The system may be represented as the system of three springs. Hence, the spring are shown. Values of spring constant can be determined as:

$$k_1 = \frac{A_1 E_1}{L_1} = \frac{400\ x\ 70\ x\ 10^3}{280} = 100\ kN/mm$$

$$k_2 = \frac{A_2 E_2}{L_2} = \frac{200\ x\ 100\ x\ 10^3}{100} = 200\ kN/mm$$

$$k_3 = \frac{A_3 E_3}{L_3} = \frac{70\ x\ 200\ x\ 10^3}{100} = 140\ kN/mm$$

From the extension of FEM, we can write the force-nodal equations for this system as:

$$\begin{bmatrix} F_1 \\ F_2 \end{bmatrix} = \begin{bmatrix} 100 & -100 \\ -100 & 100 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

$$\begin{bmatrix} F_2 \\ F_3 \end{bmatrix} = \begin{bmatrix} 200 & -200 \\ -200 & 200 \end{bmatrix} \begin{bmatrix} x_2 \\ x_3 \end{bmatrix}$$

$$\begin{bmatrix} F_3 \\ F_4 \end{bmatrix} = \begin{bmatrix} 140 & -140 \\ -140 & 140 \end{bmatrix} \begin{bmatrix} x_3 \\ x_4 \end{bmatrix}$$

From these equations we can easily determine the unknowns, but we'll have to apply the boundary conditions first.

$$F_1 = 100x_1 - 100x_2$$

$$F_2 = -100x_1 + 300x_2 - 200x_3$$

$$F_3 = -200x_2 + 340x_3 - 140x_4$$

$$F_4 = -140x_3 + 140x_4$$

At point 1 and 4, the structure is fixed, and hence no displacement can be produced here. Thus, we'll say that:

$$x_1 = x_4 = 0$$

$$F_2 = -50\ kN \qquad F_3 = 100\ kN$$

Now, simply putting these values in the equations, we get:

$$F_1 = -4.8\,kN \qquad F_4 = -45.2\,kN$$

And:

$$x_2 = 0.048\,mm \qquad x_3 = 0.323\,mm$$

And, that was the required.

Introduction to Numerical Methods

Numerical Methods: Algorithms that are used to obtain numerical solutions of a mathematical problem.

Why do we need them?

1. No analytical solution exists
2. 2. An analytical solution is difficult to obtain or not practical.

Basic Needs in the Numerical Methods:

 Practical: Can be computed in a reasonable amount of time.

 Accurate: Good approximate to the true value,

 Information about the approximation error (Bounds, error order,…).

Outlines of the Course

1. Taylor Theorem
2. Number Representation
3. Solution of nonlinear Equations
4. Interpolation
5. Numerical Differentiation
6. Numerical Integration
7. Solution of linear Equations
8. Least Squares curve fitting
9. Solution of ordinary differential equations
10. Solution of Partial differential equations