NUMERICAL METHODS FOR ENGINEERING ASSIGNMENT.

FET651

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Calculation

CH.3- System of linear equations

Goal:
Solve a system of linear equations with varying free parameters.

Problem:
Consider the following circuit.

1. Use Kirchhoff laws of current and voltage, obtain the system of equations that satisfy the currents.
2. The voltage U (in volts) is varying in the interval [200,240] by steps of 1 volt. Using Matlab or Python, write a code that solves the problem.

- Display the currents for U=240 V.
- Plot the currents as functions of U.

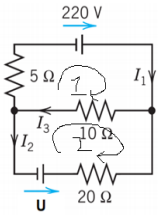

Figure 1: question

Solution

From loop 1, using kirchoff's law, traversing the circuit in the direction of current, we have;

- $I_3=I_1+I_2$ _____ 1
- $-5I_1-10I_3+220=0$

→ $+5I_1+10I_3=220$ _____ 2

- $10I_3+20I_2-U=0$

→ $10I_3+20I_2=U$ _____ 3

This implies that $-I_1-I_2+I_3 = 0$

$5I_1+0I_2+10I_3 = 0$

$0I_1+20I_2+10I_3 = 0$

Expressed in matrix form as; $\begin{pmatrix} 0 \\ 220 \\ u \end{pmatrix} = \begin{pmatrix} -1 & -1 & 1 \\ 5 & 0 & 10 \\ 0 & 20 & 10 \end{pmatrix} \begin{pmatrix} \mathrm{I}(1) \\ \mathrm{I}(2) \\ \mathrm{I}(3) \end{pmatrix}$

Python code

```
import matplotlib
import matplotlib.pylab as plt
import numpy as np
y1= []
y2= []
y3= []
b=[]
# I3 - I1 -I2 = 0 ……eq1
# 5I1 + 10I3 - 220 = 0……eq2
# 10I3 + 20I2 -u = 0……eq3
det= np.linalg.det([[-1 ,-1 ,1],[5, 0 ,10], [0, 20,10]])
for u in range(200, 241):
    b.append(u)
for u in range (200,241):
    det1=np.linalg.det([[0 ,-1 ,1],[220, 0 ,10], [u, 20,10]])
    i1=det1/det
    y1.append(i1)
for u in range (200,241):
    det2=np.linalg.det([[-1 ,0 ,1],[5, 220,10], [0,u,10]])
    i2=det2/det
    y2.append(i2)
for u in range (200,241):
    det3=np.linalg.det([[-1 ,-1 ,0],[5, 0 ,220], [0, 20,u]])
    i3=det3/det
    y3.append(i3)
plt.plot(b, y1,label = "i 1")
plt.plot(b, y2,label = "i 2")
plt.plot(b, y3,label = "i 3")
plt.xlabel('U (voltage)')
plt.ylabel('I (Current)')
plt.legend()
plt.show()
```

Output results

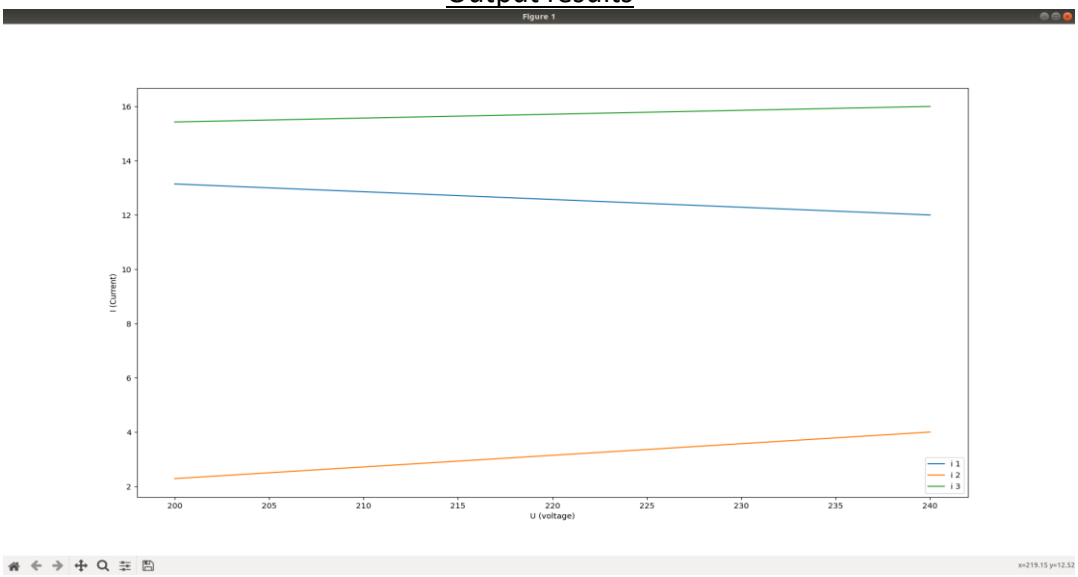

Figure 2: Output result