(viii) How many nodes are provided for a one dimensional quadratic element?
(a) 2 (b) 3 (c) 4 (d) 5.

(ix) If order of interpolation functions representing geometry of the element is same the interpolation functions define displacements, then the finite element formulation is termed as
(a) isoparametric (b) subparametric
(c) superparametric (d) none of these.

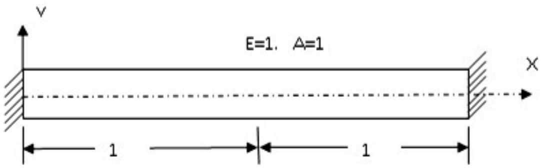
(x) Which of the following element has internal nodes?
(a) Lagrange elements (b) Serendipity elements
(c) Symmetric (d) Unsymmetrical element.

Group – B

2. (a) Simply supported beam is subjected to uniformly distributed load over entire span. Determine the bending moment and deflection at mid span by using Rayleigh-Ritz method.

(b) The potential energy for the linear elastic one-dimensional rod, with body force neglected is

$$\Pi = \frac{1}{2}\int_0^L EA\left(\frac{dy}{dx}\right)^2 dx - 2U_1$$



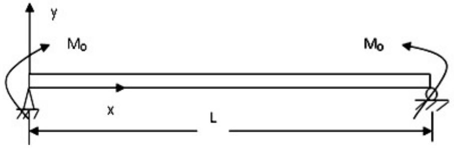
Calculate stress in the bar, where, $U_1 = U_{(x=1)}$, using Rayleigh Ritz method.

6 + 6 = 12

3. (a) A Simply supported beam is subjected to concentrated moments at both ends. The problem is governed by the following differential equation

$$EI\frac{d^2y}{dx^2} - M_0 = 0 \quad x \in [0, L]$$

With boundary conditions (support condition in this case): $y(0) = 0$ and $y(L) = 0$.



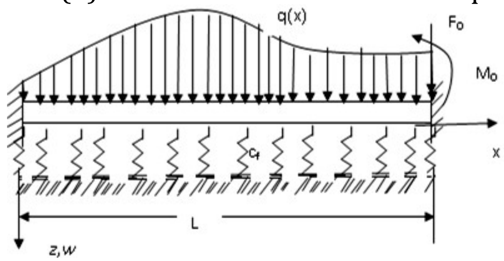
Solve the differential equation by Galerkin method.

(b) Solve the same problem by Petrov-Galerkin method.

6 + 6 = 12

Group – C

4. The transverse deflection w of a beam is governed by the fourth-order differential equation $\frac{d^2}{dx^2}\left(EI\frac{d^2w}{dx^2}\right) + c_f w = q(x)$ for $0 < x < L$, E denotes the modulus of elasticity, I the second moment of area about the y axis of the beam, q is the distributed transverse load, c_f the elastic foundation modulus. Develop (a) the weak form and (b) finite element model of the equation.



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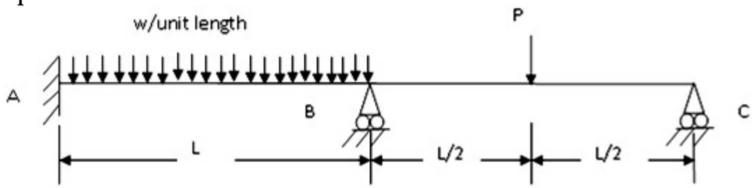
5. Use the minimum number of Euler-Bernoulli beam finite elements to analyse the beam problem shown in Fig. EI is constant throughout. In particular, give:
(i) The assembled stiffness matrix and force vector.
(ii) The specified global displacements and forces and the equilibrium conditions.
(iii) The condensed matrix equations for the primary unknowns (i.e., generilized forces) separately. Exploit symmetries, if any, in analyzing the problem.



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Group – D

6. (a) Write short notes on the following:
(i) Isoparametric finite element formulation
(ii) Geometric invariance.

(b) Derive the interpolation functions for a eight noded plate element in natural-coordinate system (ξ,η).

4 + 8 = 12

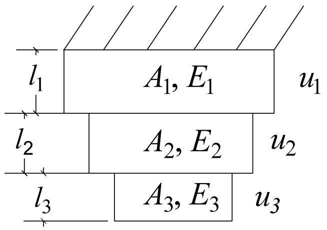
7. (a) Describe the convergence criteria and C^1 continuity for a finite element formulation.

(b) Derive the interpolation functions of a three noded one dimensional element of length h_e in local coordinate system ($\bar{x}$).

6 + 6 = 12

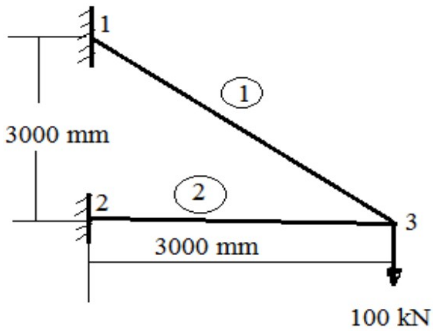
Group – E

8. Find out the global stiffness matrix of the one dimensional bar shown in the following figure using two noded bar element. A, E and u define cross-sectional area, modulus of elasticity and degree of freedom for element 1, 2 and 3 of the one dimensional bar, respectively.



12

9. For the two-bar truss shown in figure, determine the displacement at node 3. $A_1 = 500$ mm^2, $A_2 = 1000$ mm^2, $E = 2 \times 10^5$ N/mm^2.



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FINITE ELEMENT ANALYSIS (CIVL 4244)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) Finite element analysis deals with
(a) approximate numerical solution (b) boundary value problem
(c) initial value problem (d) differential equations.

(ii) For better FEA, finite element size should be
(a) increased (b) decreased
(c) unaltered (d) infinitesimally small.

(iii) Stiffness matrix is a
(a) symmetric matrix (b) skew symmetric matrix
(c) adjoined matrix (d) augmented matrix.

(iv) The Stiffness matrix gives the information of
(a) geometric behaviour (b) material behaviour
(c) both geometric and material behaviour (d) stress-strain behaviour.

(v) Galerkin method is
(a) direct method (b) variational method
(c) weighted residual method (d) energy method.

(vi) Which of the following should be continuous between adjacent elements to confirm C^0 continuity of an approximate function 'φ'? where $\varphi = \varphi(x)$
(a) Both φ and $\frac{\partial \phi}{\partial x}$ (b) φ only
(c) $\frac{\partial \phi}{\partial x}$ only (d) φ, $\frac{\partial \phi}{\partial x}$, $\frac{\partial^2 \phi}{\partial x^2}$

(vii) Rayleigh Ritz method is a
(a) direct method (b) variational technique
(c) weighted residual method (d) energy method.