

KATHMANDU UNIVERSITY
End Semester Examination
July/August, 2024

Marks Scored:

Level : B.E.
Year : III

Course : MEEG 325
Semester : I

Exam Roll No. :

Time: 30 mins.

F. M. : 10

Registration No.:

Date : **28 JUL 2024**

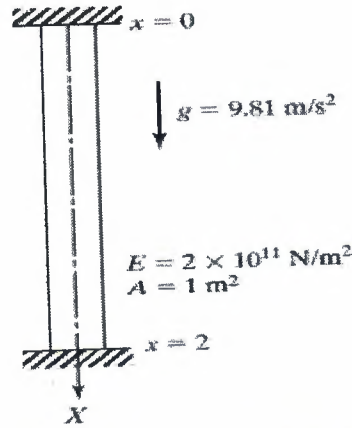
SECTION "A"

[10 Q. × 0.5 = 5 marks]

Choose and encircle in the most appropriate option from each set of choices

1. Consider a rod where the strain at any point x is given by $\epsilon_x = 5 + 4x^2$. If the length of the rod is L , what is the displacement at the tip of the rod?
 a. $L\left(L + \frac{1}{2}L^2\right)$ b. $L\left(1 + \frac{2}{3}L^2\right)$ c. $\left(1 + \frac{1}{3}L^2\right)$ d. $\left(1 + \frac{3}{4}L^2\right)$

2. Potential Energy of the given figure is



- a. $\pi = \frac{AE}{2} \int_0^2 \left(\frac{du}{dx}\right)^2 dx - \int_0^2 u \rho A dx$ b. $\pi = \frac{AE}{2} \int_0^2 \left(\frac{du}{dx}\right)^2 dx - \int_0^2 u g A dx$
 c. $\pi = \frac{AE}{2} \int_0^2 a_1^2 dx - \int_0^2 u \rho A dx$ d. $\pi = \frac{AE}{2} \int_0^2 a_1^2 dx - \int_0^2 u g A dx$

3. The elements where the order of the polynomial and the geometric approximation are the same are known as:
 a. Isoparametric elements b. Triangular elements
 c. Serendipity elements d. Hermite elements

4. Consider a simplex element with the following expression for its field variable:

$$T^{(e)} = \alpha_1 + \alpha_2 x + \alpha_3 x$$

To solve the above equation how many nodal points are require?

- a. 1 b. 2 c. 3 d. 4

5. The stiffness matrix for a triangular element in a two dimensional problem is often derived using
 a. Surface coordinates b. Thickness coordinates
 c. Volume coordinates d. Area coordinates

6. Determinant of assembled stiffness matrix before applying boundary condition is
 a. Equal to zero
 b. Less than zero
 c. Greater than zero
 d. Depends on the problem
7. For the stress analysis of transmission lines supported by electric transmission towers and subjected to axial tension, gravity, wind, and snow loads, the most appropriate type of finite element to use is:
 a. Fluid element Bar element
 b. Bar element
 c. Beam element
 d. Electrical resistor element
8. Given a plate modeled with 13 triangular elements and 2 quadrilateral elements, each with one degree of freedom, what is the minimum bandwidth of the system matrix?
 a. 3
 b. 5
 c. 7
 d. 9



9. Which of the following statements best explains the desirability of having elements with an aspect ratio close to 1 (one) in finite element modeling?
 a. It ensures good element shape.
 b. It meets the requirements of commercial finite element software
 c. It is always necessary to maintain an aspect ratio close to 1 in finite element modeling.
 d. It helps in making the diagonal elements of the stiffness matrix have same order of magnitudes.
10. The integral of the weighted residual method calculates:
 a. Some of the errors on the partial domain
 b. Some of the errors on the whole domain
 c. The sum of trial function on the whole domain
 d. The sum of basis functions on the whole domain

SECTION "B"

[10 Q. × 0.5 = 5 marks]

Fill in the Blank

11. Aspect ratio is defined as the ratio of the _____ dimension of the element to the smallest dimension.
12. Degrees of freedom are defined as the values of a primary variable at _____ points.
13. The truss member is _____ dimensional element when viewed in the local coordinate system.

14. The process of computing desired quantities in numerical form or graphical form, from the known finite element solution is called _____
15. Serendipity elements have _____ node.
16. A general plate element is a superposition of _____ elements.
17. Plane stress is defined to be a state of stress in which the normal stress and the shear stresses directed _____ to the plane are assumed to be zero.
18. The deformation in the Z direction of the beam is primarily due to _____ Effects
19. When fewer nodes are used to define the geometry than are used to define the shape function, the element is termed as _____
20. Thermal conductivity $K_x = K_y = K_z$ in case of _____ Material.

