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	168.7
200	11.61	158.2
500	8.84	135
1000	5.59	116.6

2. The network function of a circuit is

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

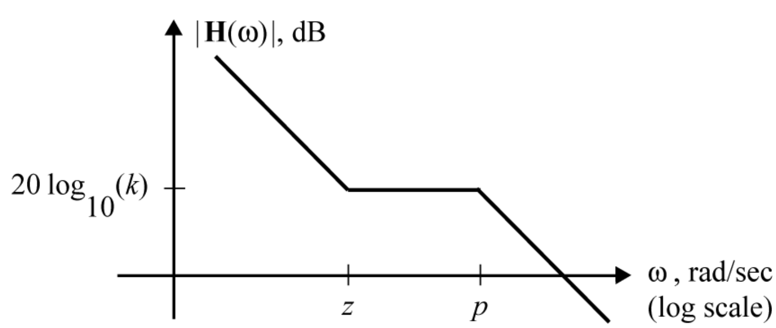
This table records frequency response data for this circuit. Determine the values of *p* and *k*:

p = ___500___ rad/s and k = __12.5__ 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:

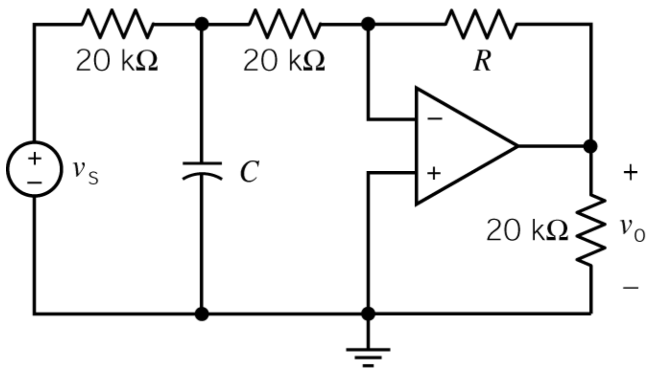
$$\mathbf{H}(\omega) = \frac{\mathbf{V}_o(\omega)}{\mathbf{V}_s(\omega)} = \frac{50 + \dfrac{1600}{j\omega}}{640 + j4\omega}$$

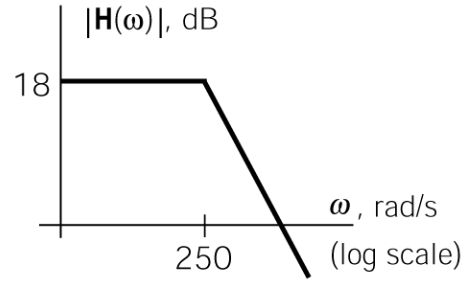


Determine the values of the constants *k*, *z* and *p* used to label the Bode plot:

k = ___0.078125___, z = ___32___rad/s and p = __160___rad/s.

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

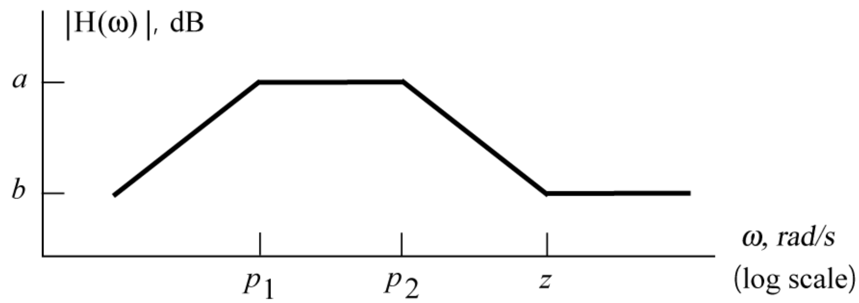




Determine the values of the resistance, R and capacitance, C:

R = ___320___ kΩ and C = ___0.4___ μF

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

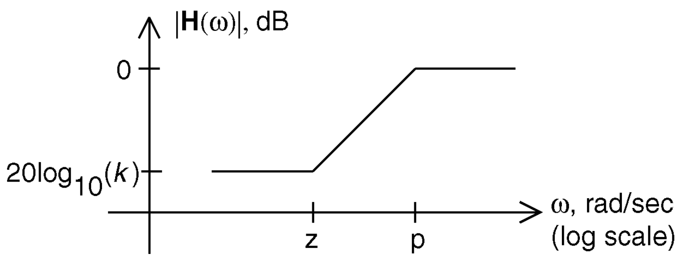


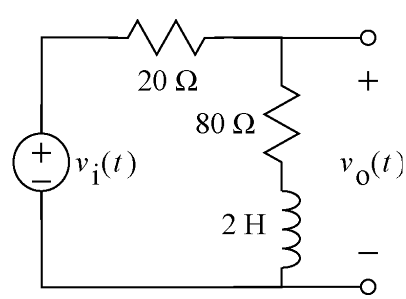
$$\mathbf{H}(\omega) = \frac{j\dfrac{\omega}{4}\left(100 + j\dfrac{\omega}{4}\right)}{\left(1 + j\dfrac{\omega}{4}\right)\left(5 + j\dfrac{\omega}{8}\right)}$$

