EE 221 Practice Problems for the Final Exam

1. The network function of a circuit is

$$\mathbf{H}(\omega) = \frac{-12.5}{1 + j\dfrac{\omega}{500}}.$$

This table records frequency response data for this circuit. Fill in the blanks in the table:

ω, rad/s	*A*, V	θ, °
0	12.5	180
100	12.26	______
200	______	158.2
500	8.84	135
1000	5.59	116.6

2. The network function of a circuit is

$$\mathbf{H}(\omega) = \frac{-k}{1 + j\dfrac{\omega}{p}}.$$

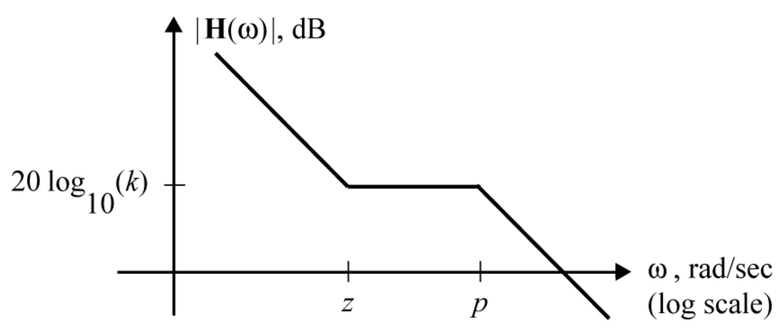
This table records frequency response data for this circuit. Determine the values of *p* and *k*:

$p =$ _________ rad/s and $k =$ _________V/V

ω, rad/s	*A*, V	θ, °
0	12.5	180
100	12.26	168.7
200	11.61	158.2
500	8.84	135
1000	5.59	116.6

3. Here's a network function and corresponding magnitude Bode plot:

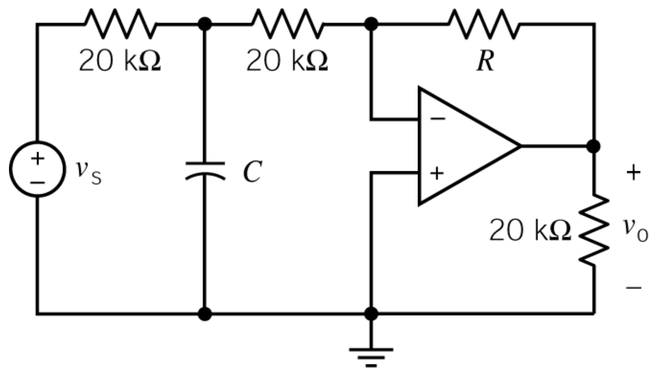
$$\mathbf{H}(\omega) = \frac{\mathbf{V}_o(\omega)}{\mathbf{V}_s(\omega)} = \frac{50 + \dfrac{1600}{j\omega}}{640 + j4\omega}$$

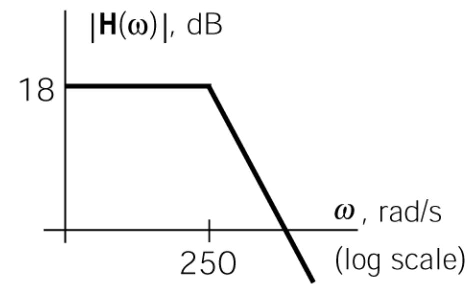


Determine the values of the constants *k*, *z* and *p* used to label the Bode plot:

$k =$ _________, $z =$ _________rad/s and $p =$ _________rad/s.

4. Here's a circuit and corresponding Bode plot. The network function of this circuit is $\mathbf{H}(\omega)=\dfrac{\mathbf{V}_o(\omega)}{\mathbf{V}_s(\omega)}$.

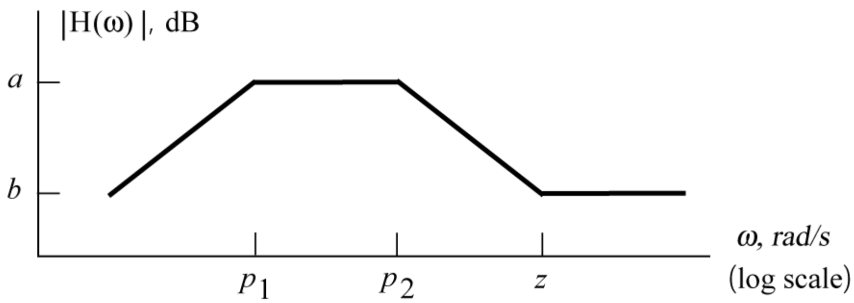




Determine the values of the resistance, R and capacitance, C :

