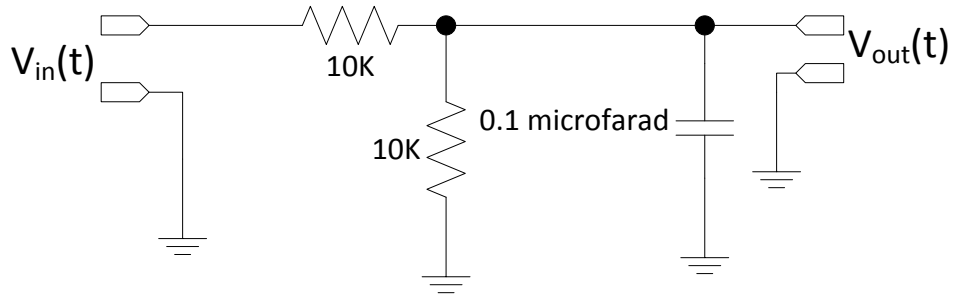
Contemporary Electronics PH351001
Fall 2017 – October 30, 2017
Homework Assignment 1

53 total points possible

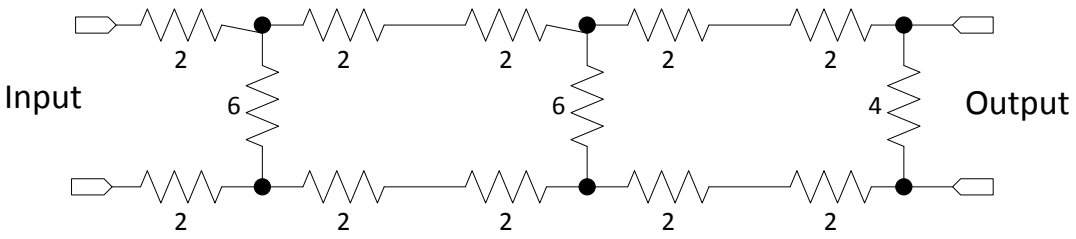
1. If at time t=0, V_{in} goes from 0 to 10 volts instantly, find $V_{out}(t)$ for this circuit and sketch it. Go as far out in t as you need in order to show the behavior. Be sure to label & indicate the scale of the axes.

5 points



2. Find the input impedance (resistance of the network looking into the input) of the circuit shown below. What voltage applied to the input results in a 1 amp current in the 4 ohm resistor at the output?

8 points



3. Design a symmetric clamp that confines the signal to the range -5.6 volts to +5.6 volts. There are multiple ways to do this, and I'm not looking for a specific solution. (Hint: Easiest with zenor diodes, can be done with regular diodes.)

2 points

4. New York City requires 10^{10} watts of electrical power, at 110 volts. A heavy power cable is 1 inch in diameter. Assume it is made of pure copper (resistivity = ~ 1.7μohm-cm).

10 points

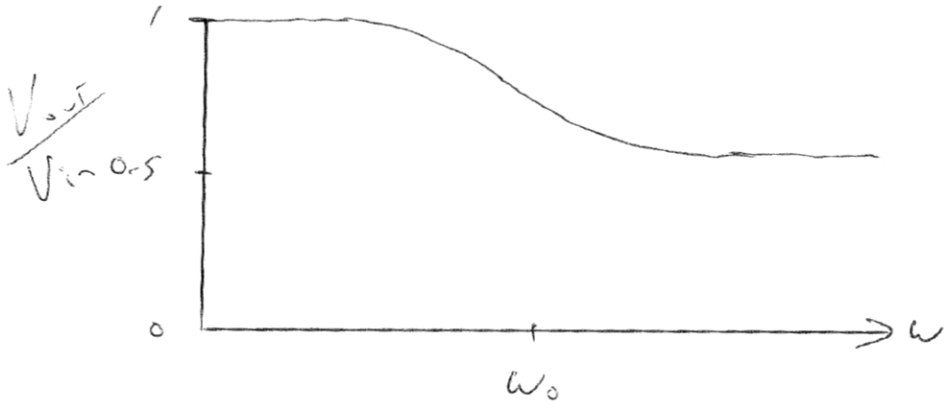
a) Calculate the power lost per foot from "I^2R losses" of the "1 inch diameter" cable.
b) Calculate the length of the "1 inch diameter" cable over which you will lose all 10^{10} watts.
c) Suppose instead it were a 1 foot (rather than 1 inch) diameter cable. What is the power lost per foot from "I^2R losses" now?
d) Calculate the length of the "1 foot diameter" cable over which you will lose all 10^{10} watts.
e) So, how do they get the power through a 1 inch diameter cable from the generator to the customers, which are typically 100 miles or more apart?

5. Three capacitors are connected in series across a 100V battery. If the capacitances are 1.0, 0.1, and 0.001 μF, respectively, calculate the potential difference across each capacitor.

