

Problem 1

- The general element stiffness matrix K^e is listed below:

$$K^e = \frac{E_e A_e}{h_e} \begin{bmatrix} \cos\theta_e & \sin\theta_e & 0 & 0 \\ -\sin\theta_e & \cos\theta_e & 0 & 0 \\ 0 & 0 & \cos\theta_e & \sin\theta_e \\ 0 & 0 & -\sin\theta_e & \cos\theta_e \end{bmatrix}^T \begin{bmatrix} 1 & 0 & -1 & 0 \\ 0 & 0 & 0 & 0 \\ -1 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} \cos\theta_e & \sin\theta_e & 0 & 0 \\ -\sin\theta_e & \cos\theta_e & 0 & 0 \\ 0 & 0 & \cos\theta_e & \sin\theta_e \\ 0 & 0 & -\sin\theta_e & \cos\theta_e \end{bmatrix}$$

So, for element 1 and 5, K^1 and K^5 are:

$$K^1 = \begin{bmatrix} 1 & 0 & -1 & 0 \\ 0 & 0 & 0 & 0 \\ -1 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix} \quad (E_1 A_1 = 1, h_1 = 1, \theta_1 = 0)$$

$$K^5 = \begin{bmatrix} 2.5 & 2.5 & -2.5 & -2.5 \\ 2.5 & 2.5 & -2.5 & -2.5 \\ -2.5 & -2.5 & 2.5 & 2.5 \\ -2.5 & -2.5 & 2.5 & 2.5 \end{bmatrix} \quad (E_5 A_5 = 5, \underline{h_5 = 1}, \theta_5 = \frac{\pi}{4})$$

- The entries which element 3 contributes and element 5 contributes are listed below:
Firstly, list matrix x , θ and Ξ :

$$x = \begin{bmatrix} 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 1 \end{bmatrix}$$

$$\theta = \begin{bmatrix} 1 & 1 & 2 & 3 & 1 \\ 2 & 3 & 4 & 4 & 4 \end{bmatrix}$$

$$\Xi = \begin{bmatrix} 1 & 1 & 3 & 5 & 1 \\ 2 & 2 & 4 & 6 & 2 \\ 3 & 5 & 7 & 7 & 7 \\ 4 & 6 & 8 & 8 & 8 \end{bmatrix}$$

- Element 3

For element 3, all the entries should be:

$$K_{33}, K_{34}, K_{37}, K_{38}, K_{43}, K_{44}, K_{47}, K_{48}, K_{73}, K_{74}, K_{77}, K_{78}, K_{83}, K_{84}, K_{87}, K_{88}$$

- Element 5

For element 5, all the entries should be:

$$K_{11}, K_{12}, K_{17}, K_{18}, K_{21}, K_{22}, K_{27}, K_{28}, K_{71}, K_{72}, K_{77}, K_{78}, K_{81}, K_{82}, K_{87}, K_{88}$$

- $K_{11}, K_{34}, K_{65}, K_{77}, K_{78}, K_{87}, K_{88}$ are expressed in terms of the element stiffness matrices K_{ij}^e :

$$K_{11} = K_{11}^1 + K_{11}^2 + K_{11}^5$$

$$K_{34} = K_{34}^1 + K_{12}^3$$

$$K_{65} = K_{43}^2 + K_{21}^4$$

$$K_{77} = K_{33}^3 + K_{33}^4 + K_{33}^5$$

$$K_{78} = K_{34}^3 + K_{43}^4 + K_{43}^5$$

$$K_{88} = K_{44}^3 + K_{44}^4 + K_{44}^5$$

Problem 3

Codes are seen in the email.

