



POT. ENERGY

$$\Pi^{(1)} = \frac{1}{2} k_1 (d_3 - d_1)^2 - f_1^{(1)} d_1 - f_3^{(1)} d_3$$

$$\Pi^{(2)} = \frac{1}{2} k_2 (d_3 - d_2)^2 - f_2^{(2)} d_2 - f_3^{(2)} d_3$$

$$\Pi^{(3)} = \frac{1}{2} k_3 (d_4 - d_3)^2 - f_3^{(3)} d_3 - f_4^{(3)} d_4$$

$$\Pi^{(4)} = \frac{1}{2} k_4 (d_5 - d_3)^2 - f_3^{(4)} d_3 - f_5^{(4)} d_5$$

$$\Pi_{TOT} = \sum_{i=1}^4 \Pi^{(i)}$$

$$\frac{\partial \Pi_{TOT}}{\partial d_1} = 0 \Rightarrow -k_1 (d_3 - d_1) - f_1^{(1)} = 0$$

$$\underline{f_1^{(1)}} = -k_1 (d_3 - d_1)$$

$$\frac{\partial \Pi_{TOT}}{\partial d_3} = 0 \Rightarrow k_1 (d_3 - d_1) - f_3^{(1)} + k_2 (d_3 - d_2) - f_3^{(2)} - k_3 (d_4 - d_3) - f_3^{(3)} - k_4 (d_5 - d_3) - f_3^{(4)} = 0$$

$$\underline{f_3^{(1)} + f_3^{(2)} + f_3^{(3)} + f_3^{(4)}} = k_1 (d_3 - d_1) + k_2 (d_3 - d_2) - k_3 (d_4 - d_3) - k_4 (d_5 - d_3)$$

$$\begin{pmatrix} f_1 \\ r \end{pmatrix} \quad \left| \begin{array}{cccc} k_1 & & & \\ & k_2 & & \\ & & -k_3 & \\ & & & -k_4 \end{array} \right| \begin{pmatrix} d_1 \\ d_2 \\ d_3 \\ d_4 \\ d_5 \end{pmatrix}$$

$$\begin{pmatrix} f_2 \\ f_3 \\ f_4 \\ f_5 \end{pmatrix} = \begin{pmatrix} 2 \\ 3 \\ 4 \\ 5 \end{pmatrix} \begin{bmatrix} -k_1 & -k_2 & k_1+k_2+k_3 & -k_3 \\ -k_2 & -k_3 & k_2+k_3 & -k_4 \\ -k_3 & -k_4 & k_3 & -k_4 \end{bmatrix} \begin{pmatrix} d_2 \\ d_3 \\ d_4 \\ d_5 \end{pmatrix}$$

NON-ZERO B.C. FOR DISPLACEMENT

$$\begin{bmatrix} k_{11} & k_{12} & k_{13} \\ k_{21} & k_{22} & k_{23} \\ k_{31} & k_{32} & k_{33} \end{bmatrix} \begin{pmatrix} d_1 = \delta \\ d_2 \\ d_3 \end{pmatrix} = \begin{pmatrix} f_1 = ? \\ f_2 \\ f_3 \end{pmatrix}$$

$$k_{11} \delta + k_{12} d_2 + k_{13} d_3 = f_1$$

$$k_{21} \delta + k_{22} d_2 + k_{23} d_3 = f_2$$

$$k_{31} \delta + k_{32} d_2 + k_{33} d_3 = f_3$$

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$$k_{12} d_2 + k_{13} d_3 = f_1 - k_{11} \delta$$

$$k_{22} d_2 + k_{23} d_3 = f_2 - \underline{k_{21} \delta}$$

$$k_{32} d_2 + k_{33} d_3 = f_3 - \underline{k_{31} \delta}$$