ECE300 Aut08 Homework 4.

Initial Problems for quiz preparation.

1. Chp6 - Problem 66

2. Compare your answers from Problem 1 to the speaker circuit frequency response shown in the figure below from the book: Electrical Engineering Uncovered by D. White and R. Doering.

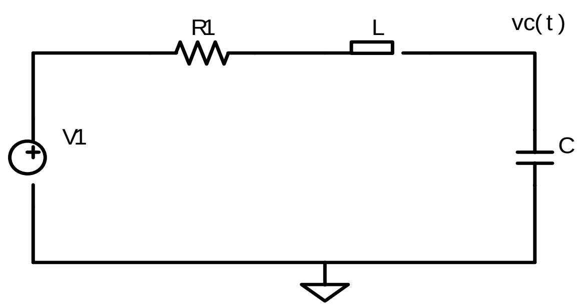
C1=2.7uF L1=190uH C2=12uF L2=0.9mH

In particular, compare the corner frequencies for the tweeter and woofer frequency response. Also estimate the midrange speaker response.

3. Chp 4. – Problem 47. Solve for the steady state response across the inductor and across the capacitor and for the difference voltage between them.

4a. In the circuit below, calculate the steady state solution for the voltage across C: vc(t). R1 = 2 L = 2mH C = 2mF V1 = 10*cos(1000t)

4b. Change the input frequency to be at resonance (maximum voltage magnitude across C) and find vc(t).



4c. Repeat 4b. for L = 2H and C = 2uF and compare to the answer in 4b.

5a-c. Using the 3 speaker circuits in the figure below, find the differential equation for each of the speaker voltages and write the natural (or homogeneous) solutions.

5d. For the tweeter speaker circuit in the figure, find the differential equation for the voltage across the capacitor C1 and write the natural solution.

Note: An easy way to find linear circuit differential equations is to use the transfer function form of the complex amplitude calculation: Vr(s) = V1(s)*N(s)/D(s) to yield

D(s)*Vr(s) = N(s)*V1(s)

Write a derivative for each s in D(s) and N(s). This is called the operator method, each s represents a derivative operation.

Complete the algebra so that D(s) and N(s) don't contain denominators with s and the size of the power of s is the order of the derivative. For example, s^2 produces second order derivative, s^3 produces third order derivatives, etc.

The natural solutions of the differential equations come from factoring D(s) into first order and second order factors. Each factor produces a natural solution of the form Ai*exp(si*t), where si are the roots of D(s)=0 from the first order and second order factors. The first order factors always produce real si (almost always negative), but the second order factors can produce complex si. This is the connection between using imaginary numbers to factor a polynomial in algebra and imaginary numbers in the exponents of exponentials for linear differential equations – these equations reduce to polynomials when eigenfunctions (in this case – exponentials) are used for the inputs.

FROM ELEC. ENGR. UNCOVERED by D. White
R. Doering

8.8 Computer-Aided Design (CAD) Tools

As the warrior of old relied on his sword, so an engineer today relies on CAD tools. Many design tasks today are extremely complex, and these tools can simplify the tasks of specification, design, verification, testing, manufacture, and maintenance. These tools enable engineers to create their designs on a computer screen, where they can be easily manipulated, and hierarchy can be exploited, instead of on paper. The design can be checked for rule violations either in a checking phase or in some programs continuously as it is created. The great strength of computers comes into play when these programs simulate the design, without ever having to build it.

Our two example programs are both circuit design programs. LogicWorks (Figure 8.5) is for digital designs, and P-Spice (Figures 8.6-8.7) is for analog designs. SPICE stands for Simulation Program with Integrated Circuit Emphasis.

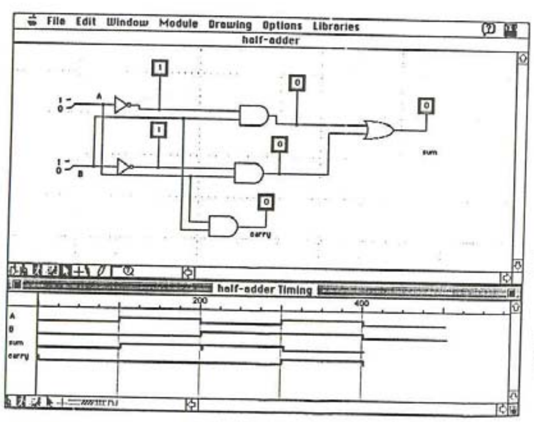


Figure 8.5 LogicWorks screen images. The top window is the schematic, and the bottom window is the timing diagram.

Both programs allow the user to create a schematic drawing of their circuit using symbols from their libraries. They can then simulate the behavior of the circuit, generating graphs of circuit behavior.

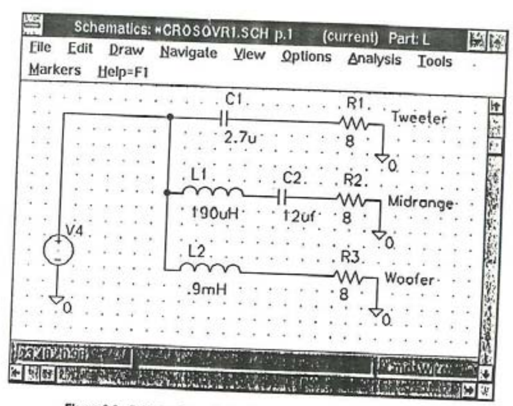


Figure 8.6 P-Spice schematic drawing of a loudspeaker crossover circuit

8.9 Finite-Element Method (FEM) Analysis

To solve engineering problems that involve objects having complex shapes, you may need to resort to purely numerical solutions, instead of using familiar analytic functions such as sines and cosines, exponentials, and polynomials. The boundaries of most real objects — such as a football helmet or a shovel — don't consist just of planes, cylinders, or spheres, so a numerical approach may be needed. A way of doing the numerical analysis is called the finite-element method (abbreviated as