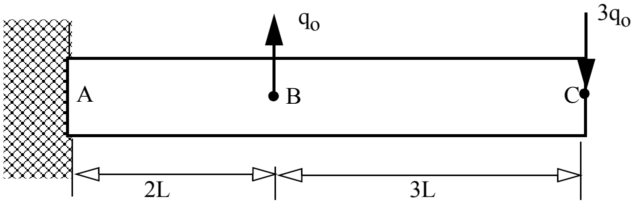
FINAL

1. The rod shown has a thermal conductivity k. Heat flows into the rod at C and out of the rod at B. Model the rod with two linear elements. Determine the temperature at point B and C and the heat flow at point A assuming the temperature at A is at zero degrees. The solution will be in terms of q_o, L, and k. Please be methodical.

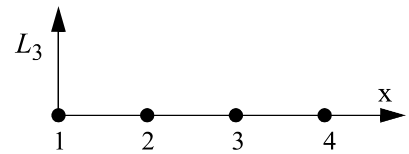


$T_B = (4Lq_o)/k$

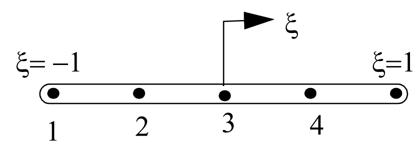
$T_{BC} = (13Lq_o)/k$

$q_A = -2q_o$

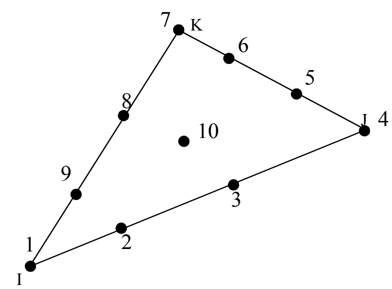
2. (i) For a cubic Lagrange polynomial sketch the approximate interpolation function (L_2) associated with node 2.



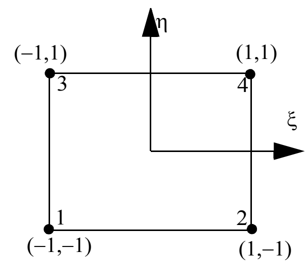
(ii) Using the natural coordinate (ξ) shown, write the interpolation function associated with nodes 2 and 3 for the quartic element.



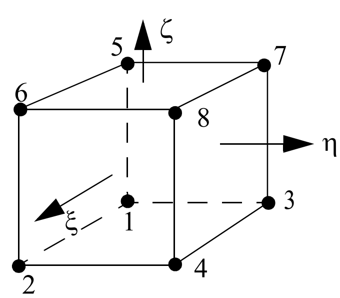
(iii) Using Area coordinates L_I, L_J, L_K write the interpolation function associated with nodes 1 and 5.



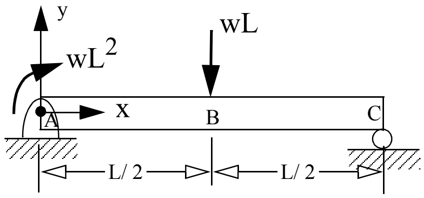
(iv) Using the natural coordinate (ξ, η) shown write the interpolation function associated with nodes 3 and 4



(v) Using the natural coordinate (ξ, η, ζ) shown write the interpolation function associated with nodes 3 and 6. Each of the coordinates (ξ, η, ζ) varies from -1 to +1.



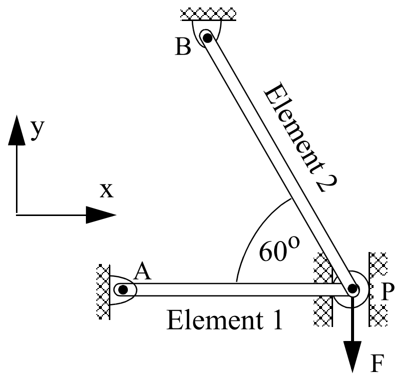
3. A simply supported beam is loaded with a force and moment as shown. A Kinematically admissible displacement field is given by $v(x) = C_1(x^2 - Lx) + C_2(x^3 - Lx^2)$. Using Rayleigh-Ritz determine the constants C_1 and C_2. Assume bending rigidity EI is a constant. The solution will be in terms of w, L, E, and I. Please be methodical.



$$C_1 = \frac{19}{48}\frac{wL^2}{EI}$$

$$C_2 = -\left(\frac{1}{6}\frac{wL}{EI}\right)$$

4. A force F= 20 kN is applied to the roller that slides inside a slot as shown. Both bars have an area of cross-section of A = 100 mm^2 and a modulus of elasticity E = 200 GPa. Bar AP and BP have lengths of L_{AP}= 200 mm and L_{BP}= 250 mm respectively. Model each bar with a linear element. (a) Write the Global stiffness matrix before incorporating the loads or boundary conditions. (b) Using FEM, determine the displacement of the roller and the reaction force acting on the roller. Please be methodical.



$$\delta_P = -0.333 \text{ mm}$$

$$R_P = 11.55 \text{ kN}$$