PROBLEMS YOU SHOULD BE ABLE TO DO AFTER YOU TAKE ECE 209

FALL 1995 **A.P. FELZER**

1. What is Euler's relation. Where does it come from

2. Show how Euler's Relation can be used to express the sinusoid $v(t) = 5\cos(100t + 1.3)$ as the real part of a complex exponential

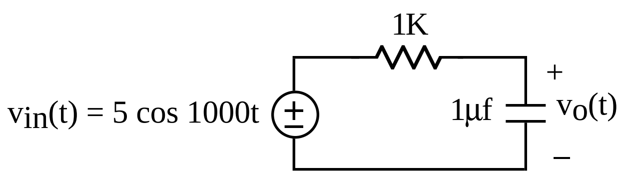
3. Find the sinusoidal steady state response $v_o(t)$ of a circuit with differential equation

$$v_o' + 1000v_o = 10v_{in}'$$

   and input $v_{in}(t) = \cos 2000t$

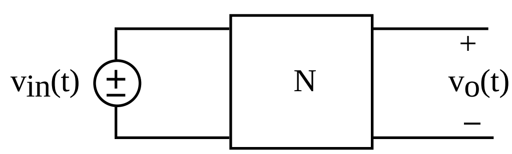
4. What are phasor circuits. Where do they come from. Why do we use them to calculate sinusoidal steady state responses. What's the connection between Euler's relation and phasor circuits

5. Find and sketch the steady state response of the following circuit

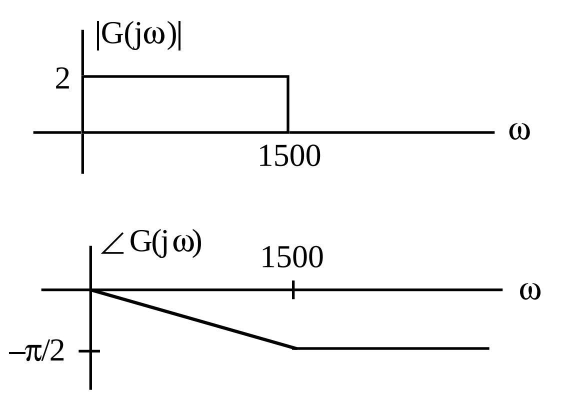


6. What are transfer functions $G(j\omega)$. How are they useful.

7. Find and plot the steady state response of the following circuit

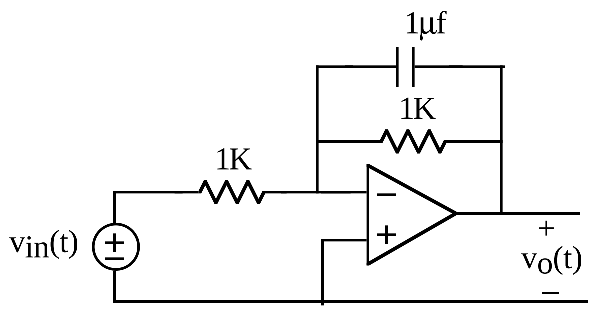


   with ideal frequency response $G(j\omega) = V_o(j\omega)/V_{in}$ given by



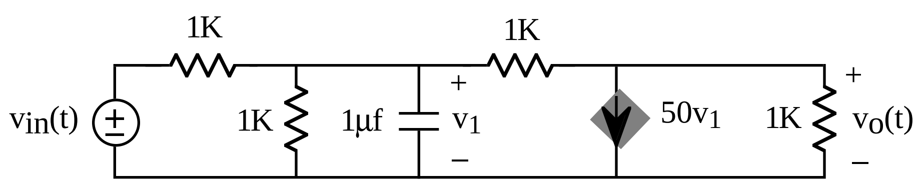
   if $v_{in}(t) = 3\cos(1000t + \pi/6) + 2\cos(2000t)$. Explain how you got your result

8. Let us now analyze the following more realistic circuit



a. Find and then sketch the magnitude and phase of the voltage transfer function $G(j\omega) = V_o(j\omega)/V_{in}$
b. Describe the similarities and differences between the ideal frequency response in Problem (6) and this more realistic frequency response
c. Make use of your transfer function to find and plot the steady state response to the same $v_{in}(t)$ as in Problem (6). Describe the similarities and differences between this response and that in Problem (6)

9. 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.

10. Why do we draw Bode Plots instead of simply plotting frequency and magnitude on linear scales

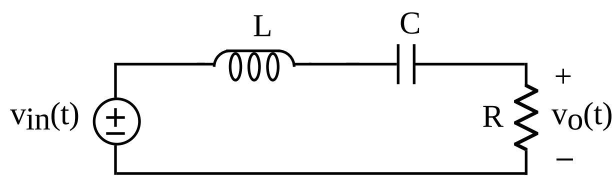
11. Use a plotting calculator or computer to obtain Bode plots for the gains of circuits with transfer functions

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

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

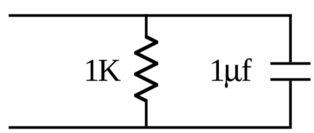
    c. $G(j\omega) = \dfrac{1000 j\omega}{(j\omega)^2 + 1000 j\omega + 10^6}$