R = _________kΩ and C = _________μF

5. Here's a magnitude Bode plot and corresponding network function:

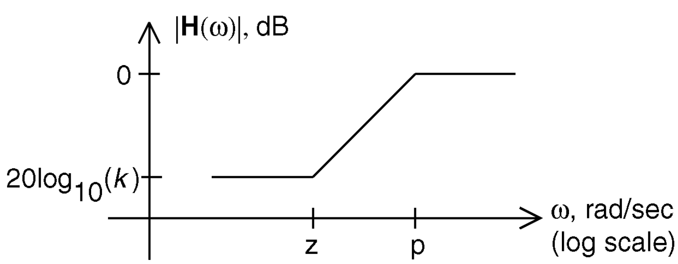


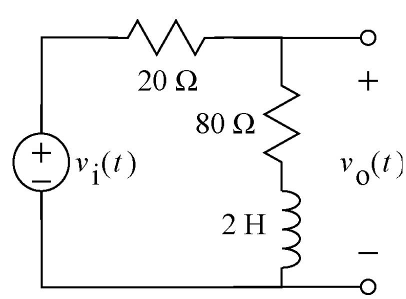
$$\mathbf{H}(\omega)=\frac{j\dfrac{\omega}{4}\left(100+j\dfrac{\omega}{4}\right)}{\left(1+j\dfrac{\omega}{4}\right)\left(5+j\dfrac{\omega}{8}\right)}$$

Determine the values of the constants a, b, p_1, p_2 and z used to label the Bode plot:

a = _______dB, b = _______dB, p_1 = _______rad/s, p_2 = _______rad/s and z = _______rad/s.

6. The input to the circuit is the voltage of the voltage source, $v_i(t)$. The output is the voltage $v_o(t)$. $\mathbf{H}(\omega)=\dfrac{\mathbf{V}_o(\omega)}{\mathbf{V}_i(\omega)}$ is the network function. The magnitude bode plot that represents this circuit is

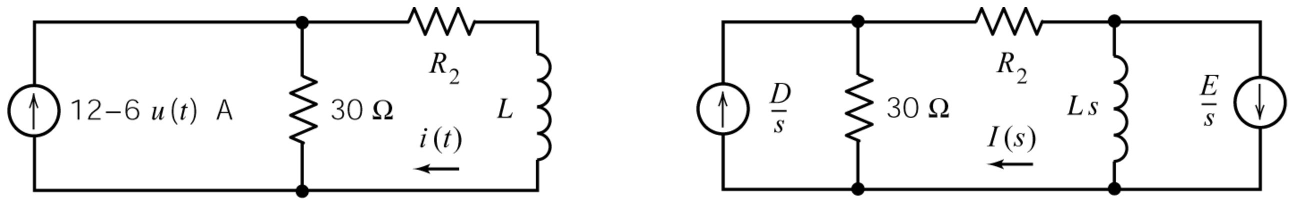


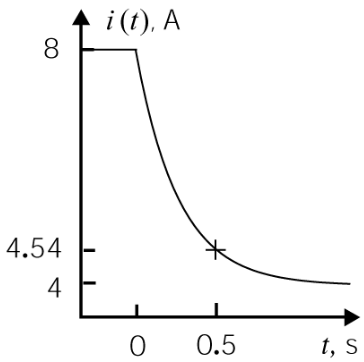


The values of the corner frequencies are z = _________rad/sec and p = _________rad/sec.

The value of the low frequency gain is k = _________V/V.

7. Here is the same circuit represented in the time domain and also in the complex frequency domain.





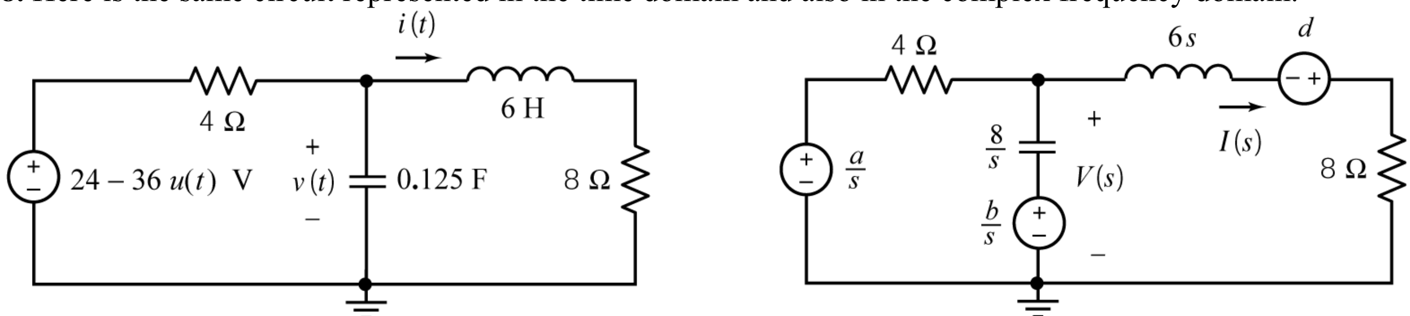
Here's a plot of the inductor current. Determine the values of D and E used to represent the circuit in the complex frequency domain:

