CEE-530/ME-524
Introduction to the Finite Element Method
HW#8
ELECTRONIC SUBMISSION ONLY
Due on: 11/28/2016

Problem 1: Show that the Q8 element does not present the problem of shear locking. Proceed in the same manner as was shown for the Q4 element in class. That is, use the given continuous displacement field to compute displacements at nodes, calculate strains in the element using the element interpolation functions, and then compare these to the exact solution.

Problem 2: Complete the Matlab code provided with this homework and compute the nodal displacements for the assembly of elements given below. You are given the main script in a file called FEScript.m. You need to complete or write the following functions:

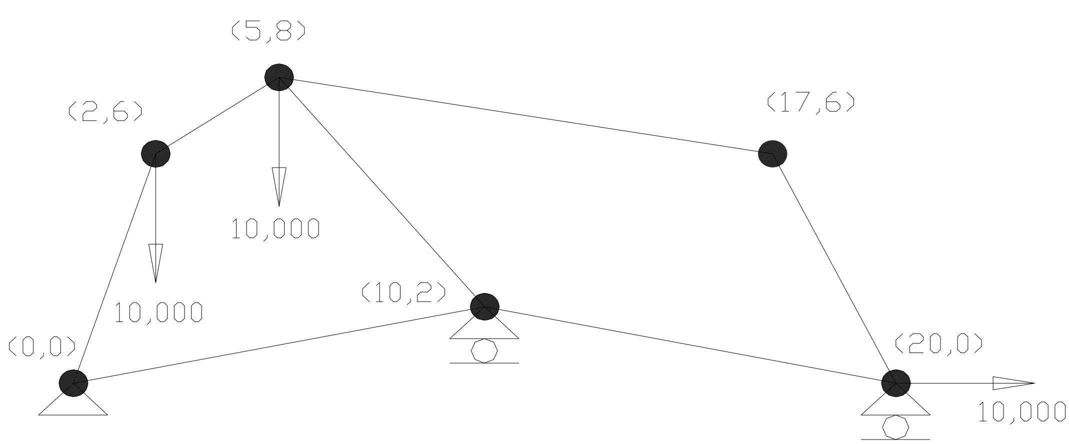
function [NodalCoord, Connectivity, essentialBcs] = getMeshSimple()
This function returns the nodal coordinates, the connectivity and dofs where essential conditions are to be enforced.

function K = assembleStiffnessMatrix(NodalCoord, Connectivity, D, thickness)
This function returns the assembled global stiffness matrix without EBCs.

function [Fg] = getForceFromGravity(NodalCoord, Connectivity, rho, g, thickness)
This function computes the contribution of a gravity body force and assembles it into a global force vector. The gravity body force is given at the end of this problem statement.

You should employ in this homework the functions you have developed in previous homeworks. Also, you are given some other utility functions that will be useful for this homework. For instance, there is a function called getElementCoordinates() that, given an element number, the nodal coordinates array, and the connectivity array, returns the coordinates of the nodes of the element in a format necessary for computing the stiffness matrix of the element.

Compare your program solution to the one given by commercial software such as ABAQUS or ANSYS (any FE software would do). Assume plane stress conditions.



Use the following information.

$h = 0.1$ (Thickness)

$E = 200E9$

$\nu = 0.3$

$\rho = 7800$ (Density)

$g = 9.8$

This structure is subjected to gravity, which comes as a body force as

$$\mathbf{b} = \begin{Bmatrix} 0 \\ -\rho g \end{Bmatrix}.$$

Units are Kg (mass), m, sec.

Problem 3: In the configuration in Problem 2, determine the eigenvalues and eigenvectors of the stiffness matrix for these two cases.

a) Full integration (i.e. 2 x 2)
b) Reduced integration (i.e. 1 point)

Plot the eigenvectors and report the number of zero eigenvalues in each case. Is the number of zero eigenvalues as expected? Provide a brief justification to your answer.