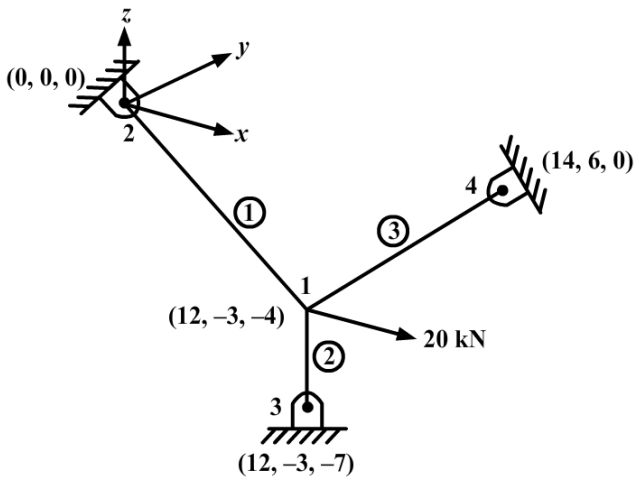
Finite Element Analysis QUIZ II (Closed Book)

Answer all questions. Maximum marks: 20

All questions carry equal marks. Time: 120 minutes

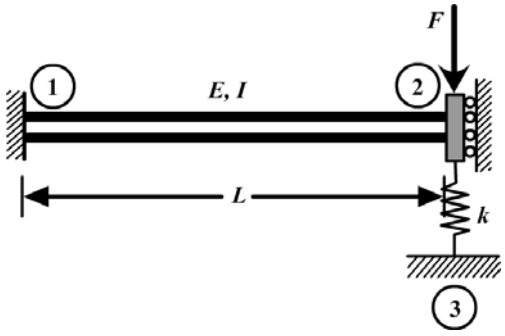
Question 1:

Analyze the space truss shown in the figure below. The truss is composed of four nodes, whose coordinates (in meters) are shown in the figure, and three elements, whose cross-sectional areas are all $10\times10^{-4}m^2$. The modulus of elasticity $E=210\ GPa$ for all the elements. A load of $20\ kN$ is applied at node 1 in the global *x*–direction. Nodes 2 to 4 are pin supported and thus constrained from movement in the *x*, *y*, and *z* directions.



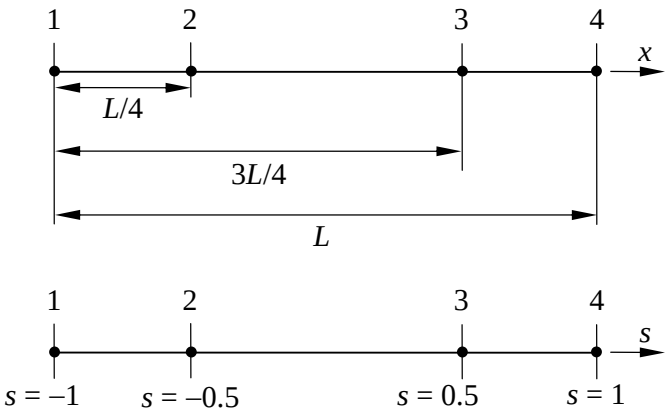
Question 2:

A beam is clamped at the left end and on a spring at the right end as shown in the figure below. A force $F=3{,}000\ N$ acts downward at the right end as shown. The spring stiffness $k=3{,}000\ N/m$. The beam properties are $L=1\ m$, $EI=1{,}000\ Nm^2$. Determine the deflection curve $v(x)$ and bending moment curve $M(x)$.



Question 3:

For the four-noded bar element shown in the figure below, show that the Jacobian determinant is $|\underline{J}| = L/2$. Also determine the shape functions N_1 to N_4 and the strain/displacement matrix $\underline{B}$.



Question 4:

Evaluate the integrals (a) $I = \int_{-1}^{1}\left[x^2 + \cos(x/2)\right]dx$ and (b) $I = \int_{-1}^{1}\left[3^x - x\right]dx$ using three-point Gaussian quadrature. $x_1, x_3 = \pm 0.77459666924148$, $x_2 = 0$, $w_1, w_3 = 5/9$, $w_2 = 8/9$.

Question 5:

Consider two triangular elements shown in figure below. The nodal displacements are given as $\{u_1, v_1, u_2, v_2, u_3, v_3, u_4, v_4\} = \{-0.1, 0, 0.1, 0, -0.1, 0, 0.1, 0\}$. Calculate displacements $\{u, v\}$ and strains $\{\partial u/\partial x, \partial v/\partial y, \partial u/\partial y + \partial v/\partial x\}$ in both elements.