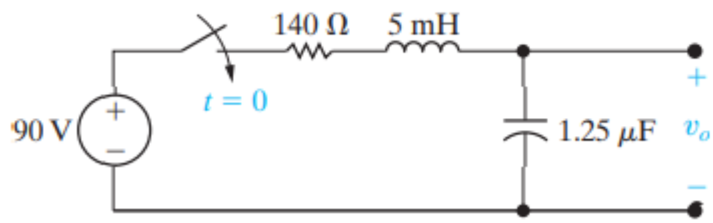
Homework-04 ENGR 117 Due date 04/06/2022

5 Questions 20 points each

Q-1 Find V_o and v_o in the circuit shown below if the initial energy is zero and the switch is closed at t=0. Also find the transfer function and identify the poles and zeros for this circuit. (Use circuit transform method)

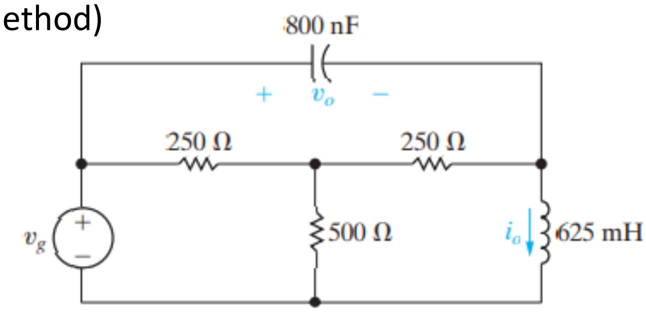


Q-2 There is no energy stored in the circuit shown below at the time the voltage source is turned on. (Use circuit transform method)

vg = 325u(t) V.

a) Find V_o and I_o

b) Find v_o and i_o



Q-3 Draw the magnitude and phase Bode diagram for the following transfer function.

$$H(s) = \frac{s(s+100)(s+1000)}{(s+10)(S+10000)}$$

Q-4 Draw the magnitude and phase Bode diagram for the following transfer function.

$$H(s) = \frac{(s+3)}{(s+30)(S+300)}$$

Q-5 Draw the magnitude and phase Bode diagram for the following transfer function.

$$H(s) = \frac{(s+1)(s+10)}{s(s+10)^2}$$

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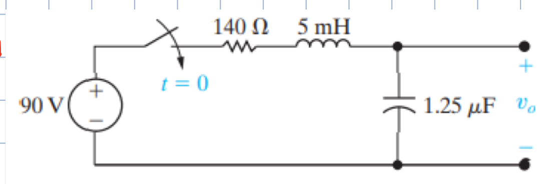
EEE117 - 02

HOMEWORK 04

05 APRIL 2022

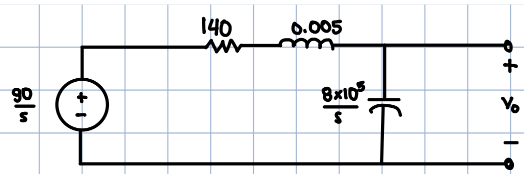
Q-1



s-domain:

$Z_C = 1/sC = 1/s(1.25\times10^{-6}) = 8\times10^{5}/s$

$Z_L = sL = s(5\times10^{-3}) = 0.005s$



VOLTAGE DIVISION RULE

$$V_o = \left(\frac{90}{s}\right)\left[\frac{8\times10^5/s}{140 + 0.005s + 8\times10^5/s}\right]$$

$$= (90/s)\left[\frac{8\times10^5}{0.005s^2 + 140s + 8\times10^5}\right]$$

$$= \frac{72\times10^6}{s(0.005s^2 + 140s + 8\times10^5)} = \boxed{\frac{1.44\times10^{10}}{s(s^2 + 28\times10^3 s + 16\times10^7)}}$$

$$V_o = \frac{1.44\times10^{10}}{s(s^2 + 28\times10^3 s + 16\times10^7)}$$

$$= \frac{1.44\times10^{10}}{s(s+8000)(s+20000)} = \frac{A}{s} + \frac{B}{s+8000} + \frac{C}{s+20000}$$

$1.44\times10^{10} = A(s+8000)(s+20000) + B(s)(s+20000) + C(s)(s+8000)$

$s = 0$: $\quad 1.44\times10^{10} = A(160\times10^6) \quad A = 90$

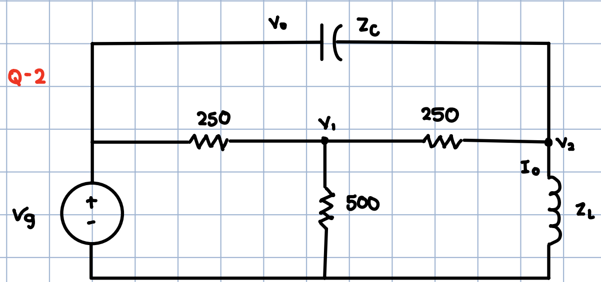
$s = -8000$: $\quad 1.44\times10^{10} = B(-96\times10^6) \quad B = -150$