12. Sketch the magnitude of the gain $G(j\omega) = V_o(j\omega)/V_{in}$ of the following series resonant circuit



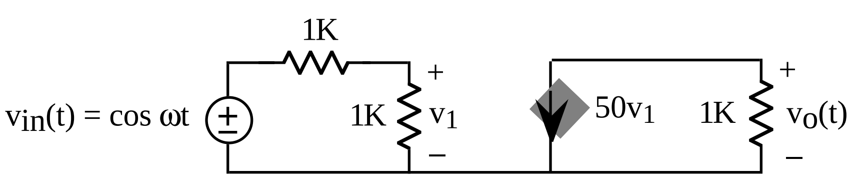
as a function of frequency ω on a log scale. How would changes in the circuit's ω_p and Q_p affect its response. Draw curves to illustrate. Repeat for a parallel RLC resonant circuit

13. Find and sketch the magnitude of the impedance Z(jω) of the following circuit



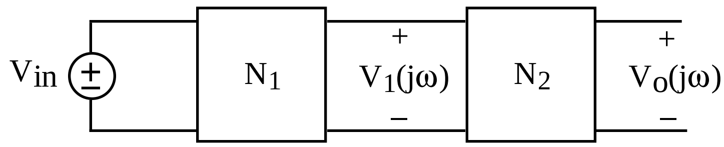
Describe and explain what’s happening as ω increases

14. How will the following circuit be affected



by connecting the RC circuit of Problem (12) to its output. Sketch the magnitude of $v_o(t)$ as a function of frequency both before and after the RC load is connected. Describe and explain the difference

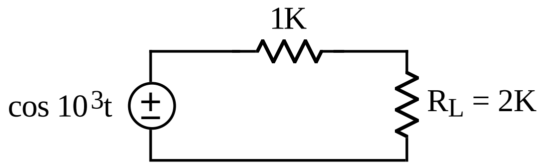
15. Under what circumstance is the overall gain $G(j\omega) = V_o(j\omega)/V_{in}$ of the following cascade of N_1 and N_2



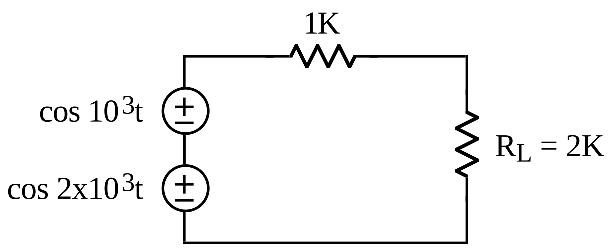
equal to the product of the open circuit voltage gains $G_1(j\omega)$ and $G_2(j\omega)$ of the individual sections. Express $|G(j\omega)|$ in terms of $|G_1(j\omega)|$ and $|G_2(j\omega)|$

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

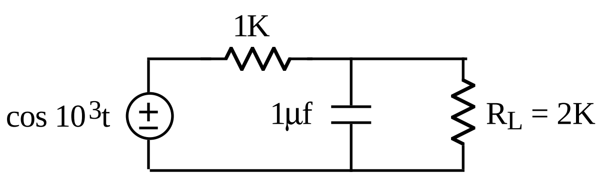
a.



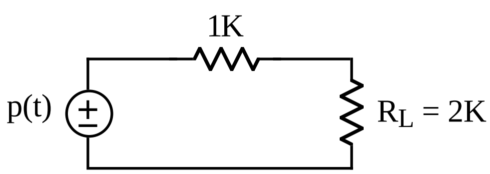
b.



c.



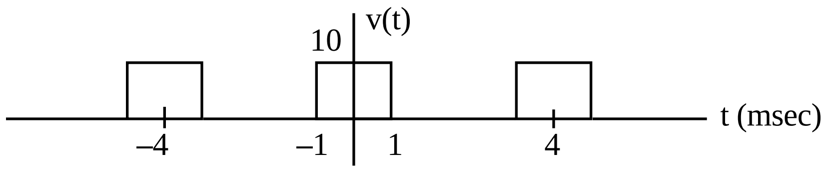
d.



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

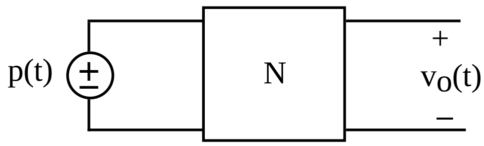
17. Why do we go to the trouble of approximating periodic signals by sums of sinusoids

18. 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

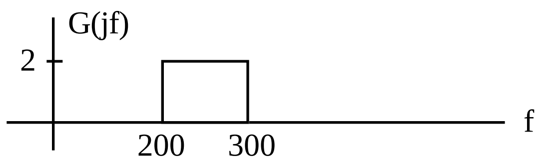


How closely does your graph resemble the pulse train. Then find and plot the response of the op amp circuit in Problem (7) to these five harmonics

19. Find the steady state response of the following circuit



with ideal frequency response



to the pulse train of Problem (17)

20. Design a 2nd order RC-active circuit to pass the 1st harmonic of the pulse train in Problem (16)