KATHMANDU UNIVERSITY
End Semester Examination [C]
December, 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 : 24 DEC 2024

SECTION "A"

[10 Q. × 0.5 = 5 marks]

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

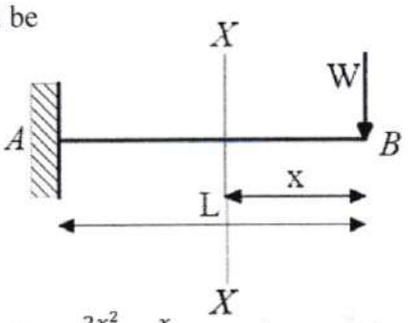
1. Strain energy of the given system will be

a. $U = \frac{W^2L^3}{6EI}$

b. $U = \frac{W^2L^3}{6AG}$

c. $U = \frac{W^2L^2}{6EI}$

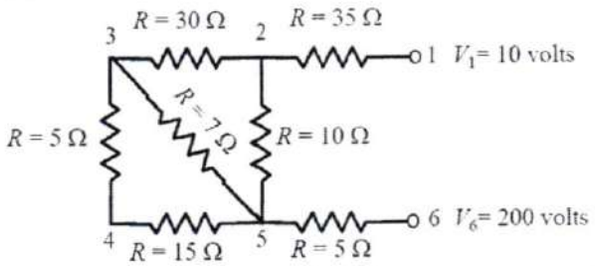
d. $U = \frac{W^2L}{6EI}$



2. Given that $N_1 = \frac{2x^2}{l^2} - \frac{2x}{l} + 1$ and $N_2 = \frac{2x^2}{l^2} - \frac{x}{l}$ are the two shape of the three set functions associated with a quadratic shape function. Which of the following represents the third shape function N_3?

a. $N_3 = \frac{4x}{l} - \frac{4x^2}{l^3}$ b. $N_3 = \frac{4x}{l^3} - \frac{4x^2}{l^2}$ c. $N_3 = \frac{4x}{l} - \frac{4x^2}{l}$ d. $N_3 = \frac{4x}{l} - \frac{4x^2}{l^2}$

3. A direct current electric network shown in Figure what is the value of K33 in the global matrix?



a. $\frac{1}{35}$ b. $\frac{1}{35} + \frac{1}{30}$ c. $\frac{1}{35} + \frac{1}{30} + \frac{1}{10}$ d. $\frac{1}{30} + \frac{1}{7} + \frac{1}{5}$

4. If For the constant strain triangle element, the shape function is

a. $N_1 + N_2 + N_3 = 1$ b. $N_1 + N_2 + N_3 = 2$

c. $N_1 + N_2 + N_3 = 3$ d. $N_1 + N_2 + N_3 = 0$

5. In the given differential equation:

$$\left[\frac{d^2}{dx^2}\left(b\frac{d^2W}{dx^2}\right)\right] + kw = f$$

Identify the independent variable

a. x b. W c. b d. f

6. The primary variable(s) for an Euler- Bernoulli beam problem is/are .....

a. Displacement. b. Rotational angle

c. Displacement and slope d. Bending moment and shear force.

7. In the equation [K]{u} = {F}, the vector {F} contains:
   a. Stiffness terms
   b. Primary variable term
   c. Force terms attributable to distributed external load
   d. Terms from external concentrated and distributed loads

8. Higher order elements are desirable when:
   a. Domain is simple
   b. Use of linear element is not possible
   c. Reduced computational effort is required
   d. Gradient of the field variable varies rapidly

9. The stiffness matrix of a shaft having the angle of twist θ , cross-sectional area A,with a polar moment of inertia J , length l, made of homogenous material with a shear modulus of elasticity G, subject to a torque T is given by

   a. $\frac{Jl}{G}\begin{bmatrix}1 & -1\\ -1 & 1\end{bmatrix}\begin{Bmatrix}\theta_1\\ \theta_2\end{Bmatrix}=\begin{Bmatrix}T_1\\ T_2\end{Bmatrix}$

   b. $\frac{lG}{J}\begin{bmatrix}1 & -1\\ -1 & 1\end{bmatrix}\begin{Bmatrix}\theta_1\\ \theta_2\end{Bmatrix}=\begin{Bmatrix}T_1\\ T_2\end{Bmatrix}$

   c. $\frac{JG}{\theta}\begin{bmatrix}1 & -1\\ -1 & 1\end{bmatrix}\begin{Bmatrix}\theta_1\\ \theta_2\end{Bmatrix}=\begin{Bmatrix}T_1\\ T_2\end{Bmatrix}$

   d. $\frac{JG}{l}\begin{bmatrix}1 & -1\\ -1 & 1\end{bmatrix}\begin{Bmatrix}\theta_1\\ \theta_2\end{Bmatrix}=\begin{Bmatrix}T_1\\ T_2\end{Bmatrix}$

10. If a domain is discretized into N linear one dimensional elements, then the number of nodes will be:
    a. N b. 2N c. N+1 d. N-1

SECTION "B"

[10 Q. × 0.5 = 5 marks]

Fill in the blank with the most suitable word(s).

11. The sum of all the local coordinates at any point in a simplex element must be equal to _____.

12. The stiffness matrix of a bar or beam element denotes the relation between nodal forces and_____.

13. Weak form _____ the differentiability requirement on the primary variable.

14. In a beam problem, known bending moments at both ends are classified as _____ boundary conditions.

15. The nodal points greater than geometry points is known as_____.

16. In the weighted residual method, w represents the _____ functions.

17. It is desirable to minimize the _____ of the stiffness matrix for efficient solution.

18. Elements whose shape and field variables are described by the same interpolation functions of the same order are known as _____ elements.