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

a = __26__dB, b = __6__dB, p_1 = __4__rad/s, p_2 = __40__rad/s and z = __400__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

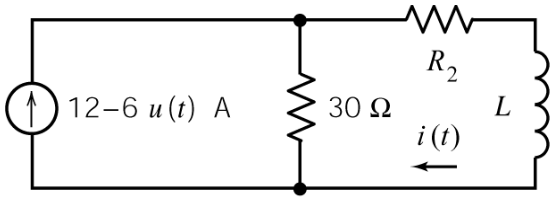


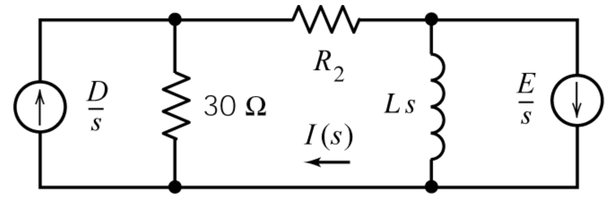


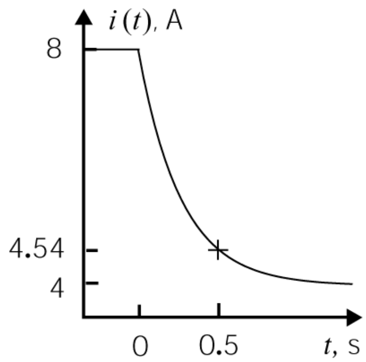
The values of the corner frequencies are z = _____40_______ rad/sec and p = ______50______ rad/sec.

The value of the low frequency gain is k = _______0.8_____ V/V.

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







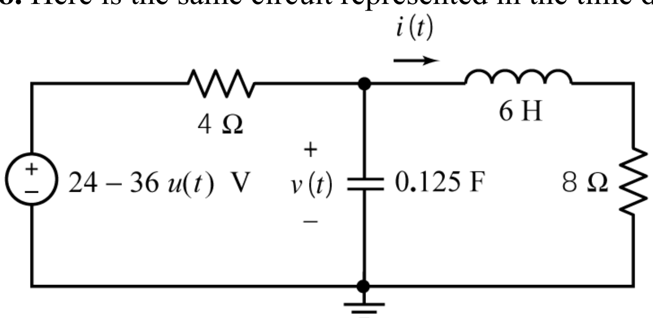
Here's a plot of the inductor current. Determine the values of D and E used to represent the circuit in the complex frequency domain:

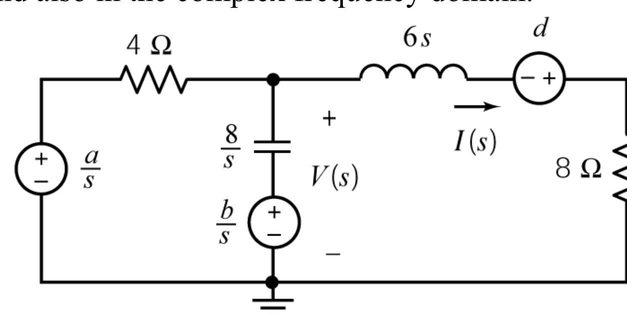
D = ___6___V and E = ___8___ V

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

R_2 = ___15___Ω and L = ___11.25___ H

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



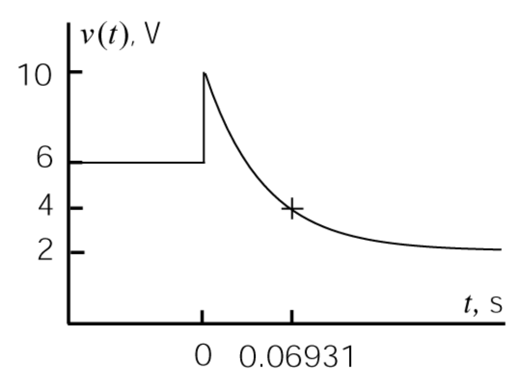


Determine the values of a, b and d used to represent the circuit in the complex frequency domain:

a = ___–12___ b = ___16___ and d = ___12___

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

a = __20___V and b = __80___ V



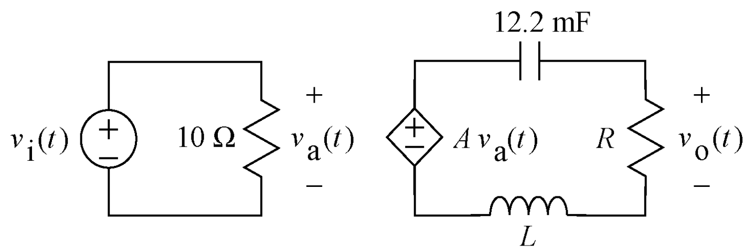
10. The Laplace transform of a voltage $v(t)=\left[be^{-at}\sin(ct)\right]u(t)$ is $V(s)=\dfrac{80}{s^2+8s+25}$. Determine the values of the constant coefficients *a*, *b*, and *c*:

$a =$ ___4___1/s, $b =$ ___26.67___V, and $c =$ ___3___V.

