Finite Element Methods in Linear Structural Mechanics
CompEng VGU, Winter 2016-2017

Assignment: Develop FEM Code for 3D Truss

In this assignment, you are required to modify the MATLAB code done in Assignment 1 to treat 3D truss structures. In modifying the code, you should follow exactly the same procedures as those utilized in the code for 2D truss structures. However, the number of degrees of freedom per node is equal to 3 in stead of 2. The element stiffness matrix for a three dimensional truss element is given by

$$\boldsymbol{k}=\frac{AE}{L}\begin{bmatrix} \cos^2\theta_x & \cos\theta_x\cos\theta_y & \cos\theta_x\cos\theta_z & -\cos^2\theta_x & -\cos\theta_x\cos\theta_y & -\cos\theta_x\cos\theta_z \\ \cos\theta_x\cos\theta_y & \cos^2\theta_y & \cos\theta_y\cos\theta_z & -\cos\theta_x\cos\theta_y & -\cos^2\theta_y & -\cos\theta_y\cos\theta_z \\ \cos\theta_x\cos\theta_z & \cos\theta_y\cos\theta_z & \cos^2\theta_z & -\cos\theta_x\cos\theta_z & -\cos\theta_y\cos\theta_z & -\cos^2\theta_z \\ -\cos^2\theta_x & -\cos\theta_x\cos\theta_y & -\cos\theta_x\cos\theta_z & \cos^2\theta_x & \cos\theta_x\cos\theta_y & \cos\theta_x\cos\theta_z \\ -\cos\theta_x\cos\theta_y & -\cos^2\theta_y & -\cos\theta_y\cos\theta_z & \cos\theta_x\cos\theta_y & \cos^2\theta_y & \cos\theta_y\cos\theta_z \\ -\cos\theta_x\cos\theta_z & -\cos\theta_y\cos\theta_z & -\cos^2\theta_z & \cos\theta_x\cos\theta_z & \cos\theta_y\cos\theta_z & \cos^2\theta_z \end{bmatrix}$$

where *A, E,* and *L* are cross-sectional area, Young's modulus and length of the element, respectively, and $\{\cos\theta_x, \cos\theta_y, \cos\theta_z\}$ are directional cosines of the element with respect to three axes *x*, *y* and *z* of Cartesian coordinates system.

To verify your code, you are required to analyze the 3D truss structure shown in the figure below. The following properties are given: cross-sectional areas of element *AB, AD, BD, BC* and *CD* are 2, 2, 1.5, 1.5 and 1 in^2, respectively, and all members have the same Young's modulus *E=30,000* ksi. You are required to submit both of your code and the output/results.