

2.092/2.093

FINITE ELEMENT ANALYSIS OF SOLIDS AND FLUIDS I

FALL 2009

Homework 7

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Assigned: Session 16
Due: Session 19

Problem 1 (20 points):

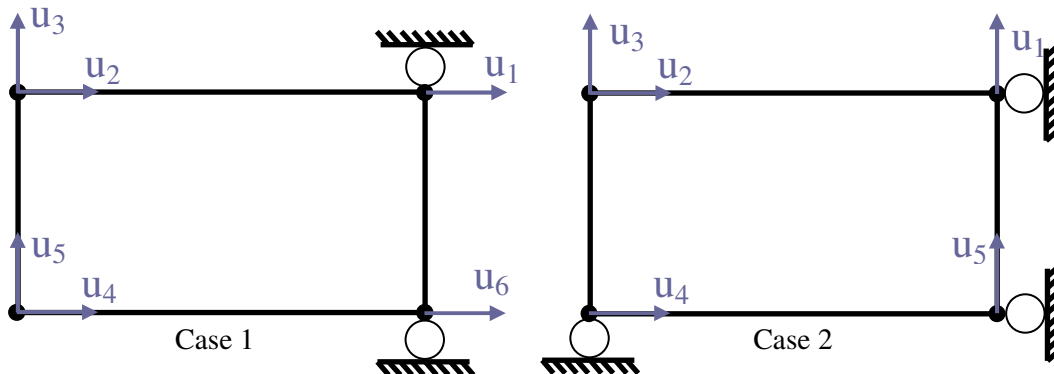
Consider the two degree of freedom system

$$\begin{bmatrix} 1 & 0 \\ 0 & 2 \end{bmatrix} \begin{bmatrix} \ddot{u}_1 \\ \ddot{u}_2 \end{bmatrix} + \begin{bmatrix} 4 & -1 \\ -1 & 4 \end{bmatrix} \begin{bmatrix} u_1 \\ u_2 \end{bmatrix} = \begin{bmatrix} 10 \\ 0 \end{bmatrix}; \quad {}^0U = 0; \quad {}^0\dot{U} = 0$$

Perform a mode superposition solution using only the lowest frequency and corresponding mode shape.

Problem 2 (10 points):

Consider the four-node finite element shown with its boundary conditions. Assume that Gauss elimination is performed in the usual order for u_1, u_2, \dots , and so on, i.e., from the lowest to the highest degree of freedom number. Determine for cases 1 and 2 whether any zero diagonal element will be encountered in the elimination process, and if so, at what stage of the solution this will be the case.



Problem 3 (10 points):

Consider the single degree of freedom equation.

$$2\ddot{U}+8U=0; \quad {}^0U=10^{-12}; \quad {}^0\dot{U}=0$$

Assume that the time step used in the central difference method time integration is $1.01 \times \Delta t_{cr}$. Estimate after how many time steps the solution will reach overflow (which is, for the computer used, given by 10^{30}).

Problem 4 (10 points):

Consider Fig. 8.1 on page 698, textbook. Describe in about one half a page (without equations!) the laboratory experiment a technician could perform to obtain the external force values shown in (b), (c), and (d).

That is, assume, the technician does not know the force values, does not know Gauss elimination and can only measure on a physical experiment with clamps as discussed in class. The technician needs to obtain from you an “exact set of steps” to perform that will always work!

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