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

$a =$ ___4__1/s, $b =$ ___0.75___V, $c =$ ___0.75___V and $d =$ ___3___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 $v_o(t)=6e^{-4t}\sin(5t)u(t)$.

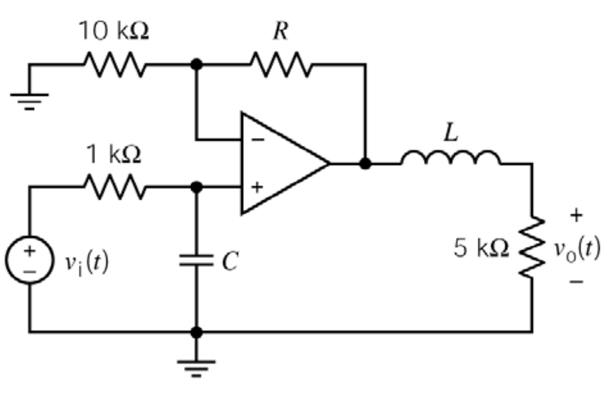


Determine the values of the gain, *A*, of the VCVS, the resistance, *R*, and the inductance, *L*.

$A =$ ______3.75______ V/V, $R =$ _____16_____ Ω and $L =$ ______2______ 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*:

$R =$ ___5___kΩ, $L =$ ___1___H and $C =$ ___0.5___**μF**.

or

$R =$ ___5___kΩ, $L =$ __2.5__H and $C =$ ___0.2___**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*:

$a=$ ___4__1/s, $b=$ ___0.75___V, $c=$ ___0.75___V and $d=$ ___3___V.

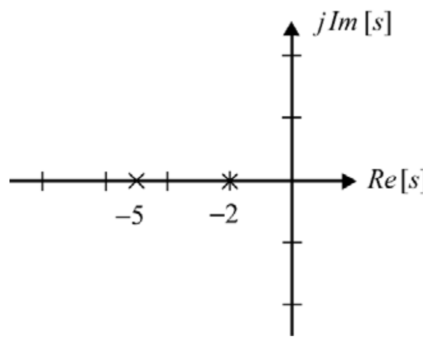
15. The transfer function of a circuit is $H(s)=\dfrac{80s}{s^2+8s+25}$. The step response of this circuit is:

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

$a=$ ___4___1/s, $b=$ ___26.67___V, and $c=$ ___3___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

$$H(s)=\frac{V_o(s)}{V_i(s)}$$



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

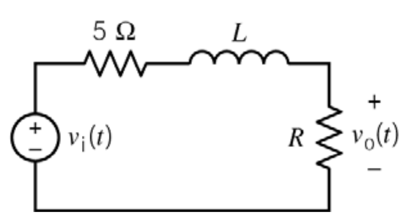
$$\mathbf{H}(0)=5$$

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

$a=$ _____5____ V, $b=$ ___10/3__ V and $c=$ ___25/3__ V.

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

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



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

$R=$ ___15___ Ω and $L=$ ___0.2___ H.

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

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

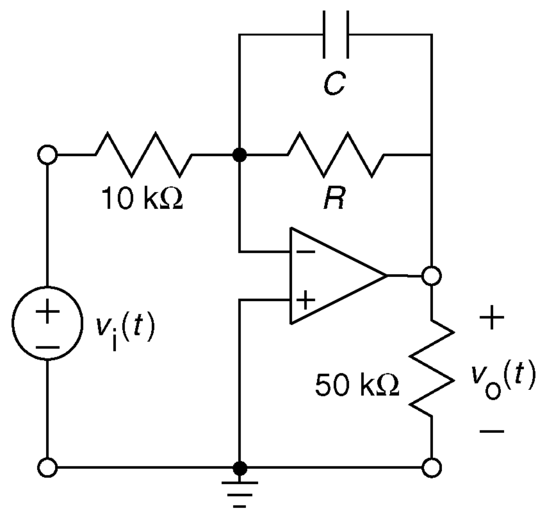
When the input is $\quad v_\text{i}(t) = 5\cos(2t+45°) \text{ V}$

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

Determine the values of A and θ.

A =___12.5__ V and θ = ___–45___°.

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 = ___25___ kΩ, C = ___0.4___ μF, c_2 = __5.59__V and θ_2 = __161.6__°

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 = _____6____ rad/s and ω_2 = ___5.8123___ rad/s