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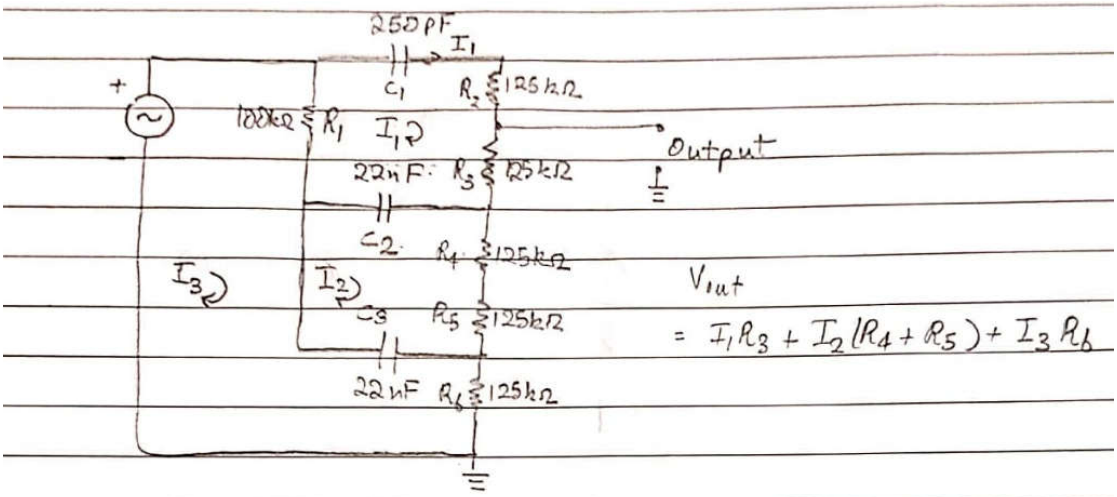
ELEC 2120-005, Lab 9: Laplace and MATLAB
October 28, 2020

Laplace and MATLAB

Section 1

Solved circuit:



$$\textcircled{1}\quad I_1\left(\frac{1}{sC_1}\right) + I_1(R_2+R_3) + (I_1-I_2)\frac{1}{sC_2} + (I_1-I_3)R_1 = 0$$

$$\textcircled{2}\quad \frac{I_2-I_1}{sC_2} + I_2(R_4+R_5) + \frac{I_2-I_3}{sC_3} = 0$$

$$\textcircled{3}\quad \frac{I_3-I_2}{sC_3} + I_3R_6 + (I_3-I_1)R_1 = 1$$

$$\textcircled{1}\quad I_1\left(\frac{1}{sC_1}+R_2+R_3+\frac{1}{sC_2}+R_1\right) - I_2\left(\frac{1}{sC_2}\right) - I_3R_1 = 0$$

$$\textcircled{2}\quad I_1\left(\frac{-1}{sC_2}\right) + I_2\left(\frac{1}{sC_2}+R_4+R_5+\frac{1}{sC_3}\right) + I_3\left(\frac{-1}{sC_3}\right) = 0$$

$$\textcircled{3}\quad -I_1R_1 + I_2\left(\frac{-1}{sC_3}\right) + I_3\left(\frac{1}{sC_3}+R_6+R_1\right) = 1$$

Code:

```
A = [1/(s*C1) + R1 + R2 + R3 + 1/(s*C2) -1/(s*C2) -R1;
    -1/(s*C2) 1/(s*C2) + R4 + R5 + 1/(s*C3) -1/(s*C3);
    -R1 -1/(s*C3) 1/(s*C3) + R6 + R1];
V = [0; 0; 1];
I = A\V
```

Section 2

Code for output voltage:

```
V_out = simplify(I(1)*R3 + I(2)*(R4 + R5) + I(3)*R6);
```

Q: Comment on how the equation was derived:

Ans: All the grounds except the ground connected to output voltage were combined. A mesh analysis was performed on the circuit to find loop currents I_1, I_2, and I_3. The value of the loop currents were then used to find the output voltage, which is basically voltage across resistors R_3, R_4, R_5, and R_6.

Remaining code:

```
[N,D] = numden(V_out)
```

Section 3

Code:

```
disp(vpa(N,4))
disp(vpa(D,4))
```

Section 4

Code:

```
Np = sym2poly(N)
Dp = sym2poly(D)
```

Section 5

Code:

```
disp('Old Polynomial Coefficients: ')
disp('Np = ')
disp(Np)
disp('Dp =')
disp(Dp)

%find maximum value
k = max([Np,Dp]);
Np = Np/k;
Dp = Dp/k;

disp('New Polynomial Coefficients: ')
disp('Np = ')
disp(Np)
disp('Dp = ')
disp(Dp)
```

Q: Comment on the value of Np(1). Why does it show up as zero?