8 points

6. (a) How would you make a filter using resistors and capacitors to give a response as shown below? Be sure to show what ω_o is in terms of your components. Remember, $\omega_o = \frac{1}{some\ resistance \times some\ capacitance}$ which for a simple RC filter, is $\omega_o = \frac{1}{RC}$

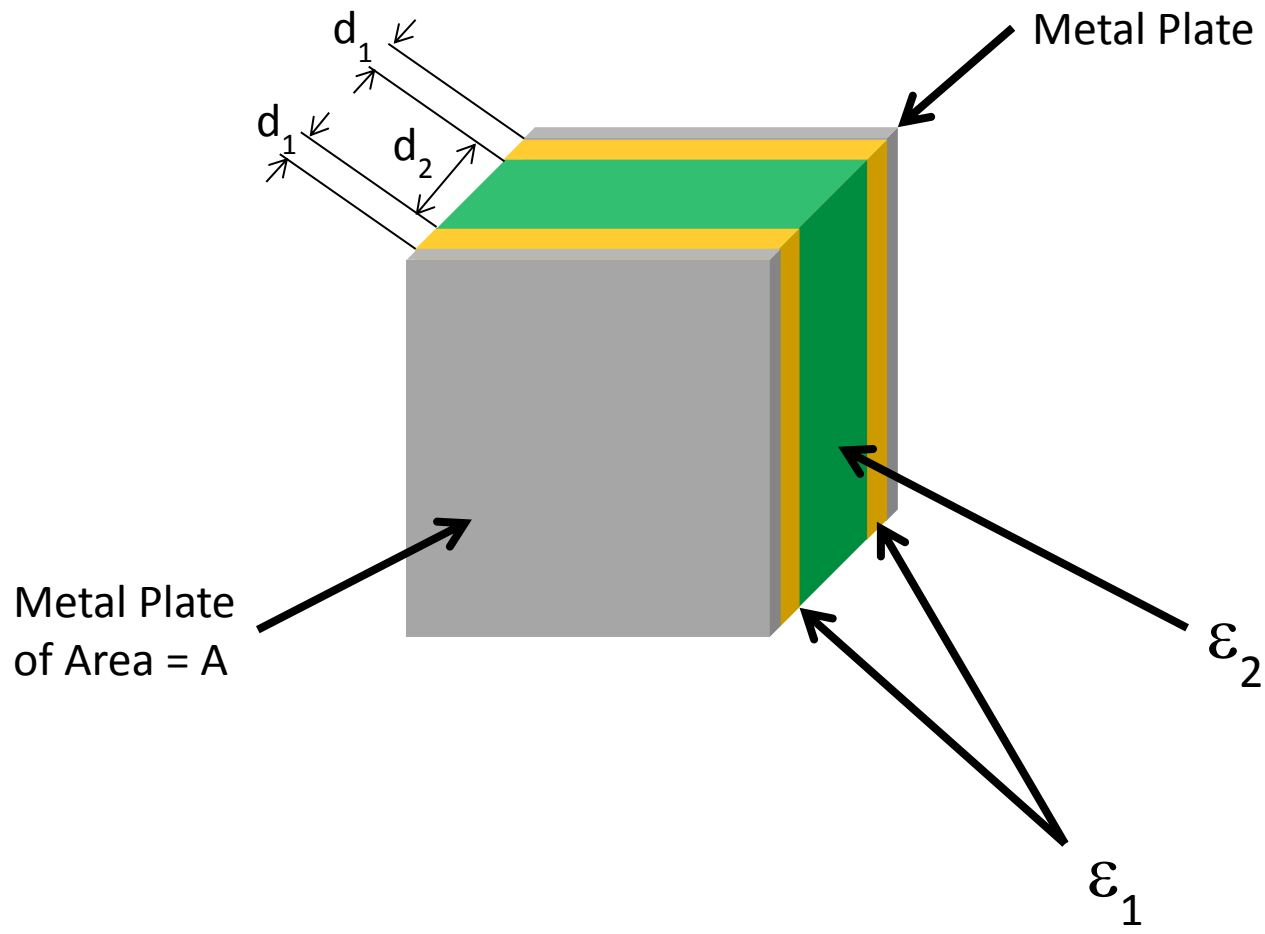
10 points



(a) Is this a high-pass filter or a low-pass filter?
(b) What would the response of the other type of filter look like? Draw it's V_{out}/V_{in} vs ω plot. (What I mean is if in "b" you said "high-pass", then by "other type" I mean "low-pass". If in "b" you said "low-pass", then by "other type" I mean "high-pass".)

10 points

7. a) Derive the expression for the capacitance of the capacitor illustrated below. The area of the capacitor plates is A, and the volume between the plates is filled with a "sandwich" composed of two dielectrics with dielectric constants ε_1 & ε_2. The sections of ε_1 are d_1 thick each, and the inner section of ε_2 is d_2 thick. (Hint: This is a variation of problems 25-48, 25-49 & 25-50 in your freshman physics text, "Fundamentals of Physics", 9th Ed, Vol. 2, by Halliday, Resnick & Walker)



b) Explain the role of the layer order in your solution.