ES128: Homework 6
Due in class on Wednesday, 5 May 2010

Problem 1

Calculate the mass matrix for the two-dimensional square element shown in Fig. 1. The element has uniform thickness t and uniform density ρ.

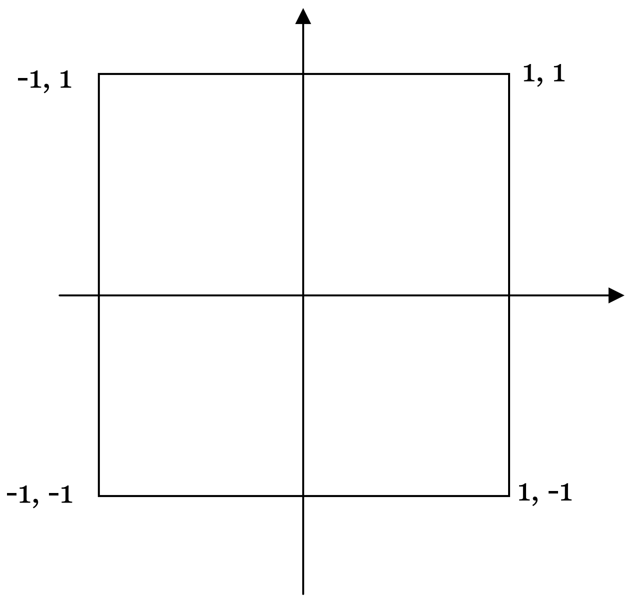

Fig.1

Problem 2

The four node parallelogram element shown below has uniform density and thickness. By integration, determine the consistent mass matrix (Hint: use the results of Problem 1 and the isoparametric formulation)

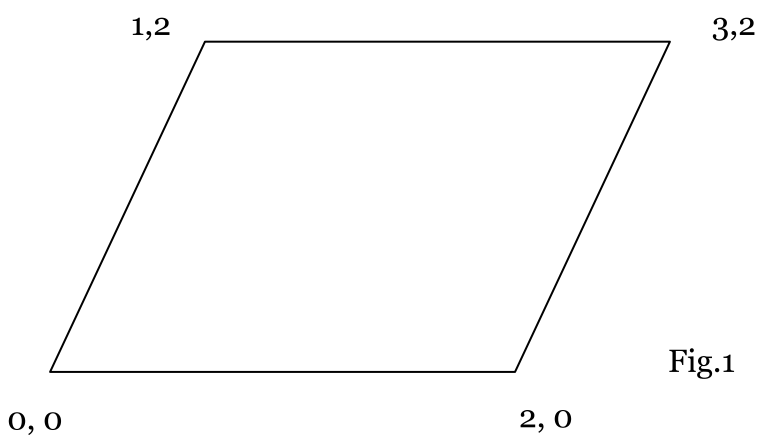

Fig.1

Problem 3

Cross-sectional area of the bar (as shown in Fig. 2) varies linearly from A_0 at the left end to γA_0 at the right end, where γ is a constant. Determine the consistent mass matrix that operates on axial degree of freedom u_1 and u_2.

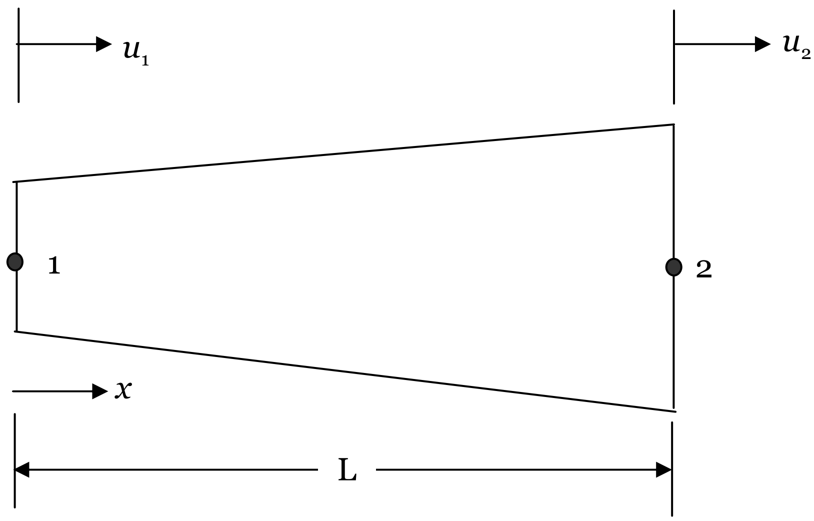

Fig. 2

Problem 4

Only axial motion is permitted in the system shown in Fig. 3. Let k=1 and m=2. Determine the fundamental vibration frequency ω_1 of the given system. Then calculate ω_1 after condensing the system to a single degree of freedom using Guyan reduction.

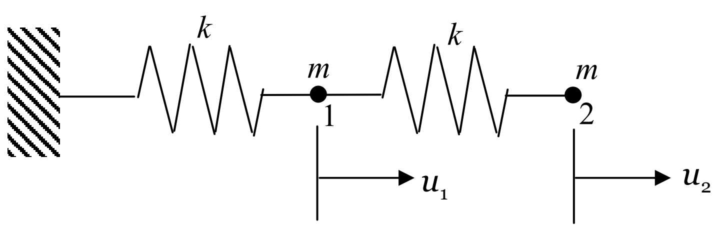

Fig. 3

Problem 5

A particle of unit mass is supported by a spring of unit stiffness, so ω_1 =1. There is no damping. At time t=0, when the particle has zero displacement and zero velocity, a unit force is applied and maintained. Use the central difference method to calculate displacement versus time over successive time steps as follows

1) Use Dt=0.5 and go to t=7

2) Use Dt=1 and go to t=7
3) Use Dt=2 and go to t=10
4) Use Dt=3 and go to t=15

Compare the results obtained above in terms of displacements versus time.
(Hint: implement the algorithm in Matlab)