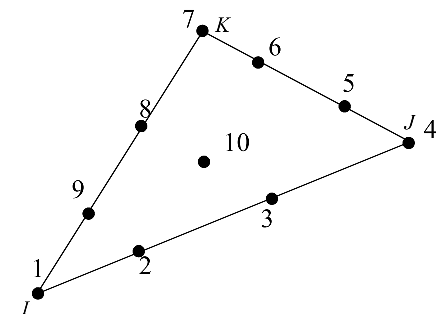
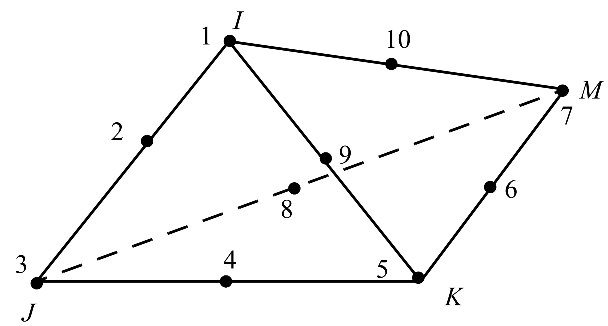
Final

1.

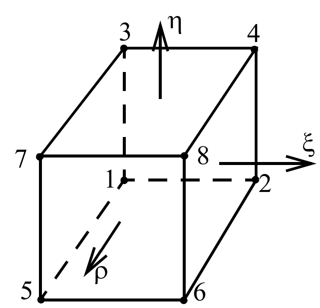
(i) Using area coordinates L_I, L_J, L_K write the Lagrange interpolation function associated with nodes 9 and 10. The nodes are uniformly spaced.



(ii) Using volume coordinates L_I, L_J, L_K,L_M write the Lagrange interpolation function associated with nodes 1 and 2. The nodes are uniformly spaced.



(iii) Using the natural coordinates ξ, η, ρ write the Lagrange interpolation function associated with nodes 1 and 2. Each coordinates varies from -1 to +1.



(iv) A non-dimensional version of beam bending problem is governed by the differential equation below.

$$\frac{d^4 \mathrm{v}}{dx^4} = -x^2 \qquad 0 \le x \le 1$$

Write the 2 equations to solve for the values of c_1 and c_2 by *Least square method* in the approximation below. *Evaluate the integrals but do not solve the algebraic equations.*

$$\mathrm{v} = c_1\left(\frac{x^4 - 2x^3 + x^2}{24}\right) + c_2\left(\frac{x^5 - 2x^4 + x^3}{24}\right)$$

2. In problems (i) through (iv) **circle** the correct answer.

(i) Eigenvectors of a symmetric matrix are orthogonal.

TRUE / FALSE

(ii) In the equation $[M]\left\{\frac{d^2u}{dt^2}\right\} + [C]\left\{\frac{du}{dt}\right\} + [K]\{u\} = \{R\}$, the three matrices are always symmetric irrespective of the application.

TRUE / FALSE

(iii) In the equation $[M]\left\{\frac{d^2u}{dt^2}\right\}+[C]\left\{\frac{du}{dt}\right\}+[K]\{u\} = \{R\}$, the three matrices are always positive definite irrespective of the application.

TRUE / FALSE

(iv) In modal analysis the eigenvalue problem corresponding to $\{R\} = 0$ in the equation $[M]\left\{\frac{d^2u}{dt^2}\right\}+[C]\left\{\frac{du}{dt}\right\}+[K]\{u\} = \{R\}$ has to be solved.

TRUE / FALSE

(v) Name two storage techniques in FEM.

1.
2.

(vi) Name two solution techniques in FEM.

1.
2.

(vii) Name the three major errors in FEM analysis.

1.
2.
3.

(viii) Name two causes for poor matrix conditioning in solution of algebraic equations in FEM.

1.
2.

(ix) Name the three basic methods of mesh refinement in FEM

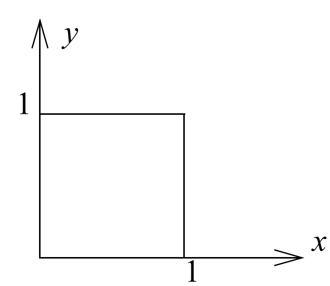
1.
2.
3.

(x) Name two indirect methods of solving forced response in dynamic problems.

1.
2.

3. From the functional given below, using the first principle for finding the stationary value of I, obtain the following: (a) The differential equation. (b) All possible essential boundary conditions at x = constant and y = constant. (c) All possible natural boundary conditions at x = constant and y = constant. **Be methodical and box your answers.**

$$I = \int_0^1\int_0^1\left[\left(\frac{\partial^2 u}{\partial x^2}\right)^2 - (1+y^2)\left(\frac{\partial u}{\partial y}\right)^2 - 14u\right]dxdy$$



4. Develop the weak form and identify the *bi-linear* and *linear functional* for the boundary value problem given below. Where a, b, c, and f are known functions of x. **Be methodical and box your answers**

$$\frac{d^2}{dx^2}\left(b\frac{d^2u}{dx^2}\right) - \frac{d}{dx}\left(a\frac{du}{dx}\right) + cu - f = 0 \qquad 0 \le x \le L$$

$$u(0) = 1 \qquad \frac{du}{dx}(0) = 0 \qquad u(L) = 0 \qquad \left. b\frac{d^2u}{dx^2}\right|_{x = L} = 0.5$$