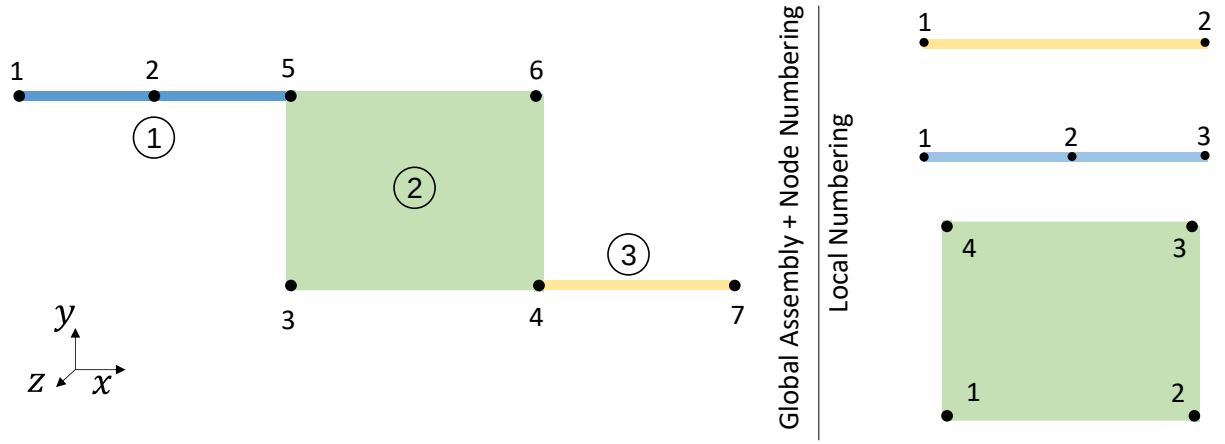
MECH 5130 Theory of Finite Element Method
Scott Stapleton

Homework 6: Element Assembly

Complete (1), (2) and (3) for pre-homework submission.

(1) For the assembly below:



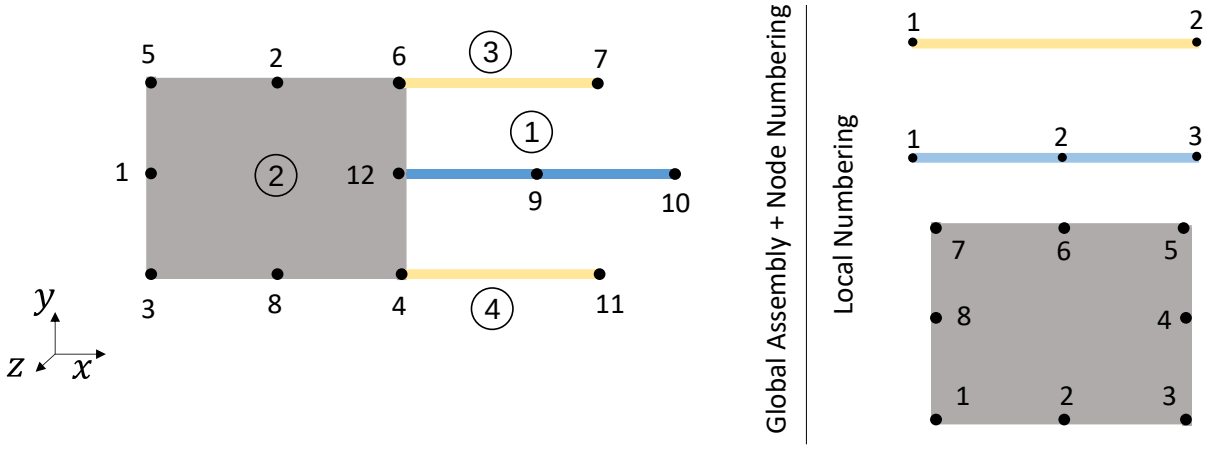
a. Derive the connectivity matrix using the global node numbers, element numbers, and local node numbers shown above.

b. Color in the squares to show which elements have components of stiffness and force in which entries in the global matrices. I know, you have not colored in boxes for an assignment since you were in 2nd grade, but just humor me!

$$\begin{bmatrix} Q_{1x} \\ Q_{1y} \\ Q_{2x} \\ Q_{2y} \\ Q_{3x} \\ Q_{3y} \\ Q_{4x} \\ Q_{4y} \\ Q_{5x} \\ Q_{5y} \\ Q_{6x} \\ Q_{6y} \\ Q_{7x} \\ Q_{7y} \end{bmatrix} =$$

$$\mathbf{KQ = F}$$

(2) For the assembly below:



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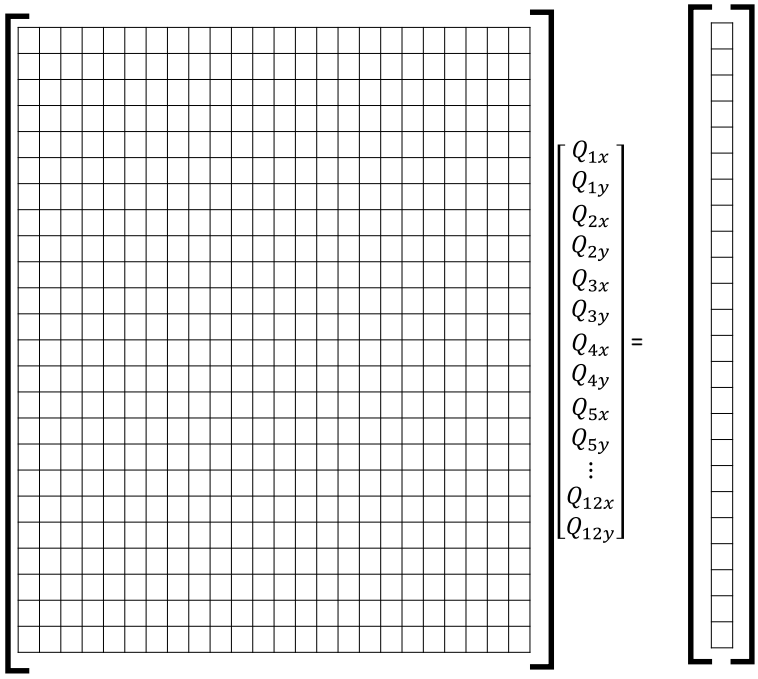
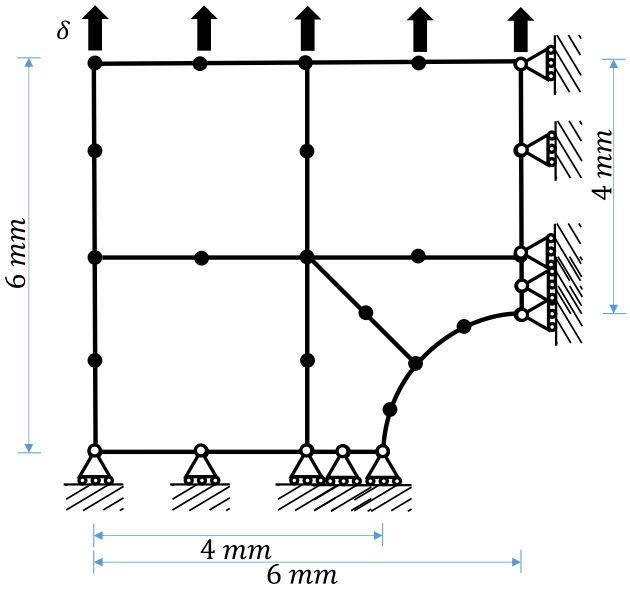


$\mathbf{KQ = F}$

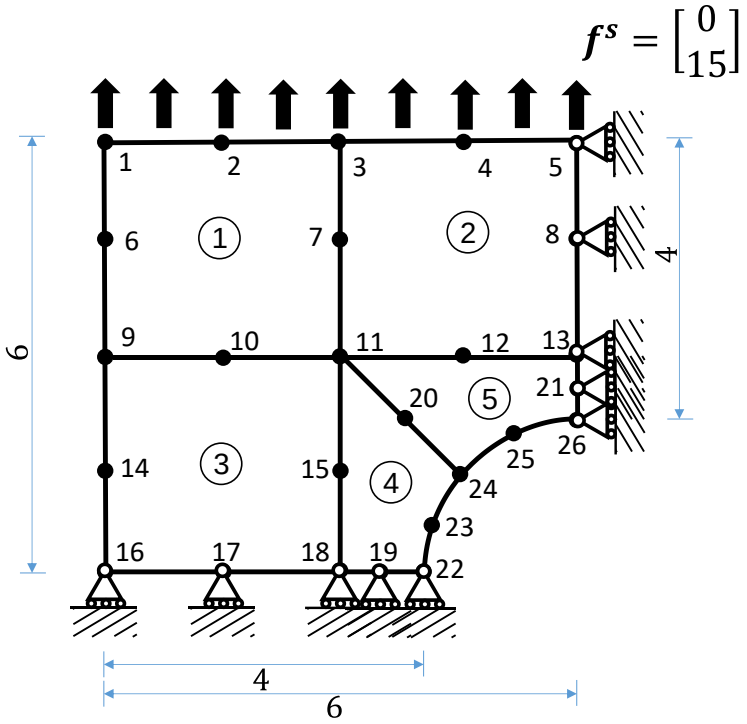
(3) Make the model shown below in Abaqus using quadratic 2-D elements. Use sectioning to get the mesh identical to that shown below. Apply the boundary conditions and generate an input file. From the input file, number all the nodes below how they were numbered in Abaqus. What seem to be the "rules" of the Abaqus numbering?



(4) Create a "bubble diagram" of the functions needed for this homework. Make sure to find the most abstract tasks and create one bubble chart that works for both elements. Show the interdependency of the functions, using arrows connecting functions as shown below, where an incoming arrow should be labelled with the inputs for the function and an outgoing arrow labeled with the outputs. Indicate in RED the functions which will need to be customized for each element and indicate which functions are new to this homework.

(5) Write pseudo-code for each of the new functions in the bubble chart. Get to enough detail that you have worked out all the indices and dimensions of any arrays needed. Look up key functions needed and show that the arrays you give to the functions are in the right form.

(6) For the 8-noded 2-D element assembly shown below (E=70,000, ν=0.33, plane stress, $t_z = 0.3$), find the global stiffness matrix **K** and the global force vector **F**. Plot a heat map of the global stiffness matrix **K** with a scale and indicate which components of the global force vector **F** are non-zero.



Local element numbering