D = _________V and E = _________V

Determine the values of the resistance R_2 and the inductance L:

R_2 = _________Ω and L = _________H

8. Here is the same circuit represented in the time domain and also in the complex frequency domain.

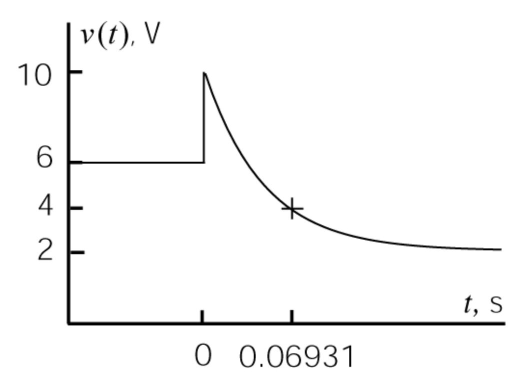


Determine the values of a, b and d used to represent the circuit in the complex frequency domain:

a = _________ b = _________ and d = _________

9. Given that $\mathcal{L}\left[v(t)\right]=\dfrac{as+b}{2s^2+40s}$ where $v(t)$ is the voltage shown to the right, determine the values of a and b.

a = _________V and b = _________V



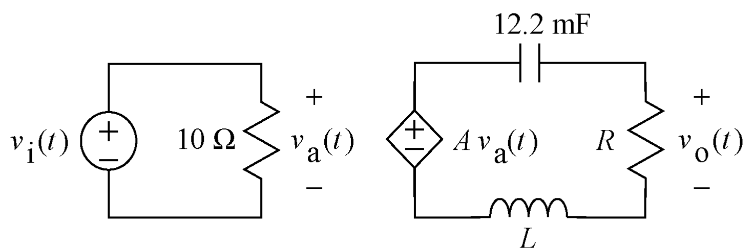
10. The Laplace transform of a voltage $v(t)=\left[b e^{-at}\sin(ct)\right]u(t)$ is $V(s)=\dfrac{80}{s^2+8s+25}$. Determine the values of the constant coefficients *a*, *b*, and *c*:

$a =$ _________ 1/s, $b =$ _________ V, and $c =$ _________ V.

11. The Laplace transform of a voltage $v(t)=\left[b-e^{-at}(c+d\,t)\right]u(t)$ is $V(s)=\dfrac{12}{s\left(s^2+8s+16\right)}$. Determine the values of the constant coefficients *a*, *b*, *c* and *d*:

$a =$ _________ 1/s, $b =$ _________ V, $c =$ _________ V and $d =$ _________ V.

12. The input to the circuit is the voltage of the voltage source, $v_i(t)$. The output is the voltage $v_o(t)$. The step response is $v_o(t)=6e^{-4t}\sin(5t)u(t)$.



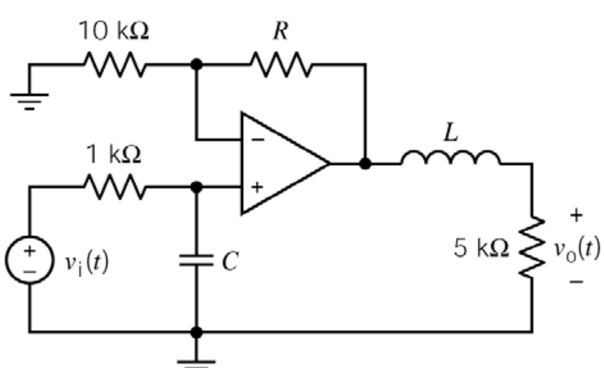
Determine the values of the gain, *A*, of the VCVS, the resistance, *R*, and the inductance, *L*.

$A =$ _________ V/V, $R =$ _________ Ω and $L =$ _________ H .

13. The input to this circuit is the voltage source voltage, $v_i(t)$. The output is the voltage, $v_o(t)$. The transfer function of this circuit is

$$H(s)=\frac{V_o(s)}{V_i(s)}=\frac{15\times10^6}{(s+2000)(s+5000)}$$

Determine the values of *R*, *L* and *C*:



$R =$ _________ kΩ, $L =$ _________ H and $C =$ _________ **μF**.

or

$R =$ _________ kΩ, $L =$ _________ H and $C =$ _________ **μF**.

14. The transfer function of a circuit is $H(s) = \dfrac{12}{s^2 + 8s + 16}$. The step response of this circuit is:

$step\ \ response = \left[b - e^{-at}(c + d\,t)\right]u(t)$. Determine the values of the constant coefficients *a*, *b*, *c* and *d*:

$a =$ _________1/s, $b =$ _________V, $c =$ _________V and $d =$ _________V.

