MSE 427/727 FEA Midterm Exam

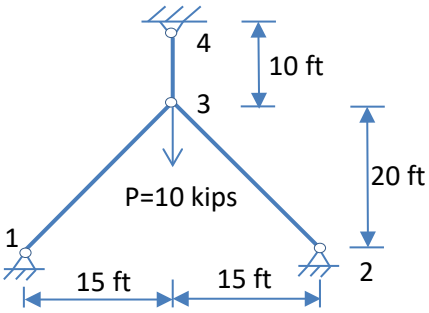
SIMON FRASER UNIVERSITY
MECHATRONIC SYSTEMS ENGINEERING

Midterm Examination – July 2, 2019

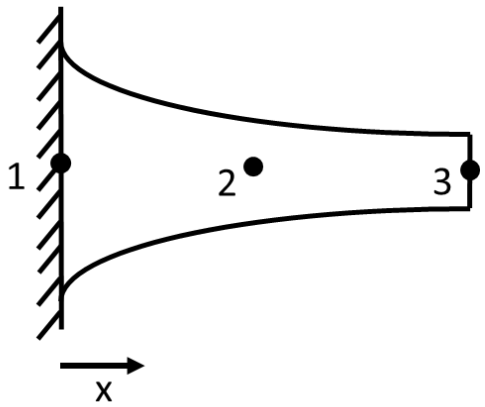
Instructor: Kambiz Hajikolaei Time: 100 minutes

Non-programmable calculators may be used
No smartphones or other electronic devices may be used
One page (8.5" x 11", one side) of handwritten notes is permitted
Answer all the questions in the booklet (not the question sheet)

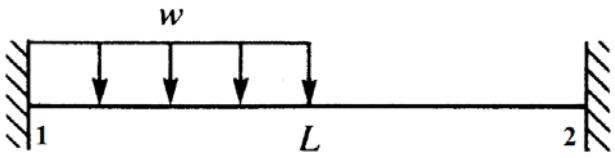
1. Use symmetry to determine the displacement at node 3 for the plane truss shown in figure. Also, find the force in the element with the length of 10 ft.
Let E=30x10^6 psi and A=3 in^2 for all elements. (25 marks)



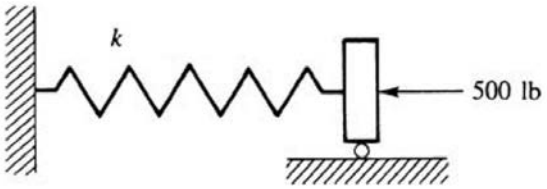
2. A bar of length L with a non-constant cross-section of $A(x) = A_0\left(1 - x^2\right)$ is subjected to a distributed axial loading of $T\left(x\right) = Cx$ $\left(force / length\right)$. Divide the bar to two elements with equal size and find the displacement of the tip (node 3). Let E be constant. (30 marks)



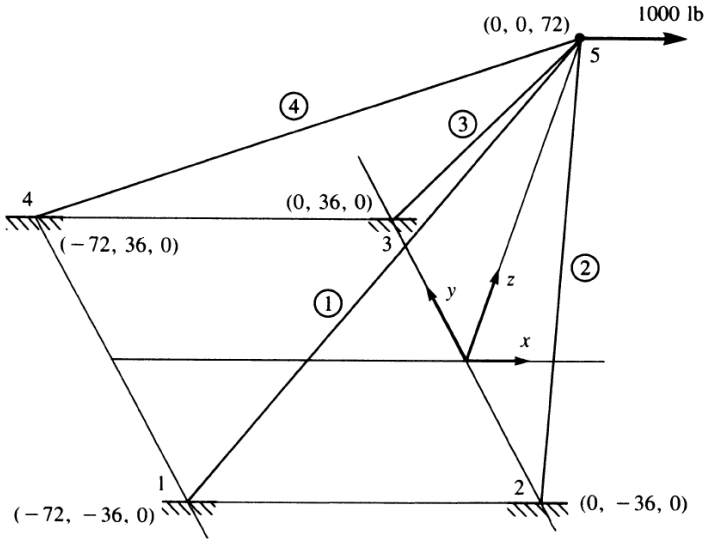
3. Use the relevant equation derived in the work-equivalence method to find the equivalent nodal forces at nodes 1 and 2 as a function of *w* and *L* for the beam with distributed loading shown. Don't divide it to two elements. (15 marks)



4. The nonlinear spring in the figure has the force/deformation relationship $f = k\delta^2$, where $k = 1000 \quad lb/in^2$. Express the total potential energy of the spring, and use Minimum Potential Energy Method to obtain the equilibrium value of displacement. (10 marks)



5. Given the truss structure shown, calculate the stress in truss element 1 if $A = 4\ in^2$ and $= 3 \times 10^7\ psi$. The nodal displacement vector has already been computed with FEM and is given as shown below. The unit of the coordinate values is inch. (10 marks)



$$d = \begin{bmatrix} u_5 \\ v_5 \\ w_5 \end{bmatrix} = \begin{bmatrix} 0.0014 \\ 0 \\ -0.00042 \end{bmatrix} \quad inch$$