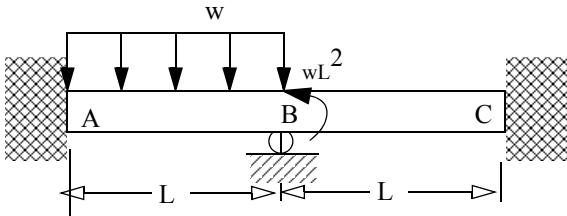


# EXAM 2

1. A beam has a uniform load and a moment applied to it as shown. Model the beam using two equal beam elements. Assume  $EI$  is a constant for the beam.

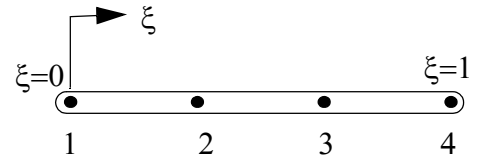
(a) Write the global stiffness matrix before incorporating the loads and boundary conditions. (b) In terms of  $w$ ,  $L$ ,  $E$  and  $I$  determine the slope at B. (c) Determine the deflection at mid-point of BC.



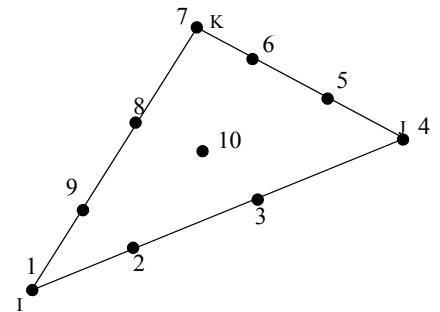
$\theta_B = \text{-----}$

$V(\text{mid BC}) = \text{-----}$

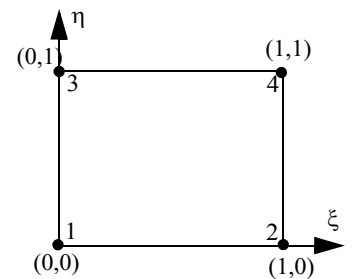
2. (a) Using the natural coordinate ( $\xi$ ) shown, write the interpolation function associated with nodes 1 and 2 for the cubic element.



(b) Using Area coordinates  $L_I, L_J, L_K$  write the interpolation function associated with nodes 8 and 10.

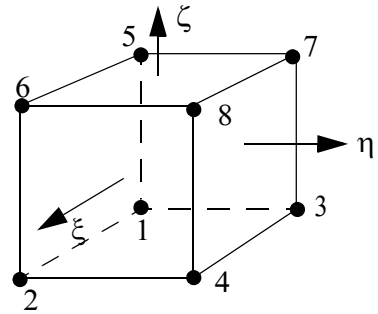


(c) Using the natural coordinate ( $\xi, \eta$ ) shown write the interpolation function associated with nodes 1 and 2.



(d) Using the natural coordinate ( $\xi, \eta, \zeta$ ) shown write the interpolation function associated with nodes 4 and 5. Each of the

coordinates  $(\xi, \eta, \zeta)$  varies from -1 to +1.



(e) Using a 3 point Gauss quadrature evaluate the following integral :  $I = \int_{-1}^1 \frac{(1 + \xi^2)}{(1 + \xi^4)} d\xi$

3. (i) Describe briefly the skyline storage scheme.
- (ii) Describe briefly the Wavefront equation solver.
- (iii) What is a Jacobian Matrix?
- (iv) What is a patch test?
- (v) What are the three major classifications of errors in FEM?
- (vi) List three types of non-linearities in FEM analysis?
- (vii) What is matrix conditioning error?

CIRCLE THE CORRECT ANSWERS BELOW

- |  |                                      |
|--|--------------------------------------|
| (viii) In FEM the bandwidth of the global stiffness matrix depends upon  | Element numbering/ Node numbering    |
| (ix) Multiple load solutions can be most efficiently solved by   | Direct methods / Iterative methods   |
| (x) In FEM stresses are found at   | Element nodes / Element Gauss points |
| (xi) In FEM the differential equations are satisfied exactly inside an element   | TRUE / FALSE                         |
| (xii) In FEM the stresses satisfy the traction boundary conditions exactly.  | TRUE / FALSE                         |
| (xiii) In FEM the displacements satisfy the displacement boundary conditions exactly.                                    | TRUE / FALSE                         |
| (xiv) In Iso-parametric elements the displacements and coordinates are approximated by the same interpolation functions. | TRUE / FALSE                         |

Answer

$$1. \theta_B = \frac{13}{96} \left( \frac{wL^3}{EI} \right) \quad v = \frac{13}{768} \left( \frac{wL^4}{EI} \right)$$

2e I=2.1961

- 3.
- (viii) Node Numbering
- (ix) Direct Methods
- (x) Gauss points
- (xi) False
- (xii) False
- (xiii) True
- (xiv) True