THEORY OF MACHINE AND MECHANISM II

TUTORIAL NO: 9

APPROXIMATE NUMERICAL METHODS

1. Determine the natural frequency of vibration for the system shown in **Figure P9.1**.
2. Write kinetic and potential energy expressions for the system shown in **Figure P9.2**, when $k_1 = k$, $k_2 = 3k$, $k_3 = 2k$; $m_1 = m$, $m_2 = 2m$ and determine the equation for ω^2 by equating the two energies. Letting $x_2/x_1 = n$, plot ω^2 versus n. Pick off the maximum and minimum values of ω^2 and the corresponding values of n, and show that they represent the two natural modes of the system.

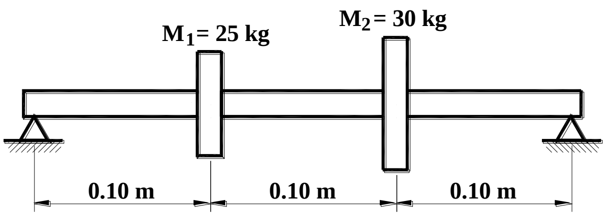

Figure P9.1

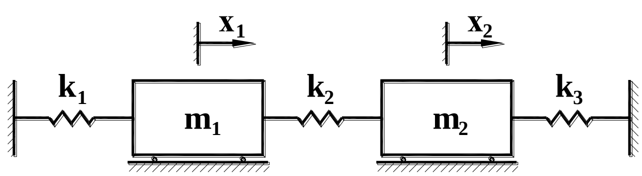

Figure P9.2

3. Using Dunkerley's equation, determine the fundamental frequency of the beam shown in **Figure P9.3**.
4. Using Dunkerley's equation, determine the fundamental frequency of the three mass cantilever beam shown in **Figure P9.4**.

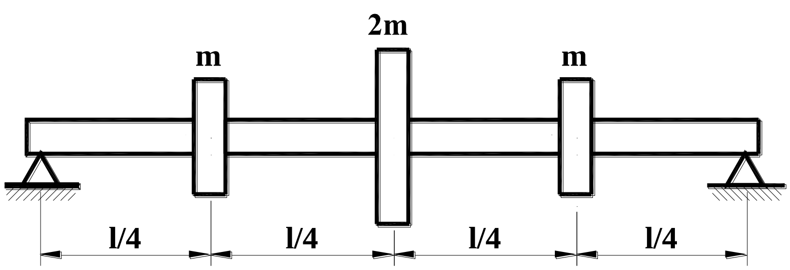

Figure P9.3

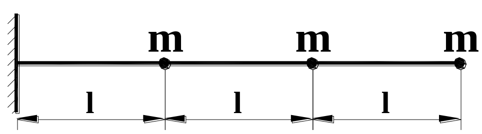

Figure P9.4

5. For the system shown in **Figure P9.5**, $k_1 = 3k$, $k_2 = 2k$, $k_3 = k$ and $m_1 = 4m$, $m_2 = 2m$ and $m_3 = m$. Set up the matrix equation and determine the three principal modes by iteration.

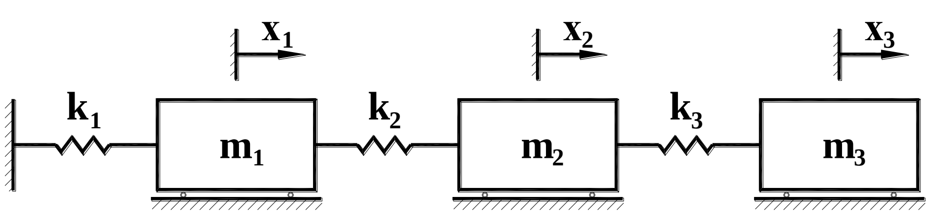

Figure P9.5

ANSWERS

1. 5850.27 rad/s

2. $\omega^2 = \frac{k}{m}\left(\frac{4-6n+5n^2}{1+2n^2}\right)$

3. $\omega^2 = 15.36\frac{EI}{ml^3}$

4. $\omega^2 = \frac{3}{19}\frac{EI}{ml^3}$

5. $\omega_1 = 0.533\sqrt{k/m}$, $\omega_2 = 1.063\sqrt{k/m}$, $\omega_3 = 1.528\sqrt{k/m}$; $\theta_1 = \begin{Bmatrix} 1 \\ 1.93 \\ 2.69 \end{Bmatrix}$, $\theta_2 = \begin{Bmatrix} 1 \\ 0.02 \\ -1.82 \end{Bmatrix}$, $\theta_3 = \begin{Bmatrix} 1 \\ -2.17 \\ 1.63 \end{Bmatrix}$