MASSACHVSETTS INSTITVTE OF TECHNOLOGY
Department of Electrical Engineering and Computer Science

6.002 – Electronic Circuits
Fall 2001

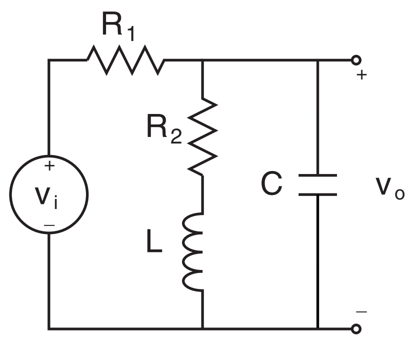
Problem Set 9

Issued: November 1st, 2001 Due: November 9, 2001

Readings:

- Agarwal & Lang Sections 14.6 and 15.3 for Thursday, November 1st.
- Agarwal & Lang Sections 15.1 and 15.2 for Friday, November 2.
- Agarwal & Lang Sections 16.1 to 16.3 for Tuesday, November 6.
- Agarwal & Lang Sections 16.5 and 16.6 for Thursday, November 8.

Problems:

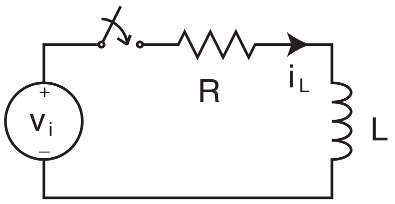


1. (a) For the above circuit, determine the system function $H(s) = V_o/V_i$ using the impedance method. $R_1 = 1k\Omega$, $R_2 = 250\Omega$, $L = 50mH$ and $C = 1\mu F$ in the circuit.

   (b) Calculate the numerical values of the poles and zeros of $H(s)$ and plot their locations in the complex s-plane. Based on the pole-zero locations, provide a sketch of $|H(j\omega)|$ vs. ω.

   (c) Determine the behavior of the circuit as $s \to 0$ and $s \to \infty$ directly from the circuit and compare with the behavior found from $H(s)$ as found in (a).

2. An inductive load, e.g., a motor, is suddenly connected to the power mains at $t = 0$ as indicated in the figure. Since the switch closure can occur at an arbitrary time relative to the phase of the line voltage, a phase shift ϕ has been included in $v_i(t) = V_i \sin(\omega t + \phi)$.

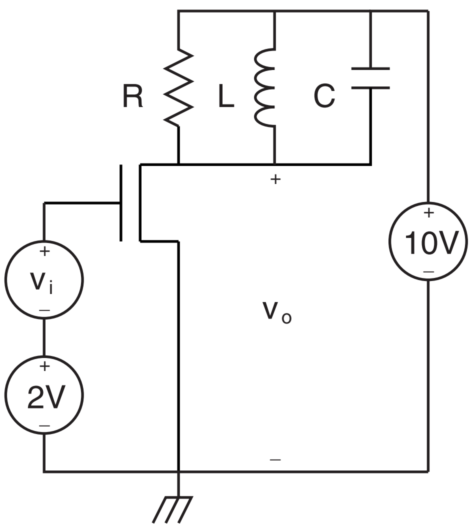


   (a) Determine the solution for $i_L(t)$ for $t > 0$ assuming $i(0) = 0$.

   (b) Sketch your solution for $i_L(t)$ in the case $\phi = 0$ and $\omega L/R \gg 1$. What is the peak value of the current and how does it compare with the amplitude of $i_L(t)$ when the sinusoidal steady-state is reached?

   (c) Find the value of ϕ for which the transient will be eliminated, i.e., the circuit will be in sinusoidal steady state for $t > 0$.

3. In the circuit shown below, the small signal input voltage is given by $v_i(t) = V_i \cos \omega t$ and the value of the resistor is $5\sqrt{L/C}$. In this problem, only the sinusoidal steady-state response is of interest.



   (a) Draw the small-signal model for this circuit. Assume $K = .002A/V^2$ and $V_T = 1V$.

   (b) Find $H(s) = V_o/V_i$ where V_o and V_i are the complex amplitudes of the output and input incremental voltages.

   (c) Sketch $|H(j\omega)|$ and $\arg H(j\omega)$ vs. ω. What is the maximum gain of the circuit and at what frequency does it occur?

4. Exercise 6, pg 879 A&L. (Note: ignore the middle circuit with the op-amp.)

5. Problem 8, pg 923 A&L.