TAKE HOME EXAM (EML 4536)

100 Points

Part A

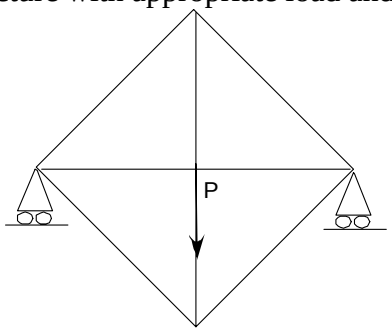
Provide brief answers to following questions (3 points each)

1) What does an element of Stiffness matrix K_{ij} represent? What does the row $(K_{21}, K_{22}, K_{23}, ...)$ represent?
2) What is the order of stiffness matrix for a structure with N elements and M nodes for a two dimensional problem
3) Can the following matrix represent the stiffness matrix? Specify reasons.

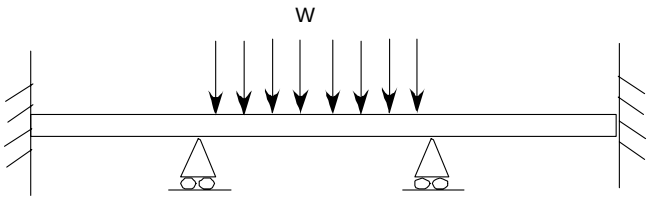
$$\begin{bmatrix} 1 & 23 & 0 \\ 23 & 6 & -8 \\ 0 & 8 & 9 \end{bmatrix}$$

4) What is a singular matrix? What happens to a stiffness matrix when boundary conditions are applied
5) Write the polynomial displacement function for a bar element with four nodes.
6) Why do we need cubic displacement functions to describe beam elements?
7) Use symmetry to simplify the following structures. (Do not need to solve it. Draw the simplified structure with appropriate load and boundary conditions)

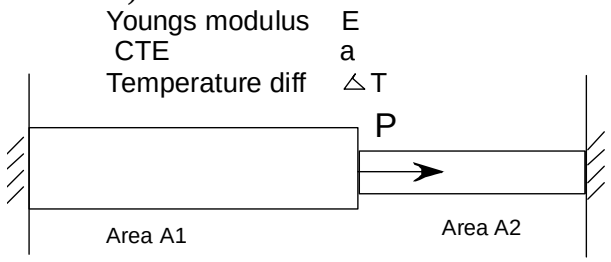
(a)



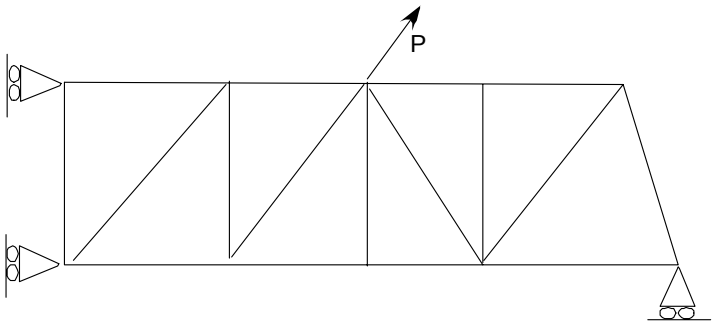
(b)



8) Assemble the load vector for following structure. (Do not need to solve it. Assemble the load vector)



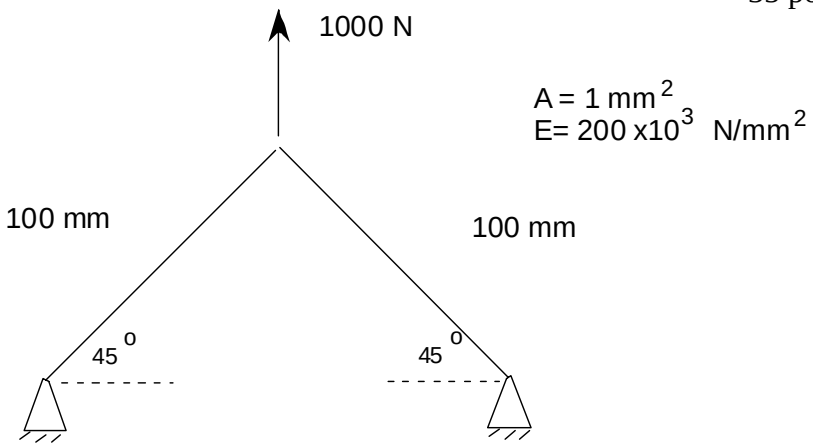
9) Write the number of elements, nodes required and degree of freedom to solve following truss using FEM.



10) Write the degree of freedom per node for following elements.
    a) Bar
    b) 3D Truss
    c) Beam

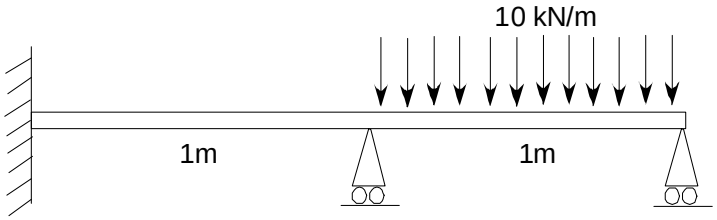
Part B

1) (a) Solve the following truss for displacements and forces using finite element method. Estimate the stresses and strains in each member. (USE SYMMETRY)
35 points



(b) If coefficient of thermal expansion is 2 E-06 /C and temperature is raised by 200 C solve for stresses and strains.

2) Solve the following beam for displacements and rotations at the nodal points using FEM. 35 points



$EI = 6 \times 10^{5}$ N/m