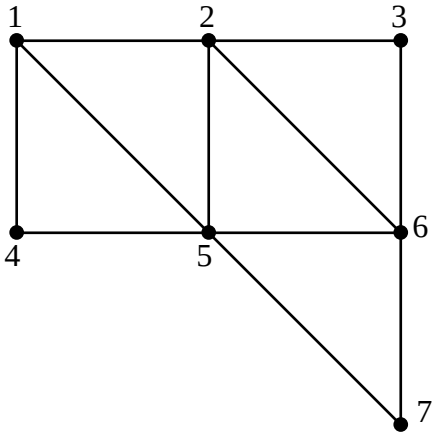
ME 712, Finite Element Method Applications Exam 1, Spring 1998

Open book, open notes. Test books will be provided.

1. Show the topology of the structure stiffness matrix for the truss below below. Let X represent a 2×2 non-zero submatrix and 0 represent a 2×2 zero submatrix. A submatrix is non-zero if any element in it is non-zero. Thus the stiffness matrix will have 7 rows and 7 columns of 2×2 submatrices. Put your result in band form. (15 points)



2. Can the bandwidth of the previous problem be reduced? If so, describe briefly what technique should have been used to the nodes. (5 points)

3. Given the differential equation for a beam is $EI\frac{d^4w}{dx^4} = 0$, determine the shape function for a beam corresponding to a rotation θ at the right end. That is, if there is no rotation of deflection at the left and, and the deflection at the right end is zero with a rotation of θ, what is the displacement of the beam between the nodes? Prove that your answer satisfies the differential equation and the boundary conditions. (20 points)

4. Determine the stiffness matrix for a 1-D rod with a cross section $A(x) = 1 + x$. (20 points)

5. Determine the mass matrix for the rod of problem 4. (20 points)

6. Use the principle of virtual work to find the deflection of the system below. Assume all three rods have the same stiffness k. (20 points)