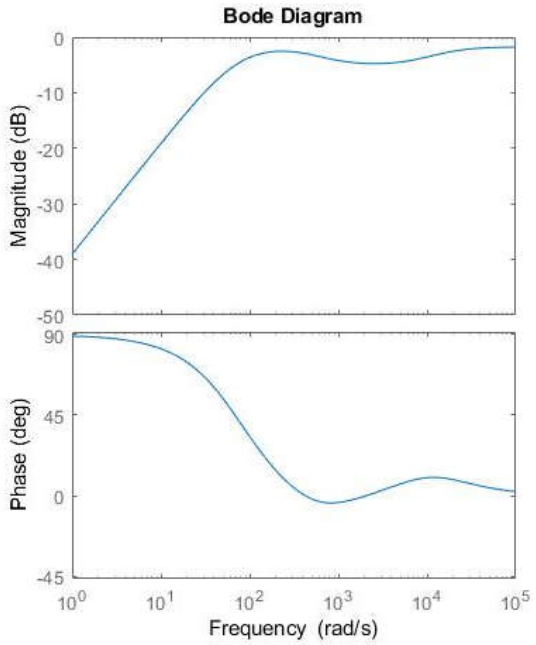
Ans: Np(1) shows up as zero because the value is divided by 'k' which is its max value meaning the values will be shifted down or dampened.

Section 6

Code:

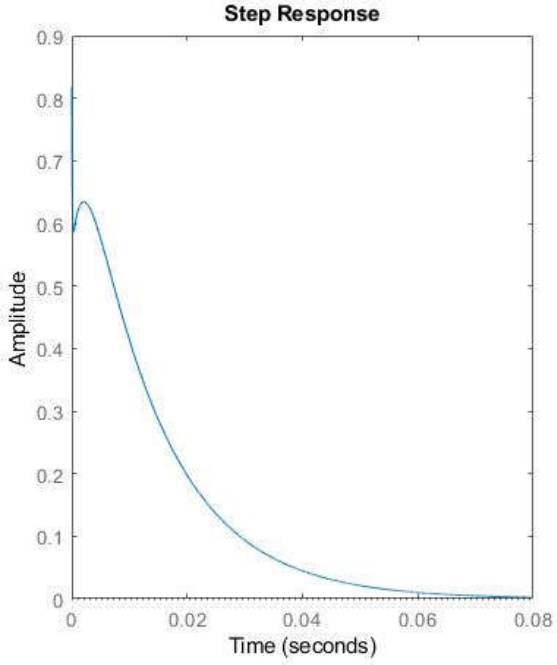
```
H = tf(Np,Dp)

subplot(1,3,1)
bode(H)
subplot(1,3,2)
step(H)
subplot(1,3,3)
pzmap(H)
```

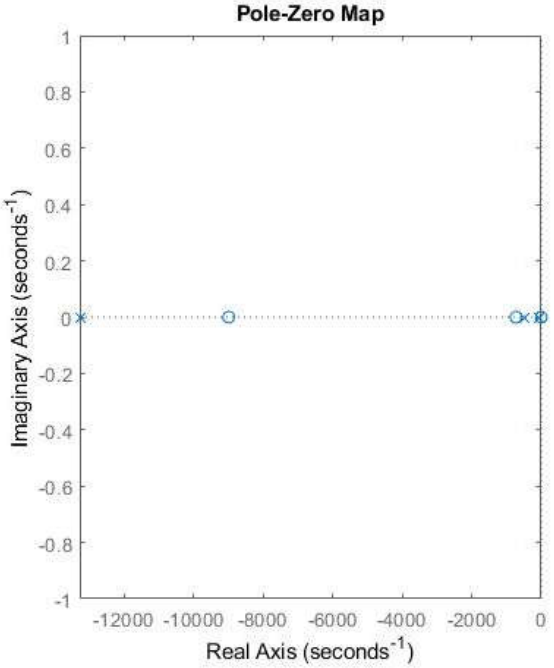
Plots:



Q: Comment on the shape of the bode plot.

Ans: This bode plot is a representation of the frequency response of the system. Magnitude increases with increase in frequency while phase decreases with increase in frequency.





Feedback

The only improvement I can think of for this lab is that I feel we should have been given some of the expected outputs of the MATLAB code to cross check our own outputs with. Other than that, the lab was great!