19. In the point collocation method, the residual is set equal to_____ at the same selected points in the domain.

20. The process of deriving numerical or graphical results from the finite element solution is called _____.

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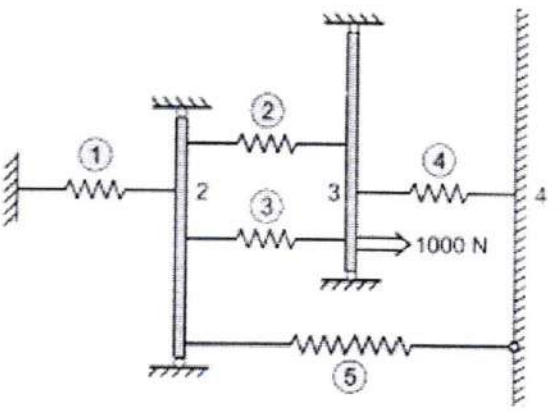
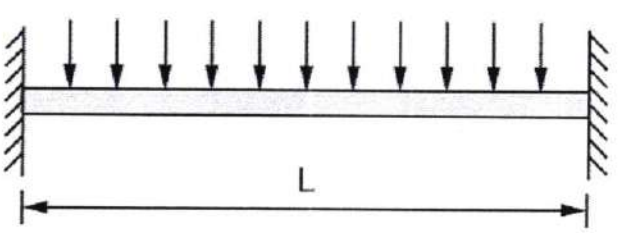
SECTION "C"

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

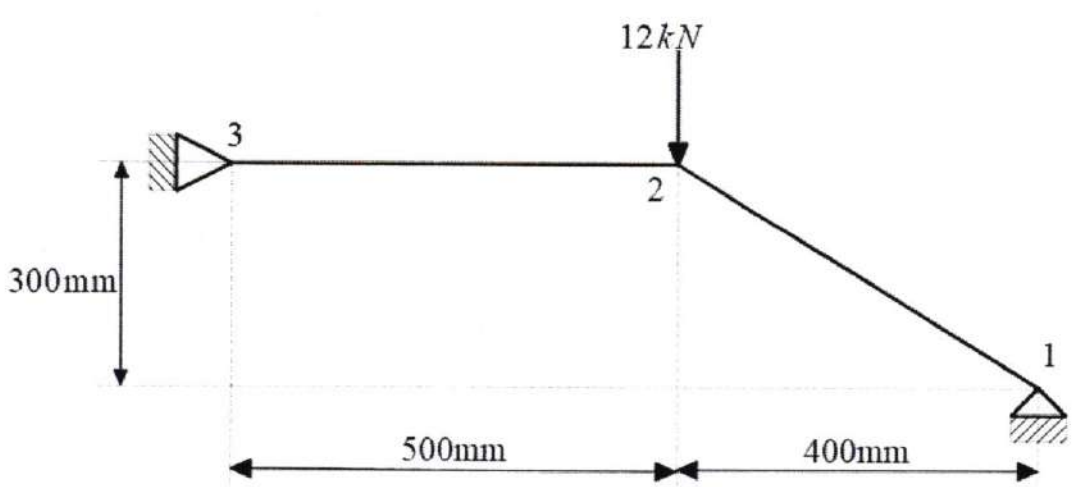
1. Given the five-spring assemblage shown in the figure, determine the displacements at nodes 2 and 3. Assume that the rigid vertical bars at nodes 2 and 3 connecting the springs remain horizontal at all times but are free to slide or displace left or right. There is an applied force of 1000 N to the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



2. Using R-R Method, determine the maximum deflection of the beam fixed at both ends subjected to a uniformly distributed load (W) over entire length as shown in figure. Take E as young's modulus, I as moment of inertia and A as area of cross-section and use a displacement function as: $y = a_4(x^4 + l^2x^2 - 2lx^3)$ [1+1+1+2=5]



3. For the two bar truss shown in figure. Determine the nodal displacement and stresses in each develop in each element. Take$E = 2 \times 10^5 \frac{N}{mm^2}$, $A = 200\ mm^2$. [3+2=5]



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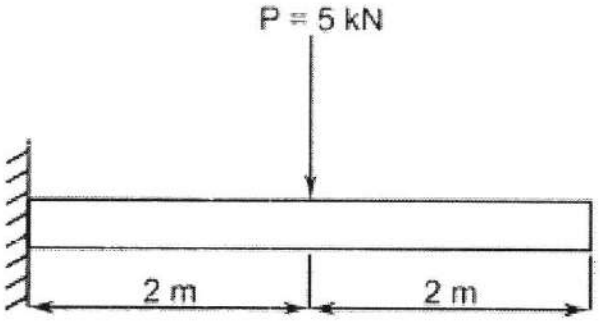
4. A cantilever beam subjected to concentrated load. For the beam shown in figure. Determine deflection and reactions .Given : E = 210GPa and I = 2×10^{-4} m^4. [3+2=5]



5. The differential equation of physical phenomenon is given by $\frac{d^2u}{dx^2} + 50 = 0$ which is $0 \leq x \leq 10$. the trial function is $y = ax(10 - x)$. The boundary conditions are $u(0) = 0$, $y(10) = 0$.
Calculate the values of parameter a_1 by Galerkin's method [2+2=4]

6. For the triangular element shown in figure, obtain the following: [2+2+2=6]
   i. Jacobian matrix
   ii. B matrix (strain displacement matrix) and
   iii. Strains

Take the nodal displacement for the CST element are

$q_1 = 0.001\ mm$, $q_4 = 0.002\ mm$

$q_2 = -0.004\ mm$, $q_5 = -0.002mm$

$q_3 = 0.003\ mm$ $q_6 = 0.006\ mm$