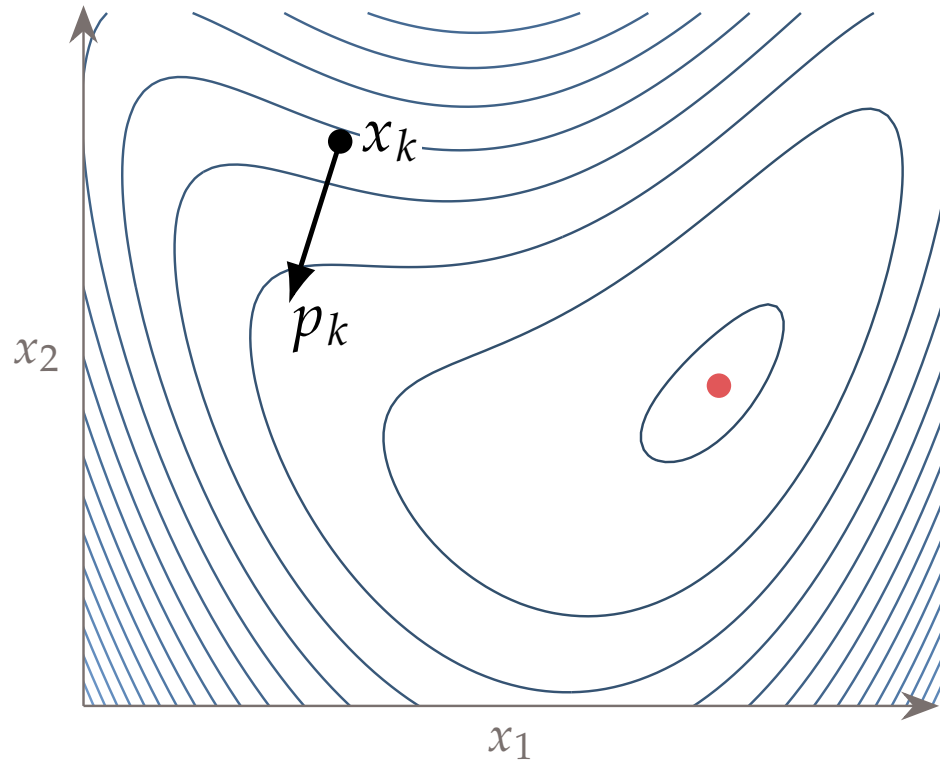


Linear Algebra Practice Problems



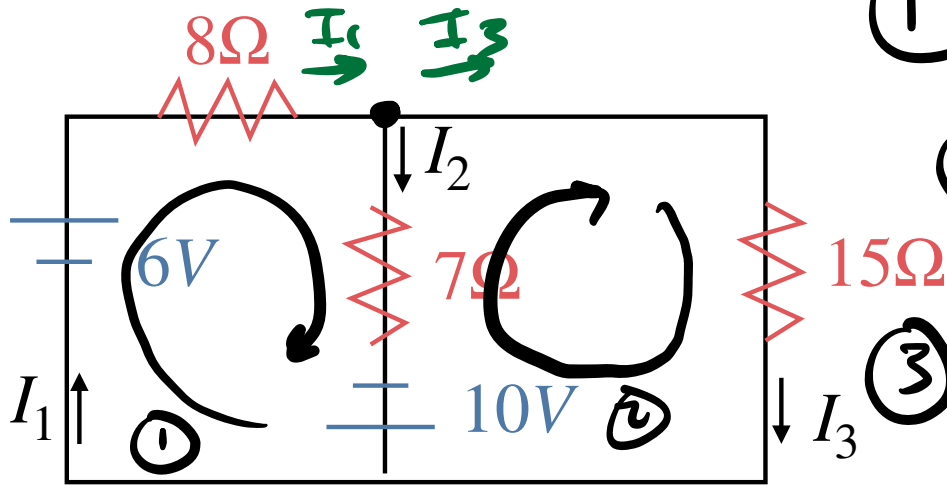
ME EN 275
Andrew Ning
aning@byu.edu

Linear Systems Review

$$Ax = b$$

$$A = \begin{matrix} \boxed{\text{LU}} & \boxed{\text{LU}} \\ L & U \end{matrix}$$

Electric Circuit



$$Ax = b$$

$$\begin{bmatrix} -8 & -7 & 0 \\ 0 & 7 & -15 \\ 1 & -1 & -1 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} -16 \\ 10 \\ 0 \end{bmatrix}$$