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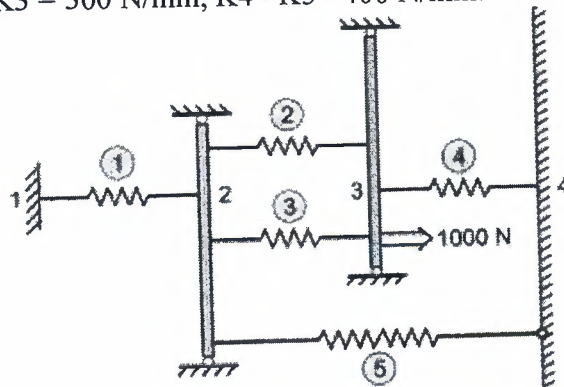
Course : MEEG 325
Semester : I
F. M. : 55

SECTION "C"

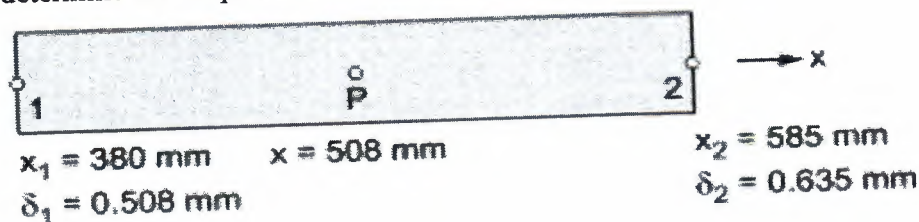
Attempt *ALL* questions. All question carry equal marks. Assume suitably if any date missing. Do not change the node and element number if specified.

1. The differential equation of a physical phenomenon is given by $AE \frac{d^2u}{dx^2} + ax = 0$. The given trial function is $u(x) = a_0 + a_1x + a_2x^2 + a_3x^3$. The boundary conditions are $u(0) = 0, AE \frac{du}{dx} |_{x=L} = 0$. By using Galerkin's technique calculate the values of $u(x)$. [1+1+1+2=5]

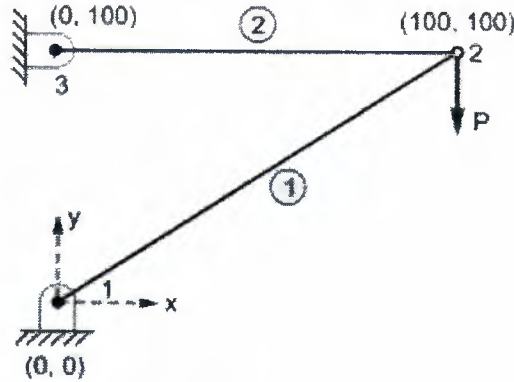
2. Given the five-spring assemblage shown in the figure, determine the displacements at nodes 2 and 3. Assume that the rigid vertical bars at nodes 2 and 3 connecting the springs remain horizontal at all times but are free to slide or displace left or right. There is an applied force of 1000 N to the right at node 3. The spring constants are as follows: $K_1 = 500$ N/mm, $K_2=K_3 = 300$ N/mm, $K_4 =K_5 =400$ N/mm. [1+1+1+2=5]



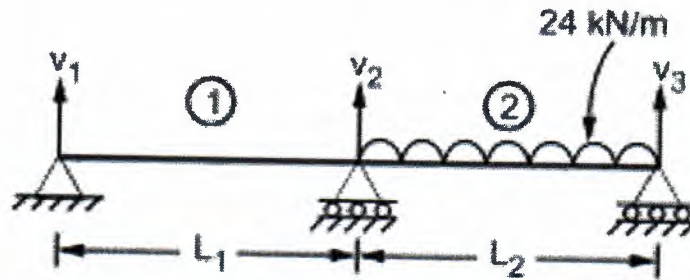
3. Consider the bar in figure with cross sectional area $A= 7.75 \times 10^{-4}$ m² and Young's modulus $E = 2.07 \times 10^{11}$ N/m². If deflection at node 1 is 0.508 mm and at node 2 is 0.635 mm, determine the shape function N_1 and N_2 [2+3 =5]



4. For the truss shown in figure, force P is acts at node 2. The displacement of node 2 is $U_x = 0.01$ mm and $U_y = -0.02$ mm. Determine the force P. Given Area of element 1 (A_1) = $100\sqrt{2}$ mm², Area of element 2 (A_2) = 50 mm² and $E = 2 \times 10^5$ N/mm². [3+2=5]



5. Determine the slope and vertical deflection at the center of the following beam model. Assume $L_1=L_2=1$ m, $E = 200$ Gpa and $I = 4 \times 10^6$ mm⁴. [2+3=5]



6. Determine the [B] and [D] matrices for the triangular element shown in figure under plane strain condition, assume the following values: $E = 200$ Gpa, $\mu = 0.25$, and thickness $t = 1$ mm [1+2+2 = 5]

