

JK LAKSHMIPAT UNIVERSITY, JAIPUR

INSTITUTE OF ENGINEERING AND TECHNOLOGY

End Term Examination (Regular), Nov.-Dec. 2015

B. Tech. in Civil Engineering, Semester VII

Roll No.....

CE-726 : Finite Element Analysis

Time: 3 hours

Max. Marks: 100

Instructions to students:

1. Do not write anything other than your roll number on question paper.
2. Assume suitable data wherever required and mention it clearly.
3. Writing appropriate units, nomenclature, and drawing neat sketches/schematics/ flow chart wherever, required are an integral part of the answer.

Q.1A True/False questions (10 questions @ 1 mark)

10

- i. CST element has constant strain throughout the body.
- ii. In Plane strain condition, one dimension is very small as compare to other two dimensions.
- iii. In a finite element, sum of shape functions is equal to 0, except nodes.
- iv. For a CST Element, Sum of all the elements of a stiffness matrix is unity.
- v. Serendipity members do not have Internal Nodes.
- vi. CST element has 4x4 order stiffness matrix.
- vii. A horizontal truss member will have 12 zero values in the stiffness matrix.
- viii. A system is in equilibrium if the potential energy of the system is zero.
- ix. K_{12} and K_{21} are same in the stiffness matrix of a CST element.
- x. The value of shape function cannot be negative.

Q.2 Short answer type questions (4 questions @ 2.5 Marks)

- i. Define plane strain condition. 2.5
- ii. Write the stress strain relationship in matrix form (complete matrix). 2.5
- iii. Derive stiffness matrix of a truss member inclined at an angle ' θ ' with horizontal axis. 'A' is area of the bar and E is the modulus of Elasticity of the material. 05

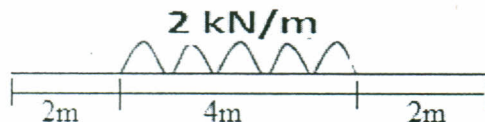
Q.3 A particle is moving along a straight line through a fluid medium. The displacement (x) of that particle at various times (t) is given in table below. If it is released from rest at $x = 0$, Calculate the time using lagrange interpolation when it reaches to the position 5cm and 7cm from start.

10

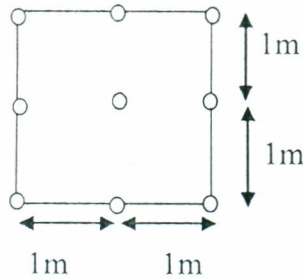
t (sec.)	0	5	7	10
x (cm)	0	4	5.6	8

Q.4A Find out the force matrix (force vector) for a beam shown below

05

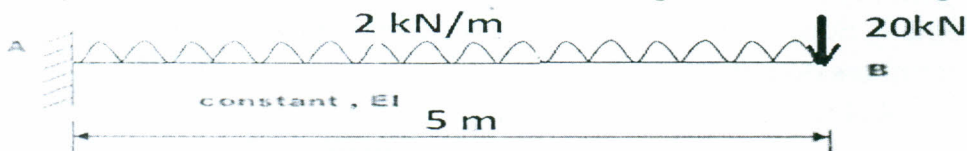


- Q.4B Calculate the values of shape functions at (0.5, 0.8) for a square plate of 2m as shown in figure below - 05



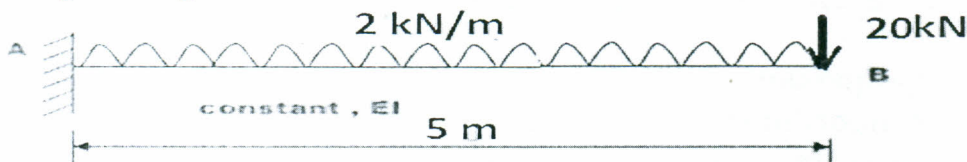
- Q.5 A structural member is in plane stress condition. The values of known stresses and strains are $\sigma_x = 2 \text{ kN/mm}^2$, $\sigma_y = 3 \text{ kN/mm}^2$, $\tau_{xy} = 4 \text{ kN/mm}^2$, $\gamma_{xy} = 50$. Value of poisson's ratio is $\nu = 0.7$. Calculate the modulus of elasticity (E) of the material and strain in x and y direction (ϵ_x & ϵ_y). Also calculate the values of stresses to produce same strains in a member which has same material properties and is in plane strain condition. 10

- Q.6A Calculate the reactions of a cantilever beam having loads as shown in figure using FEM. 10



