THEORY OF MACHINE AND MECHANISM II

TUTORIAL NO: 8

VIBRATION OF MULTI DEGREE OF FREEDOM SYSTEMS

1. **Figure P8.1** shows a three degrees of freedom system. Determine the stiffness matrix.
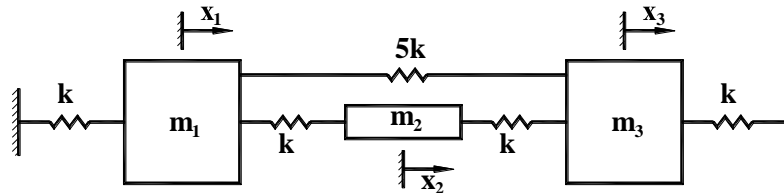

Figure P8.1

2. Determine the influence coefficients and flexibility matrix of the spring-mass system shown in **Figure P8.2**.
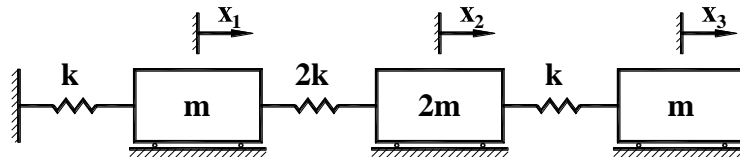

Figure P8.2

3. Determine the natural frequencies and the corresponding mode shapes of the system shown in **Figure P8.3**.

4. Determine the natural frequencies and the corresponding mode shapes of multi degree of freedom spring mass system shown in **Figure P8.4**.
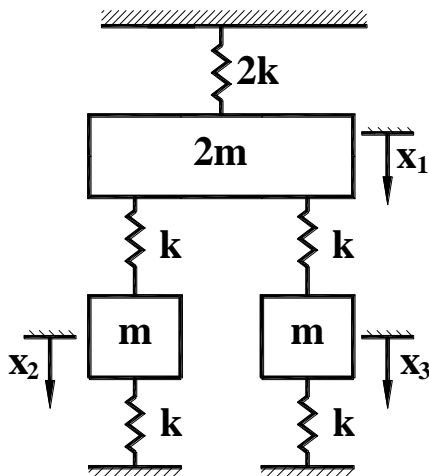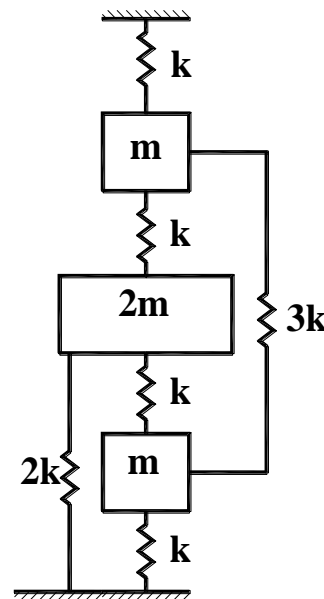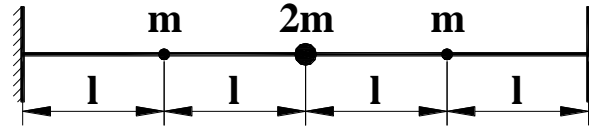

Figure P8.3

Figure P8.4

5. A string is stretched with a large tension T between two points and has three point masses fixed along its length as shown in **Figure P8.5**. The masses can vibrate freely in the lateral direction. Determine the three natural frequencies and the corresponding mode shapes.

Figure P8.5

ANSWERS

1. $\begin{bmatrix} 6k & -k & 0 \\ -k & 2k & -k \\ 0 & -k & 6k \end{bmatrix}$

2. $\begin{bmatrix} 1/k & 1/k & 1/k \\ 1/k & 2/3k & 2/3k \\ 1/3k & 2/3k & 5/3k \end{bmatrix}$

3. $\omega_1 = 0.4369\sqrt{k/m}$, $\omega_2 = 1.1441\sqrt{k/m}$, $\omega_3 = 1.732\sqrt{k/m}$; $\begin{Bmatrix} 1 \\ 1 \\ 1 \end{Bmatrix}$, $\begin{Bmatrix} 1 \\ 0 \\ 0 \end{Bmatrix}$, $\begin{Bmatrix} 1 \\ -1 \\ -1 \end{Bmatrix}$

4. $\omega_1 = 1.1206\sqrt{k/m}$, $\omega_2 = 1.6311\sqrt{k/m}$, $\omega_3 = 2.8432\sqrt{k/m}$

5. $\omega_1 = 0.766\sqrt{T/ml}$, $\omega_2 = 1.414\sqrt{T/ml}$, $\omega_3 = 1.847\sqrt{T/ml}$; $\begin{Bmatrix} 1 \\ 1.414 \\ 1 \end{Bmatrix}$, $\begin{Bmatrix} 1 \\ 0 \\ -1 \end{Bmatrix}$, $\begin{Bmatrix} 1 \\ -1.414 \\ 1 \end{Bmatrix}$