23S-EC ENGR-3-LEC-1 Homework 6

SANJIT SARDA

TOTAL POINTS

100 / 100

QUESTION 1

1 Q1 **25 / 25**

✓ **- 0 pts** *Correct*

- 5 pts Minor Mistake

- 10 pts Major Mistake

- 25 pts Incorrect

QUESTION 2

2 Q2 **25 / 25**

✓ **- 0 pts** *Correct*

- 5 pts Minor mistake

- 10 pts Major mistake

- 25 pts Incorrect

QUESTION 3

3 Q3 **25 / 25**

✓ **- 0 pts** *Correct*

- 25 pts Incorrect

QUESTION 4

4 Q4 **25 / 25**

✓ **- 0 pts** *Correct*

- 5 pts Repeat mistake

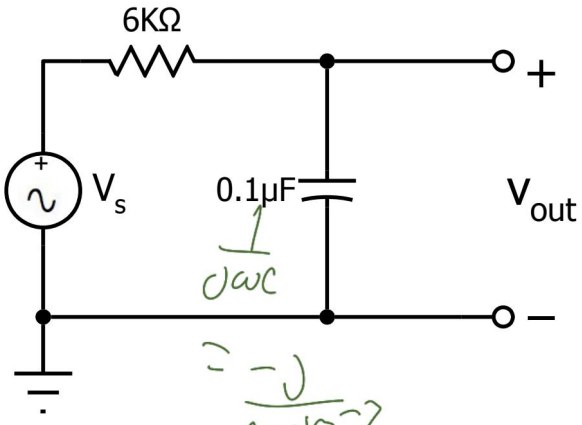
- 5 pts Minor mistake

- 10 pts Major mistake

- 25 pts Incorrect

EE3 Spring 2023
Homework Problem 6

1) Derive the expression for the capacitive impedance, keeping ω as an unknown.
2) Derive the expression for v_{out} / v_s. Treat this as a voltage divider, with ω as an unknown.
3) Using your favorite analysis code, Compute the magnitude and phase angle of the resulting expression over a range of frequencies from 100 Hz to 100KHz.
4) Plot the resulting two curves as a Bode Plot as shown on Slide 23 of the Week 6 Lecture. Keep the log scaling on the frequency axis and the linear scales on the vertical axes. Express the magnitude in dB.



$\frac{1}{j\omega C} = \frac{-j}{\omega \cdot 10^{-7}}$

$= \frac{-j10^7}{\omega}$

① $Z_C = \frac{-j\cdot 10^7}{\omega}$

② $V_{out} = \frac{Z_C}{Z_R + Z_C} V_S \rightarrow \frac{V_o}{V_S} = \frac{(-1j\cdot 1E7)/\omega}{(6000 + (-j\cdot 1E7/\omega)} = \frac{2.5E7}{9\omega^2 + 2.5E7} - j\frac{15000}{9\omega^2 + 2.5E7}$

③

```python
# freq_in is from 100Hz to 100kHz
freq_in = np.linspace(100, 100000, 10000)
# convert to omega
omega = 2 * np.pi * freq_in
def vout(omega):
    # voltage divider with Z1 = 6000, Z2 = 1/(j*omega*10e-7)
    # return (-1j*1e7)/(omega*(6000-(1j*1e7)/omega)) # ? this does the same thing but eh is less adventurous
    return (2.5e7)/(9*omega**2 + 2.5e7) - 1j*(omega*15000)/(9*omega**2 + 2.5e7)

# plot the magnitude and phase of vout in a Bode plot
plt.figure(figsize=(10, 5))
plt.subplot(121)
plt.semilogx(freq_in, 20*np.log10(np.abs(vout(omega))))
plt.xlabel('Frequency (Hz)')
plt.title('Magnitude of Bode plot of the voltage divider')
plt.ylabel('Magnitude (dB)')
plt.subplot(122)
plt.semilogx(freq_in, np.angle(vout(omega)))
plt.xlabel('Frequency (Hz)')
plt.ylabel('Phase (rad)')
plt.title('Phase shift of Bode plot of the voltage divider')
plt.show()
```