Problem 4

$$u = [0, 0, 0, 0, 0.0899, 0, 0.0899, -0.0333]^T$$

$$f = [-0.1, -0.1, 0, 0.1, 0, 0, 0.1, 0]^T$$

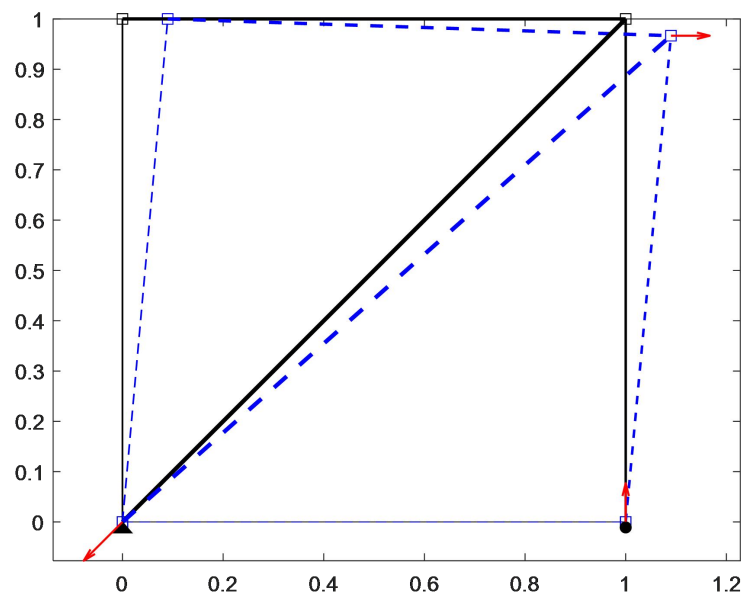


Figure 1. The plot of deformed truss 1

Problem 5

u =

0
0
-0.1054
0
0.0487
0.0723
0.0848
-0.0351
0.1027
-0.1914

f = [-0.0000 -0.2500 0 0.7500 0 0 0
0 0 -0.5000]

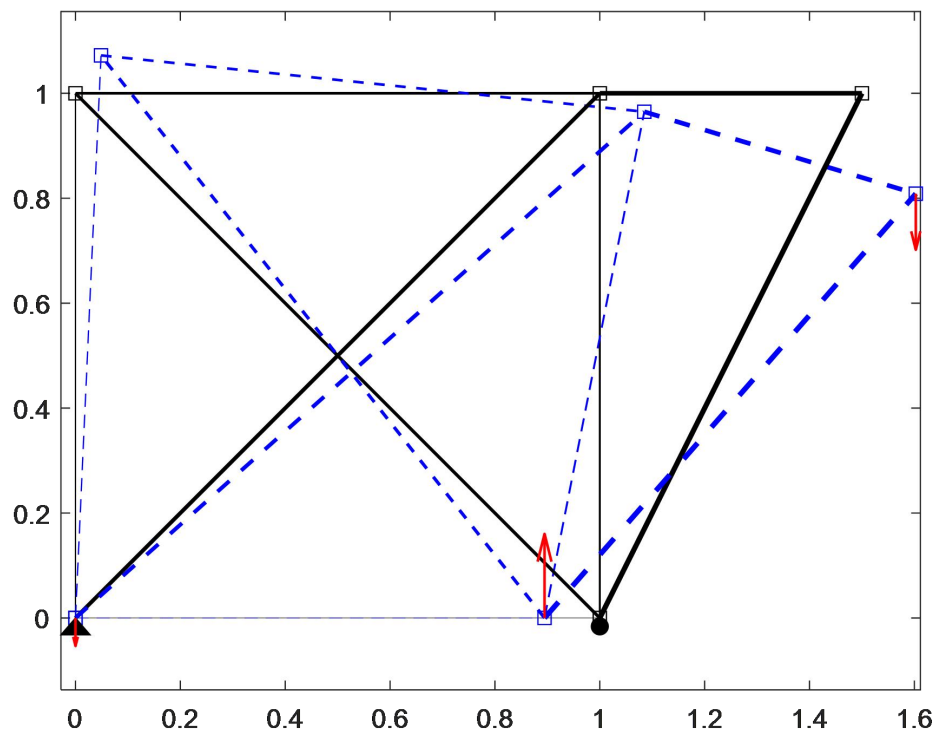


Figure 2.The plot of deformed truss 2