$s = -20000$: $\quad 1.44\times10^{10} = C(240\times10^6) \quad C = 60$

$$V_o(s) = \frac{90}{s} - \frac{150}{s+8000} + \frac{60}{s+20000}$$

$$\boxed{v_o(t) = [90 - 150e^{-8000t} + 60e^{-20000t}]u(t)}$$

Q-2



$V_g(s) = 325/s$

$Z_C = \frac{1}{sC} = \frac{1}{s(800\times10^{-9})} = \frac{1.25\times10^6}{s}$

$Z_L = sL = s(625\times10^{-3}) = 0.625s$

NODE V_1: $\quad \frac{V_1 - V_g}{250} + \frac{V_1}{500} + \frac{V_1 - V_2}{250} = 0$

$$V_1\left[\frac{1}{250} + \frac{1}{500} + \frac{1}{250}\right] = \frac{V_g}{250} + \frac{V_2}{250}$$

$$V_1\left(\frac{1}{100}\right) = \frac{325/s}{250} + \frac{V_2}{250}$$

$$V_1 = (1.3/s + V_2/250)100$$

$$= 130/s + 0.4V_2$$

NODE V_2: $\quad \frac{V_2 - V_g}{Z_C} + \frac{V_2 - V_1}{250} + \frac{V_2}{Z_L} = 0$

$$V_2\left[\frac{1}{Z_C} + \frac{1}{250} + \frac{1}{Z_L}\right] - \frac{V_1}{250} = \frac{V_g}{Z_C}$$

$$V_2\left[\frac{1}{\frac{1.25\times10^6}{s}} + \frac{1}{250} + \frac{1}{0.625s}\right] - \frac{V_1}{250} = \frac{325/s}{\frac{1.25\times10^6}{s}}$$

$$V_2\left[\frac{s}{1.25\times10^6} + \frac{1}{250} + \frac{1}{0.625s}\right] - \frac{130/s + 0.4V_2}{250} = 2.6\times10^{-4}$$

$$V_2\left[\frac{s}{1.25\times10^6} + \frac{1}{250} + \frac{1}{0.625s} - \frac{1}{625}\right] = 2.6\times10^{-4} + 0.52/s$$

$$V_2\left[\frac{s}{1.25\times10^6} + \frac{1}{0.625s} + \frac{3}{1250}\right] = 2.6\times10^{-4} + 0.52/s$$

$$V_2\left[\frac{781.25s^2 + 1.5625\times10^9 + 2343750s}{(1.25\times10^6)(781.25s)}\right] = 2.6\times10^{-4} + 0.52/s$$

$$V_2\left[\frac{s^2 + 3000s + 2\times10^6}{1.25\times10^6 s}\right] = 2.6\times10^{-4} + 0.52/s$$

$$V_2 = \frac{325s + 0.65\times10^6}{s^2 + 3000s + 2\times10^6} = \frac{325}{s+1000}$$

(a) $V_o = V_g - V_2 = 325/s - \frac{325}{s+1000}$

$$= \boxed{\frac{325\times10^3}{s(s+1000)}}$$

$I_o = V_2/0.625s$

$$= \frac{325}{0.625s(s+1000)} = \boxed{\frac{520}{s(s+1000)}}$$

(b) $V_o = \dfrac{325\times10^3}{s(s+1000)} = \dfrac{A}{s} + \dfrac{B}{s+1000}$

$325\times10^3 = A(s+1000) + B(s)$

$s=0: \quad 325\times10^3 = A(1000) \qquad A = 325$

$s=-1000: \quad 325\times10^3 = B(-1000) \qquad B = -325$

$V_o = \dfrac{325}{s} - \dfrac{325}{s+1000}$

$$\boxed{v_o = 325\,(1-e^{-1000t})\,u(t)\ \text{V}}$$

$I_o = \dfrac{520}{s(s+1000)} = \dfrac{A}{s} + \dfrac{B}{s+1000}$

$520 = A(s+1000) + B(s)$

$s=0: \quad 520 = A(1000) \qquad A = 0.52$

$s=-1000: \quad 520 = B(-1000) \qquad B = -0.52$

$I_o = \dfrac{0.52}{s} - \dfrac{0.52}{s+1000}$

$$\boxed{i_o = 0.52\,(1-e^{-1000t})\,u(t)\ \text{A}}$$

Q-3 $H(s) = \dfrac{s(s+100)(s+1000)}{(s+10)(S+10000)}$

$H(s) = \dfrac{s\,(s/100+1)(s/1000+1)\times10^5}{(s/10+1)(s/10000+1)\times10^5}$

$= \dfrac{s\left(1+\frac{s}{100}\right)\left(1+\frac{s}{1000}\right)}{\left(1+\frac{s}{10}\right)\left(1+\frac{s}{10000}\right)}$