✓ 0.5s Python Python Python

1 Q1 **25 / 25**

✓ **- 0 pts** *Correct*

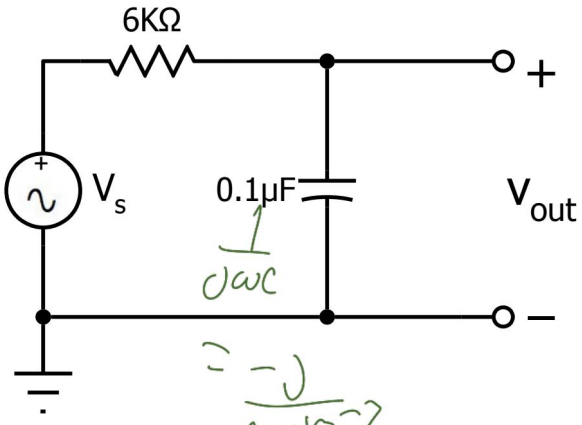
- 5 pts Minor Mistake

- 10 pts Major Mistake

- 25 pts Incorrect

EE3 Spring 2023
Homework Problem 6

1) Derive the expression for the capacitive impedance, keeping ω as an unknown.
2) Derive the expression for v_{out} / v_s. Treat this as a voltage divider, with ω as an unknown.
3) Using your favorite analysis code, Compute the magnitude and phase angle of the resulting expression over a range of frequencies from 100 Hz to 100KHz.
4) Plot the resulting two curves as a Bode Plot as shown on Slide 23 of the Week 6 Lecture. Keep the log scaling on the frequency axis and the linear scales on the vertical axes. Express the magnitude in dB.



$\frac{1}{j\omega C} = \frac{-j}{\omega \cdot 10^{-7}}$

$= \frac{-j10^7}{\omega}$

① $Z_C = \frac{-j\cdot 10^7}{\omega}$

② $V_{out} = \frac{Z_C}{Z_R + Z_C} V_S \rightarrow \frac{V_o}{V_S} = \frac{(-1j\cdot 1E7)/\omega}{(6000 + (-j\cdot 1E7/\omega)} = \frac{2.5E7}{9\omega^2 + 2.5E7} - j\frac{15000}{9\omega^2 + 2.5E7}$

③

```python
# freq_in is from 100Hz to 100kHz
freq_in = np.linspace(100, 100000, 10000)
# convert to omega
omega = 2 * np.pi * freq_in
def vout(omega):
    # voltage divider with Z1 = 6000, Z2 = 1/(j*omega*10e-7)
    # return (-1j*1e7)/(omega*(6000-(1j*1e7)/omega)) # ? this does the same thing but eh is less adventurous
    return (2.5e7)/(9*omega**2 + 2.5e7) - 1j*(omega*15000)/(9*omega**2 + 2.5e7)

# plot the magnitude and phase of vout in a Bode plot
plt.figure(figsize=(10, 5))
plt.subplot(121)
plt.semilogx(freq_in, 20*np.log10(np.abs(vout(omega))))
plt.xlabel('Frequency (Hz)')
plt.title('Magnitude of Bode plot of the voltage divider')
plt.ylabel('Magnitude (dB)')
plt.subplot(122)
plt.semilogx(freq_in, np.angle(vout(omega)))
plt.xlabel('Frequency (Hz)')
plt.ylabel('Phase (rad)')
plt.title('Phase shift of Bode plot of the voltage divider')
plt.show()
```