OR

- Q.6B Calculate the deflections at the end (point B) of a cantilever beam having loads as shown in figure using FEM. 10

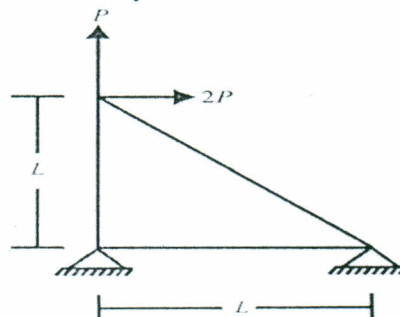


- Q.7 Prepare the stiffness matrix of a CST element. The vertexes of triangle are (2, 4), (5, 6), (3, 7). The Poisson's ratio $\nu = 0.4$. 10

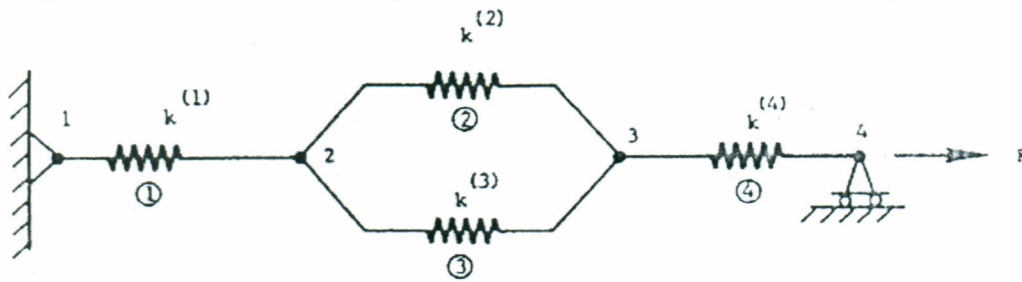
OR

- Q.7B Prepare the stiffness matrix of a CST element. The vertexes of triangle are (0, 0), (2, 2), (0, 2). The Poisson's ratio $\nu = 0.2$. 10

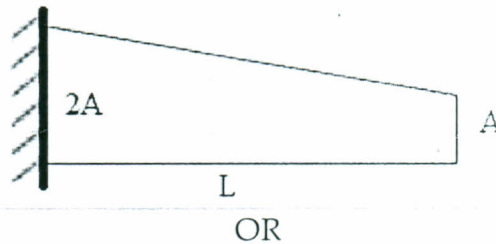
- Q.8A Analyze the truss shown below by finite element method. Assume the cross sectional area of the inclined member as 1.5 times the area (A) of the horizontal and vertical members. Assume modulus of elasticity is constant for all the members and is E. 10



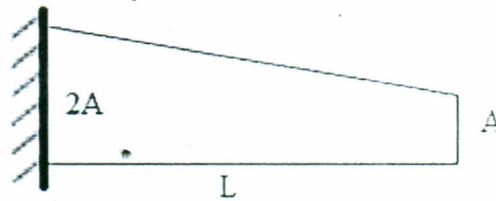
- Q.9A A spring system is shown below. Calculate the displacement of each node at equilibrium using minimum potential energy method. Also check the results using stiffness method. 10



- Q.9B A metallic rod of varying cross section, length 'L', is fixed as shown below. Assuming two sub domains, calculate the elongation in the rod (using Rayleigh Ritz Method) due to applied load intensity 'q' along complete length. The modulus of elasticity is E. 10



- Q.9B A metallic rod of varying cross section, length 'L', is fixed as shown below. Assuming three term displacement function, calculate the elongation in the rod (using Rayleigh Ritz Method) due to applied load intensity 'q' along complete length. The modulus of elasticity is E. 10



Given for beams

$$N_1 = l - \frac{3x^2}{l_e^2} + \frac{2x^3}{l_e^3}$$

$$N_2 = x - \frac{2x^2}{l_e} + \frac{x^3}{l_e^2}$$

$$N_3 = \frac{3x^2}{l_e^2} - \frac{2x^3}{l_e^3} \text{ and } N_4 = \frac{-x^2}{l_e} + \frac{x^3}{l_e^2}$$

$$[K] = \frac{EI}{l_e^3} \begin{bmatrix} 12 & 6l_e & -12 & 6l_e \\ 6l_e & 4l_e^2 & -6l_e & 2l_e^2 \\ -12 & -6l_e & 12 & -6l_e \\ 6l_e & 2l_e^2 & -6l_e & 4l_e^2 \end{bmatrix}$$