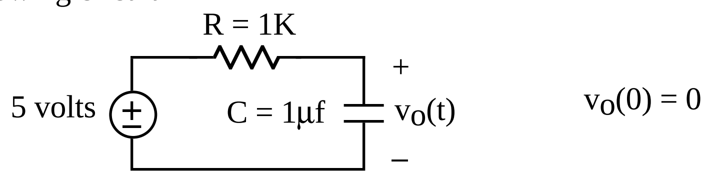
PROBLEMS YOU SHOULD BE ABLE TO DO BEFORE YOU TAKE ECE 307

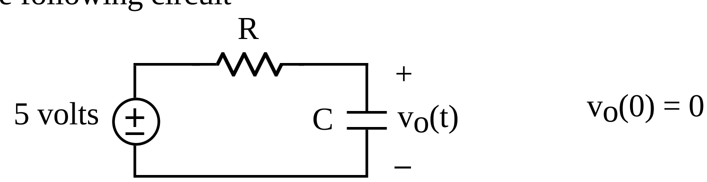
FALL 1995 **A.P. FELZER**

1. Given the following circuit



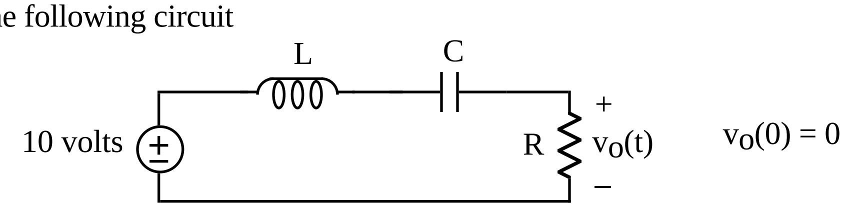
   a. Find and sketch $v_o(t)$. Explain why the curve looks the way it does. Identify the forced and transient parts of the response
   b. How will increasing C affect the response of $v_o(t)$. Explain why. Sketch a graph to illustrate what $v_o(t)$ looks like when C is small and another graph to illustrate what $v_o(t)$ looks like when C is large
   c. How will increasing R affect the response of $v_o(t)$. Explain why. Sketch a graph to illustrate what $v_o(t)$ looks like when R is small and another graph to illustrate what $v_o(t)$ looks like when R is large

2. How does the time constant τ of a first order circuit affect its response. Sketch the response of the following circuit



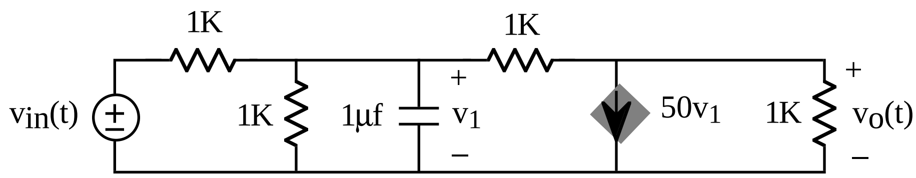
   if τ is small and then if τ is large. Describe and explain the difference between the two responses

3. Given the following circuit



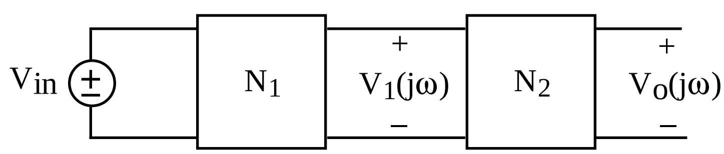
   with $v_o(t) < 0$ and $v_o'(0) < 0$. Sketch $v_o(t)$ if the circuit is
   a. Underdamped
   b. Overdamped
   c. Critically Damped
   Make use of SPICE to find the response of the circuit with values of R, L and C of your choice

4. Given the following circuit in the sinusoidal steady state



a. Draw the phasor circuit
b. Write and put in matrix form the phasor node equations
c. Solve your equations in part (b) for the node voltage phasors if $v_{in}(t) = 5\cos(1000t + 1.2)$. Then find and sketch the steady state $v_o(t)$
d. Verify that a SPICE transient analysis results in the same steady state $v_o(t)$ you got in part (c)
e. Make use of your results in part (c) to find the average power P_{av} being supplied by $v_{in}(t)$ and the average power P_{av} being received by the load R_L
f. Find the input impedance $Z_{in}(j\omega) = V(j\omega)/I(j\omega)$ as seen by the independent source. Sketch $|Z_{in}(j\omega)|$ as a function of ω. Describe and explain why your graph looks the way it does. Then use SPICE to get a graph of $|Z_{in}(j\omega)|$ as a function of ω.
g. Find the voltage transfer function $G(j\omega) = V_o(j\omega)/V_{in}$. Sketch $|G(j\omega)|$ as a function of ω. Describe and explain why your graph looks the way it does. Then use SPICE to get a graph of $|G(j\omega)|$ as a function of ω.
h. Find the Thevenin Equivalent output impedance $Z_o(j\omega) = V_o(j\omega)/I_o(j\omega)$ as seen by the load R_L. Sketch $|Z_o(j\omega)|$ as a function of ω. Describe and explain why your graph looks the way it does. Then use SPICE to get a graph of $|Z_o(j\omega)|$ as a function of ω.

