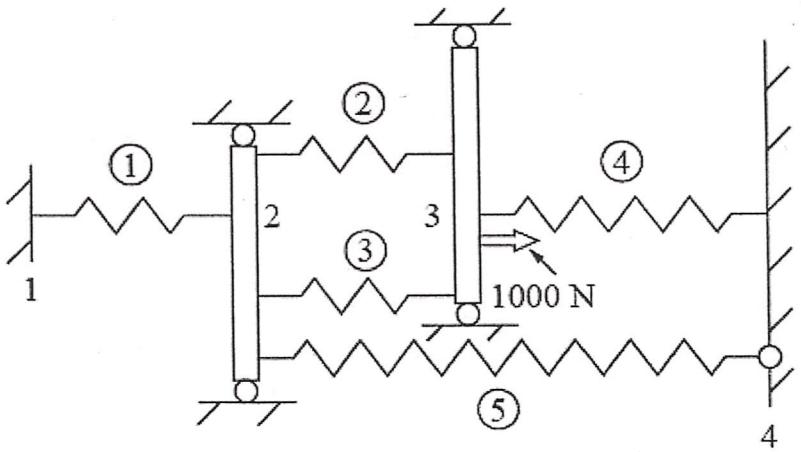
Q9. For the bar assemblage shown in the figure, determine the nodal displacements, the forces in each element, and the reactions.



OR

For the five-spring assemblage shown in the figure, determine the displacements at nodes 2 and 3 and the reactions at nodes 1 and 4. Assume the rigid vertical bars at nodes 2 and 3 connecting the springs remain horizontal at all times but are free to slide or displace left or right. There is an applied force at node 3 of 1000 N to the right.



Let $k^{(1)} = 500$ N/mm, $k^{(2)} = k^{(3)} = 300$ N/mm, and $k^{(4)} = k^{(5)} = 400$ N/mm.

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