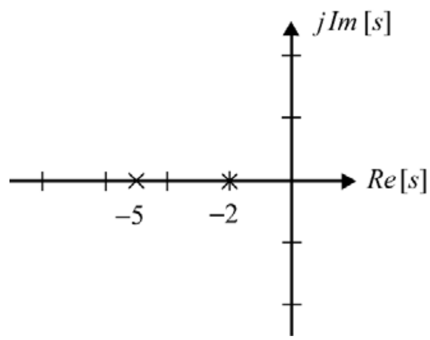
15. The transfer function of a circuit is $H(s) = \dfrac{80\,s}{s^2 + 8\,s + 25}$. The step response of this circuit is:

$step\ \ response = \left[b\,e^{-at}\sin(c\,t)\right]u(t)$. Determine the values of the constant coefficients *a*, *b*, *c* and *d*:

$a =$ _________1/s, $b =$ _________V, and $c =$ _________V.

16. The input to a linear circuit is the voltage, v_{i}. The output is the voltage, v_{o}. The transfer function of the circuit is

$$H(s) = \frac{V_{\text{o}}(s)}{V_{\text{i}}(s)}$$



The poles and zeros of $H(s)$ are shown on this pole-zero diagram. (There are no zeros.) The dc gain of the circuit is

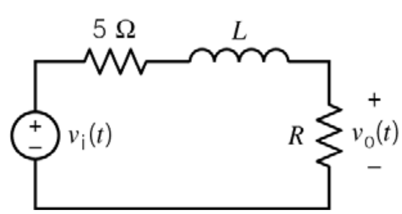
$$\mathbf{H}(0) = 5$$

The step response of the circuit is $v_{\text{o}}(t) = \left(a + b\,e^{-5t} - c\,e^{-2t}\right)u(t)$ V. Determine the values of the constants *a*, *b* and *c*.

$a =$ _________V, $b =$ _________ V and $c =$ _________V.

17. The input to a circuit is the voltage source voltage, v_{i}. The step response of the circuit is

$$v_{\text{o}}(t) = \frac{3}{4}\left(1 - e^{-100t}\right)u(t)\ \ \text{V}$$



Determine the value of the inductance, *L*, and of the resistance, *R*

$R =$ _________Ω and $L =$ _________H.

18. The input to a circuit is the voltage source voltage, v_i. The step response of the circuit is

$$v_o(t) = 5\left(1-(1+2t)e^{-2t}\right)u(t) \text{ V}$$

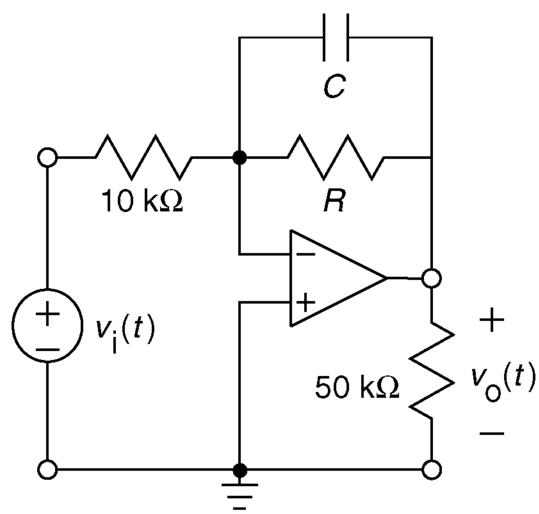
When the input is $\qquad v_i(t) = 5\cos(2t+45°) \text{ V}$

the steady-state response is $\qquad v_i(t) = A\cos(2t+\theta) \text{ V}$

Determine the values of A and θ.

$A =$_________V and $\theta =$ _________°.

19. The input to a circuit is the voltage $v_i(t)$. The output is the voltage $v_o(t)$.



When the input is:

$$v_i(t) = 2 + 4\cos(100t) + 5\cos(200t+45°) \text{ V}$$

the corresponding output is:

$$v_o(t) = -5 + 7.071\cos(100t+135°) + c_2\cos(200t+\theta_2) \text{ V}$$

Determine the value of R, C, c_2, and θ_2:

$R =$ _________kΩ, $C =$ _________μF, $c_2 =$ _________V and $\theta_2 =$ _________°

20. The transfer function of a circuit is $H(s) = \dfrac{20}{s+8}$. When the input to this circuit is sinusoidal, the output is also sinusoidal. Let ω_1 be the frequency at which the output sinusoid is twice as large as the input sinusoid and let ω_2 be the frequency at which output sinusoid is delayed by one tenth period with respect to the input sinusoid. Determine the values of ω_1 and ω_2.

ω_1 = _________ rad/s and $\omega_2 =$ ________rad/s