$\omega_1 = \dfrac{1}{1/10} = 10$ rad/sec

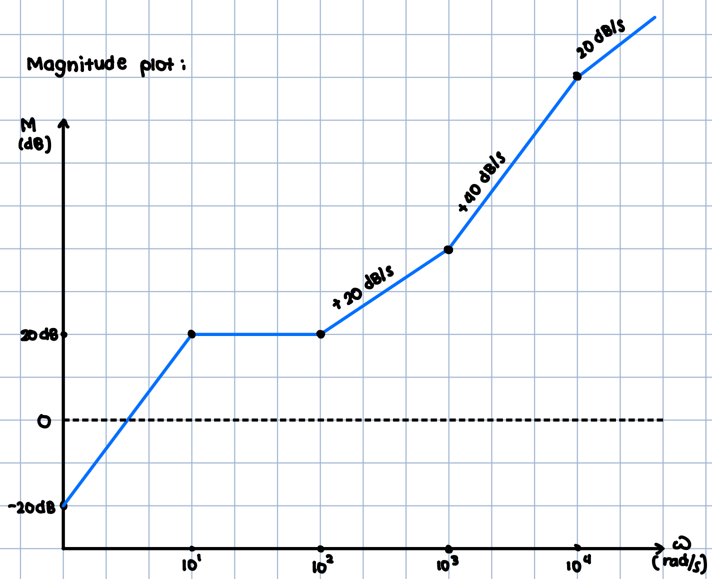
$\omega_2 = \dfrac{1}{1/100} = 100$ rad/sec

$\omega_3 = \dfrac{1}{1/1000} = 1000$ rad/sec

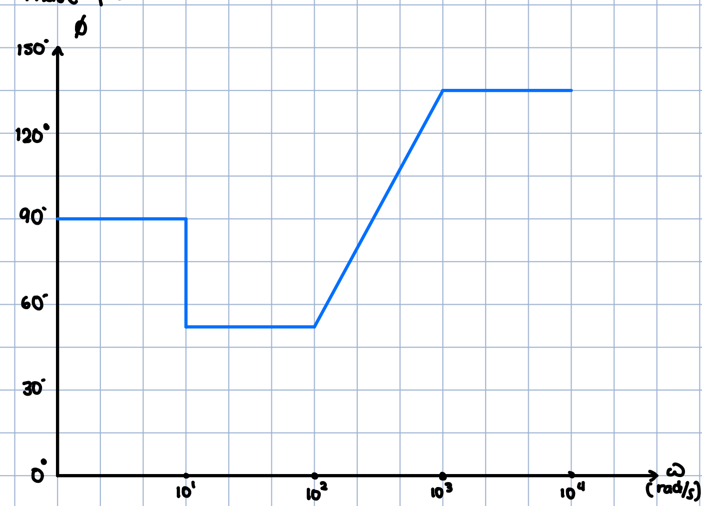
$\omega_4 = \dfrac{1}{1/10000} = 10\,000$ rad/sec

starting magnitude: $20\log(K) + 20\log(0.1)$

Magnitude plot:



Phase plot:

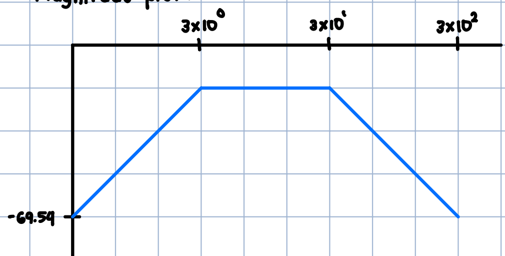


Q-4 $H(s) = \dfrac{(s+3)}{(s+30)(S+300)}$

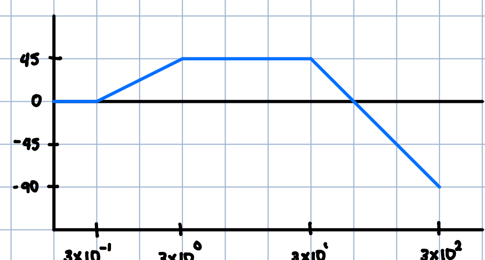
$= \dfrac{(1+s/3)}{(1+s/30)(1+s/300)} \cdot \dfrac{1}{3000}$

starting point: $20\log(1) - 20\log(3000) = -69.54$

Magnitude plot:



phase plot:

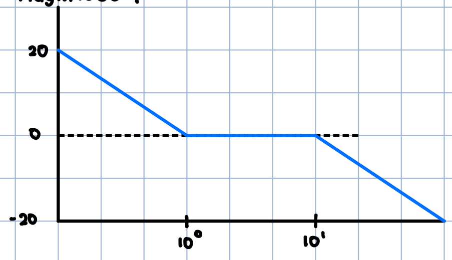


Q-5

$$H(s) = \frac{(s+1)(s+10)}{s(s+10)^2}$$

$$= \frac{(s+1)}{s(s+10)} = \frac{(s+1)}{s(s/10+1)} \cdot \frac{1}{10}$$

Magnitude plot :



Phase plot :