$$\textcircled{1} \quad 6 - I_1 \cdot 8 - I_2 \cdot 7 + 10 = 0$$

$$\textcircled{2} \quad -10 + I_2 \cdot 7 - I_3 \cdot 15 = 0$$

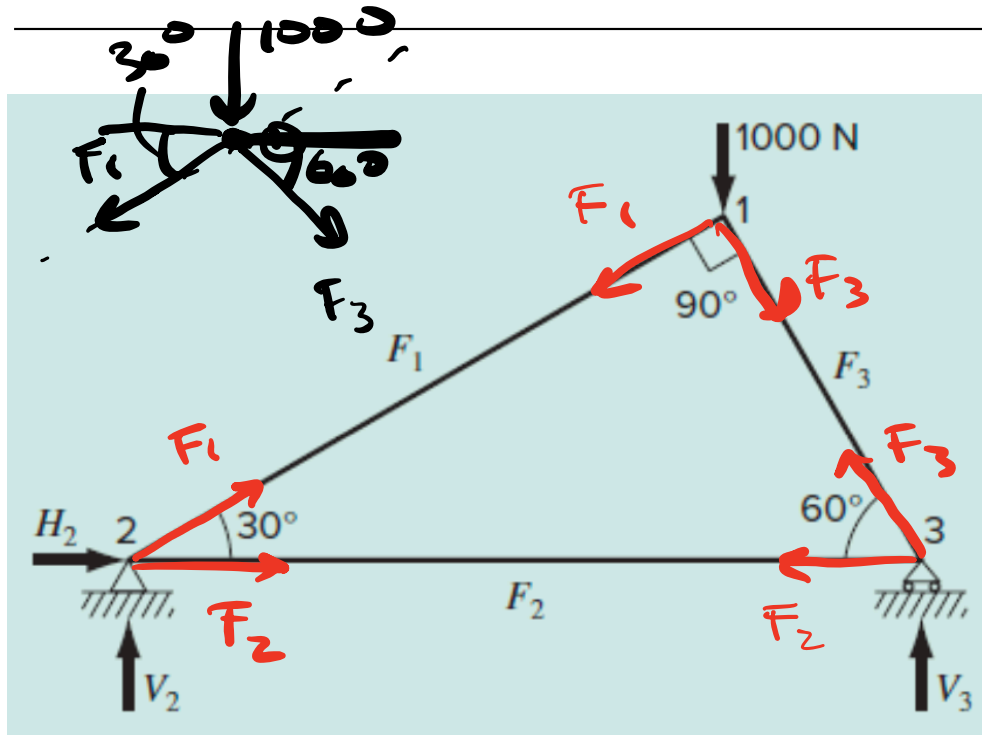
$$\textcircled{3} \quad I_1 = I_2 + I_3$$

$$\textcircled{1} \quad -8I_1 - 7 \cdot I_2 + 0 \cdot I_3 = -16$$

$$\textcircled{2} \quad 0 \cdot I_1 + 7I_2 - 15 \cdot I_3 = 10$$

$$\textcircled{3} \quad I_1 - I_2 - I_3 = 0$$

Statics



$$2x) F_2 + H_2 + F_1 \cos 30^\circ = 0$$

$$2y) V_2 + F_1 \sin 30^\circ = 0$$

$$3x) -F_2 - F_3 \cos 60^\circ = 0$$

$$3y) V_3 + F_3 \sin 60^\circ = 0$$

$$1x) F_3 \cos 60^\circ - F_1 \cos 30^\circ = 0$$

$$1y) -1000 - F_3 \sin 60^\circ - F_1 \sin 30^\circ = 0$$

Source: Chapra and Clough
Applied Numerical Methods with Python

$$F_2 + H_2 + F_1 \cos 30^\circ = 0$$

$$V_2 + F_1 \sin 30^\circ = 0$$

$$-F_2 - F_3 \cos 60^\circ = 0$$

$$V_3 + F_3 \sin 60^\circ = 0$$

$$F_3 \cos 60^\circ - F_1 \cos 30^\circ = 0$$

$$-1000 - F_3 \sin 60^\circ$$

$$- F_1 \sin 30^\circ = 0$$

$$\begin{bmatrix} \cos 30^\circ & 1 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & -\cos 60^\circ & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & \cos 60^\circ & -\cos 30^\circ & 0 & 0 \\ 0 & 0 & -\sin 60^\circ & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & -\sin 30^\circ & 0 \end{bmatrix} \begin{bmatrix} F_1 \\ F_2 \\ F_3 \\ H_2 \\ V_2 \\ V_3 \end{bmatrix}$$

$$= \begin{bmatrix} 0 \end{bmatrix}$$

Resource Allocation

9.10 A civil engineer involved in a construction project requires 4800, 5800, and 5700 m³ of sand, fine gravel, and coarse gravel, respectively. There are three pits from which these materials can be obtained. The composition of material in these pits is

