**Problem 3 (35 points)**

Learning objectives:

- o   Solve a system of equations.
- o   Correctly use variables in loops and/or conditional statements.

Matrices can be used to solve systems of linear equations, as we learned during the course. In civil engineering applications, matrices can be employed to obtain reactions and internal forces in a statically determined truss structure. The following system of linear equations can be used to solve the truss shown in the figure below:

$$-0.866F_1 + 0.5\,F_3 = 0$$
$$-0.5F_1 - 0.866\,F_3 = P$$
$$0.866F_1 + F_2 + H_1 = 0$$
$$0.5F_1 + V_1 = 0$$
$$-F_2 - 0.5\,F_3 = 0$$
$$0.866F_3 + V_2 = 0$$

where the 6 unknown variables are the internal forces F_1, F_2, F_3, and the support reactions V_1, V_2, H_1.
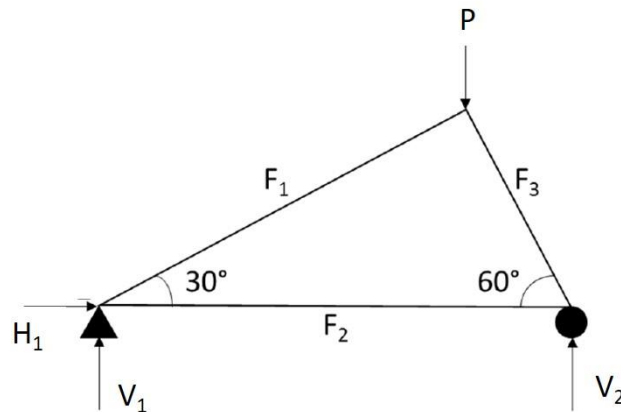
Task 1:

Set the external load $P = 1$ lb. and write a MATLAB program that calculates the 6 unknown forces F_1, F_2, F_3, V_1, V_2, H_1 by solving the above system of linear equations, using the formulation $\mathbf{A}\,\mathbf{x} = \mathbf{B}$, where $\mathbf{A}$ is a 6 by 6 matrix of coefficients, $\mathbf{x}$ is a 6 by 1 vector of unknown, and $\mathbf{B}$ is a 6 by 1

vector of coefficients. **Explain what each variable and equation represent**. You could add comments (%) to your scripts to explain what each variable and operation represent.

Task 2:

Write a MATLAB program to solve the above system of linear equations for a range of P between 250 lb. and 1250 lb. with increment of 10 lb.. Use a loop in your program. In the same figure, plot F_1(x-axis) versus P (y-axis) and F_2 (x-axis) versus P (y-axis). Make sure to add labels to x- and y-axis, use different colors and line styles in your figures, linewidth of 2, and add a legend to your figure. **Explain what each variable and equation in your program represent**. You could add comments (%) to your scripts to explain what each variable and operation represent.

What can you understand from this plot? What is the relation between F_1, F_2, and P?

What is the mean value of F_1, F_2, and F_3? What is the maximum value of V_1, V_2, and H_1?

Task 3:

Modify the program in Task 2 with the following conditions:

- when F_2 exceeds 430 lb., replace F_2 with 0;
- when V_1 exceeds 200 lb., replace V_1 with 0.

In the same figure, plot F_1(x-axis) versus P (y-axis) and F_2 (x-axis) versus P (y-axis). Make sure to add labels to x- and y- axis, use different colors and line styles in your figures, linewidth of 2, and add a legend to your figure. **Explain what each variable and equation represent**. You could add comments (%) to your scripts to explain what each variable and operation represent.

Did the plot change in comparison with the plot in Task 2? How?