✓ 0.5s Python Python Python

2 Q2 **25 / 25**

✓ **- 0 pts** *Correct*

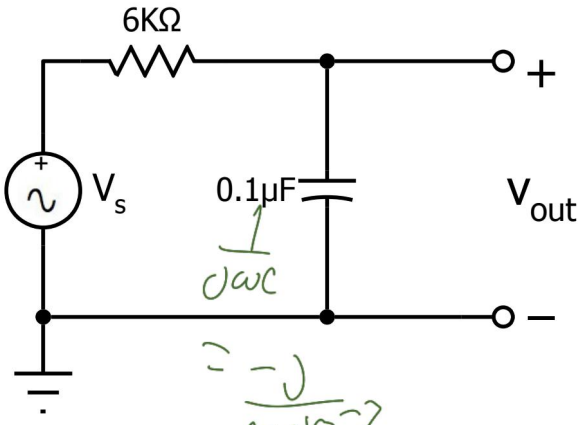
- 5 pts Minor mistake

- 10 pts Major mistake

- 25 pts Incorrect

EE3 Spring 2023
Homework Problem 6

1) Derive the expression for the capacitive impedance, keeping ω as an unknown.
2) Derive the expression for v_{out} / v_s. Treat this as a voltage divider, with ω as an unknown.
3) Using your favorite analysis code, Compute the magnitude and phase angle of the resulting expression over a range of frequencies from 100 Hz to 100KHz.
4) Plot the resulting two curves as a Bode Plot as shown on Slide 23 of the Week 6 Lecture. Keep the log scaling on the frequency axis and the linear scales on the vertical axes. Express the magnitude in dB.



$\frac{1}{j\omega C} = \frac{-j}{\omega \cdot 10^{-7}}$

$= \frac{-j10^7}{\omega}$

① $Z_C = \frac{-j\cdot 10^7}{\omega}$

② $V_{out} = \frac{Z_C}{Z_R + Z_C} V_S \rightarrow \frac{V_o}{V_S} = \frac{(-1j\cdot 1E7)/\omega}{(6000 + (-j\cdot 1E7/\omega)} = \frac{2.5E7}{9\omega^2 + 2.5E7} - j\frac{15000}{9\omega^2 + 2.5E7}$

③

```python
# freq_in is from 100Hz to 100kHz
freq_in = np.linspace(100, 100000, 10000)
# convert to omega
omega = 2 * np.pi * freq_in
def vout(omega):
    # voltage divider with Z1 = 6000, Z2 = 1/(j*omega*10e-7)
    # return (-1j*1e7)/(omega*(6000-(1j*1e7)/omega)) # ? this does the same thing but eh is less adventurous
    return (2.5e7)/(9*omega**2 + 2.5e7) - 1j*(omega*15000)/(9*omega**2 + 2.5e7)

# plot the magnitude and phase of vout in a Bode plot
plt.figure(figsize=(10, 5))
plt.subplot(121)
plt.semilogx(freq_in, 20*np.log10(np.abs(vout(omega))))
plt.xlabel('Frequency (Hz)')
plt.title('Magnitude of Bode plot of the voltage divider')
plt.ylabel('Magnitude (dB)')
plt.subplot(122)
plt.semilogx(freq_in, np.angle(vout(omega)))
plt.xlabel('Frequency (Hz)')
plt.ylabel('Phase (rad)')
plt.title('Phase shift of Bode plot of the voltage divider')
plt.show()
```