	Sand %	Fine Gravel %	Coarse Gravel %
Pit1	55	30	15
Pit2	25	45	30
Pit3	25	20	55

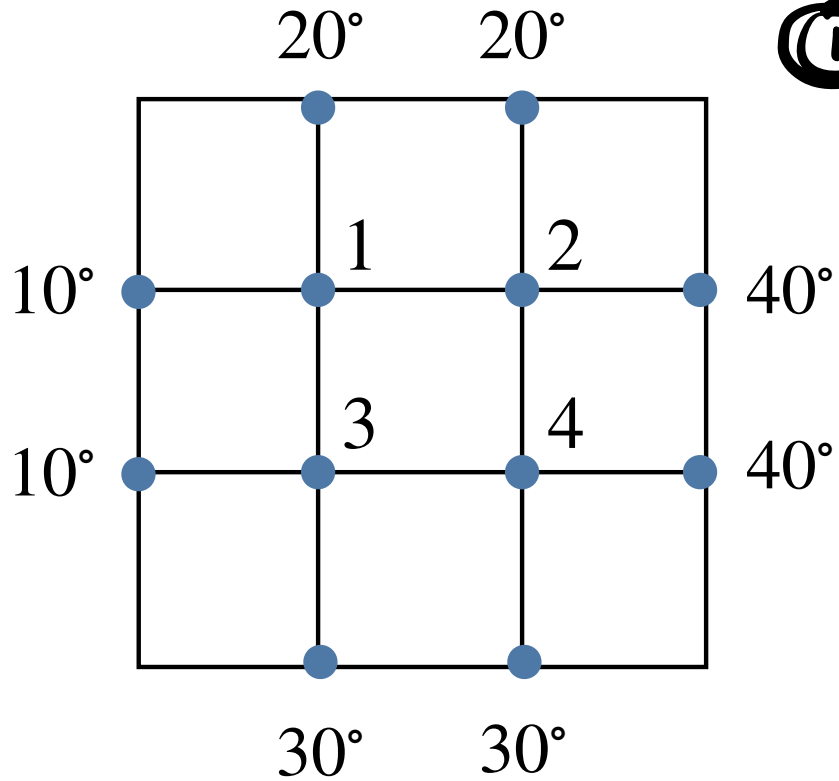
How many cubic meters must be hauled from each pit in order to meet the engineer's needs? Use one of the Python functions introduced in this chapter to solve the problem.

$$S = 0.55p_1 + 0.25p_2 + 0.25p_3$$

$$f = 0.3p_1 + 0.45p_2 + 0.2p_3$$

$$C = 0.15p_1 + 0.3p_2 + 0.55p_3$$

Heat Transfer



①

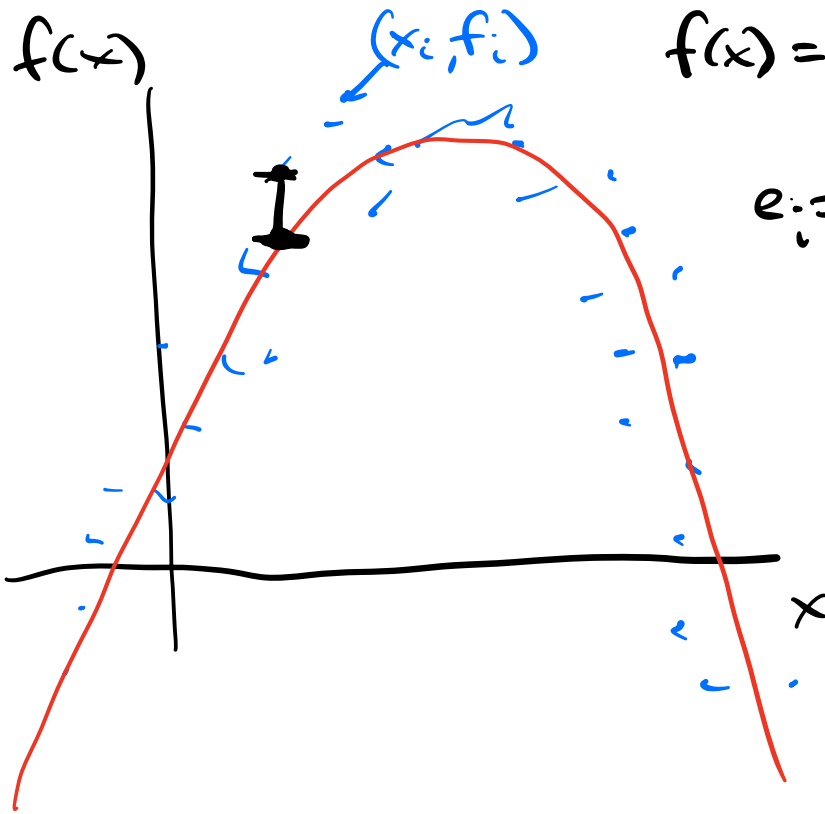
$$\frac{10 + 20 + T_2 + T_3}{4} = T_1$$

$$4T_1 - T_2 - T_3 = 30$$

$$\begin{bmatrix} 4 & -1 & -1 & 0 \end{bmatrix} \begin{bmatrix} T_1 \\ T_2 \\ T_3 \\ T_4 \end{bmatrix} = \begin{bmatrix} 30 \end{bmatrix}$$

Source: David C Lay, Linear Algebra

$$\begin{bmatrix} \bullet & \bullet & \bullet \\ \bullet & \bullet & \bullet \\ \bullet & \bullet & \bullet \\ \bullet & \bullet & \bullet \\ \bullet & \bullet & \bullet \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} \bullet \\ \bullet \\ \bullet \\ \bullet \\ \bullet \end{bmatrix}$$



$$Ax = b$$

A has more rows than columns so equality not possible.

error

$$e = Ax - b$$

min $\sqrt{e_1^2 + e_2^2 + e_3^2 + \dots}$

least squares

np.linalg.lstsq(A, b)