5. Under what circumstance is the overall gain $G(j\omega) = V_o(j\omega)/V_{in}$ of the following cascade of N_1 and N_2



equal to the product of the open circuit voltage gains $G_1(j\omega)$ and $G_2(j\omega)$ of the individual sections. Express $|G(j\omega)|$ in terms of $|G_1(j\omega)|$ and $|G_2(j\omega)|$

6. Use a plotting calculator or computer to obtain Bode plots for the gains of circuits with transfer functions

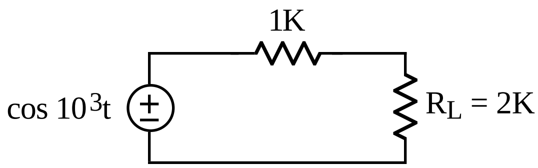
a. $G(j\omega) = \dfrac{1000}{j\omega + 1000}$

b. $G(j\omega) = \dfrac{j\omega}{j\omega + 1000}$

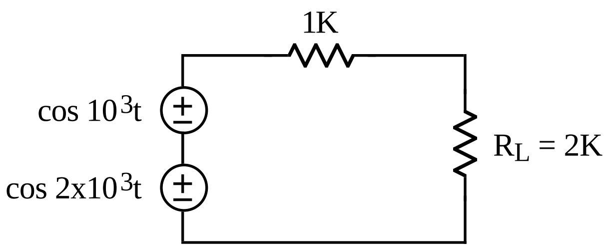
c. $G(j\omega) = \dfrac{1000\,j\omega}{(j\omega)^2 + 1000\,j\omega + 10^6}$

7. Find the average powers P_{av} being supplied by the sources and delivered to the loads R_L in each of the following circuits

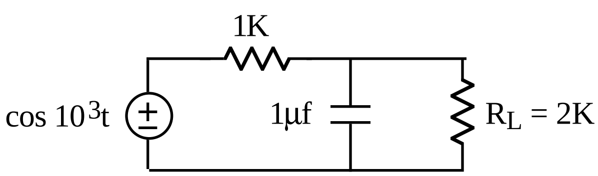
a.



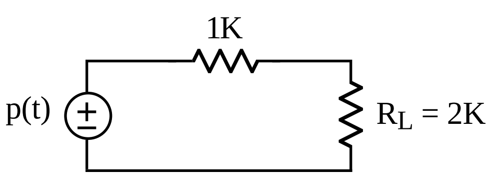
b.



c.



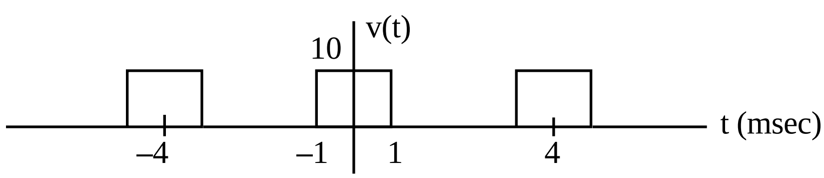
d.



where p(t) is a pulse train with magnitude h = 10 volts, pulse width a = 5 msec and period T = 15 = msec

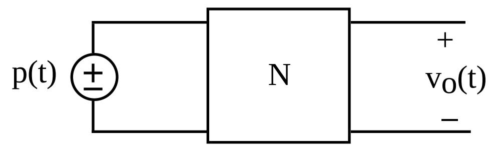
8. Why do we go to the trouble of approximating periodic signals by sums of sinusoids

9. Find and then make use of a plotting calculator or computer to graph the sum of the first five harmonics of the following pulse train

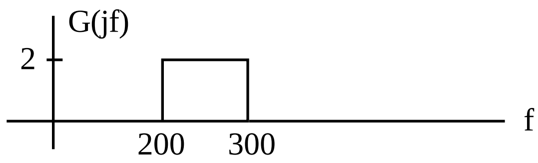


How closely does your graph resemble the pulse train. Then find and plot the response of the op amp circuit in Problem (7) to these five harmonics. Draw the corresponding spectral and power spectral plots

10. Find the steady state response of the following circuit



with ideal frequency response



to the pulse train of Problem (17)