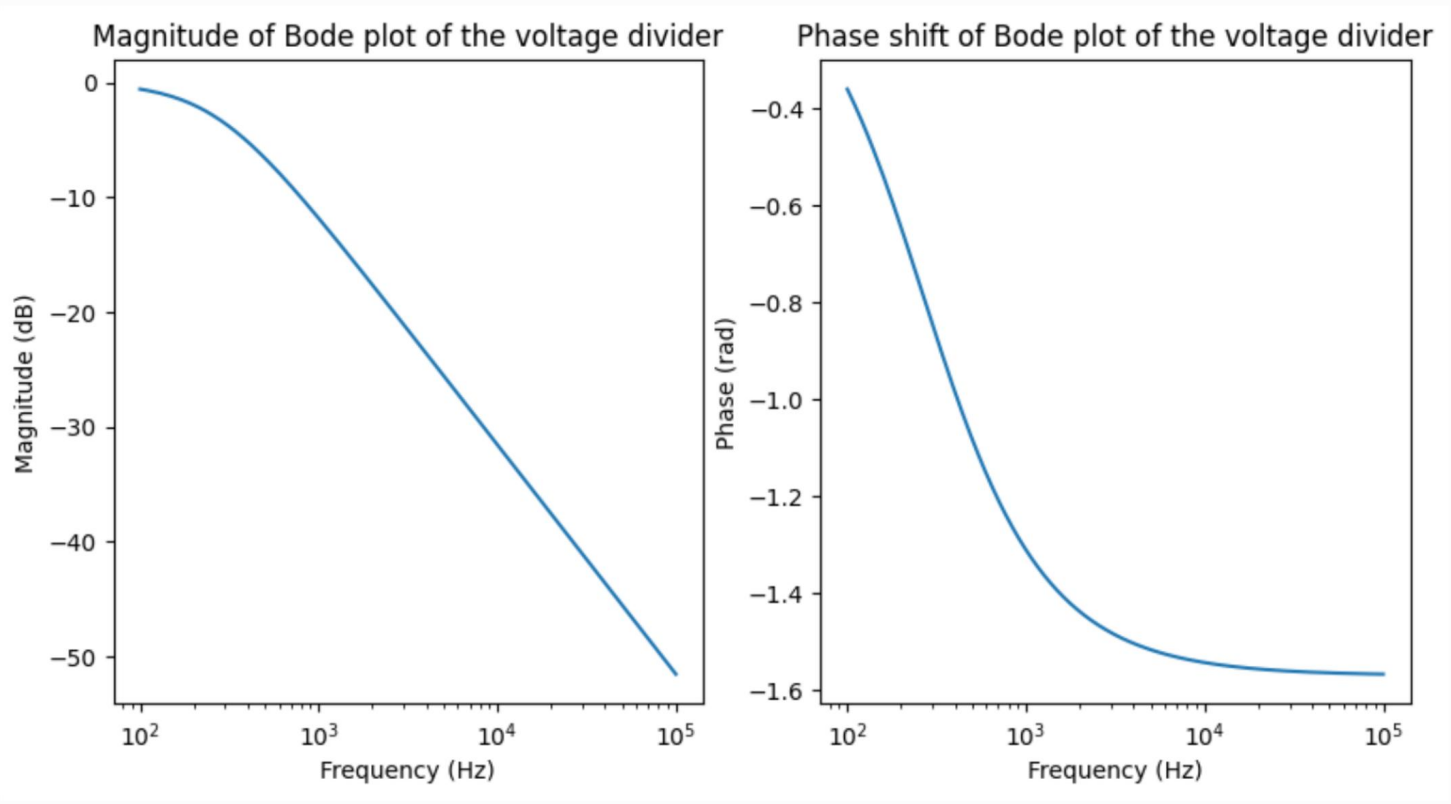
✓ 0.5s Python Python Python

3 Q3 **25 / 25**

✓ **- 0 pts** *Correct*

- 25 pts Incorrect

9


Magnitude of Bode plot of the voltage divider
Magnitude (dB)
0
−10
−20
−30
−40
−50
10^2
10^3
10^4
10^5
Frequency (Hz)
Phase shift of Bode plot of the voltage divider
Phase (rad)
−0.4
−0.6
−0.8
−1.0
−1.2
−1.4
−1.6
10^2
10^3
10^4
10^5
Frequency (Hz)

4 Q4 **25 / 25**

✓ **- 0 pts** *Correct*

- 5 pts Repeat mistake

- 5 pts Minor mistake

- 10 pts Major mistake

- 25 pts Incorrect