ECE300 Aut08 Homework 3

Initial Problems for quiz preparation

1a. Solve for the branch voltage and branch current of the 4K resistor in the circuit in Figure 1.

1b. Replace the 4K resistor with a resistor that absorbs maximum power and state the voltage and current in this replacement resistor.

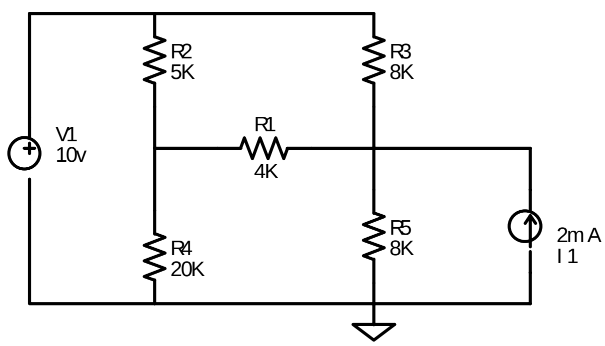


Figure 1

2a. Solve for the current and voltage in the 72 ohm resistor in Figure 2b using a Thevenin equivalent circuit. V2 is an ammeter, and can be ignored for now.

2b. Write the differential equations for the capacitor current and voltage in Figure 2a. Write them for both the circuit as drawn and using a Thevenin equivalent.

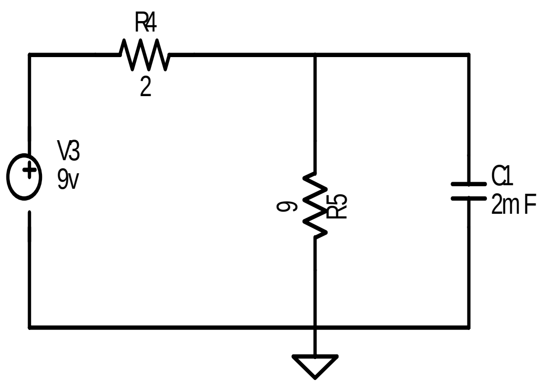


Figure 2a

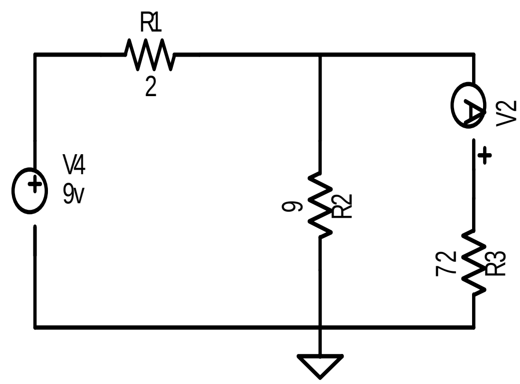


Figure 2b

After quiz

1. Show that the solution of the capacitor voltage vc(t) in section 4.3 of the forced response of a series R-C circuit with an input of V*cos(wt) can be written as:

Vc*cos(wt – theta)

Where Vc is the amplitude magnitude equal to V/squrt(1 + $(wRC)^2$) and theta is an angle equal to $\tan^{-1}(wRC)$.

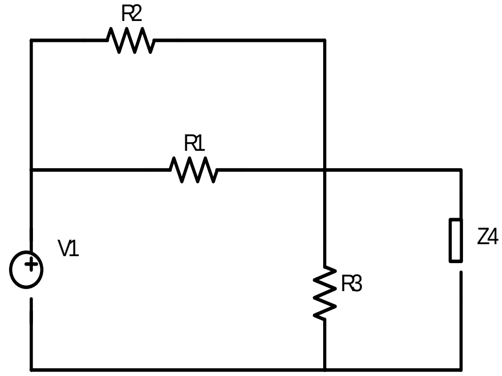
This is the typical form for sinusoidal answers, since it shows the delay (phase angle) between the input and output as drawn on Figure 4.22. It also shows that change in magnitude between input and output. Note that when wRC = 1, the magnitude is reduced by squrt(2) and the delay angle is 45 degrees. This anchor point corresponds to the case when the input frequency w is 1/RC, the inverse of the circuit time constant.

2. Let the input to the same circuit be equal to an exponential V*exp(st).

Show that the output amplitude Vc is now equal to V/(1 + sRC), and the output waveform vc(t) is Vc*exp(st). Show that the output amplitude Vc could have been obtained by using a voltage divider formula on the amplitudes with the “resistance” of the capacitor equal to 1/sC. **This is a key observation, since we will be able to obtain the answers of the branch voltages and currents without having to find the differential equations!**

3. Show that when s = j*w, that we can obtain the answer to input cosine case: Vc*cos(wt – theta).

4. In the circuit below, Z4 is a 2uH inductor. Write the differential equation for the voltage va across the inductor. Let the input V1 be equal to V*exp(st), and the “resistance” of the inductor be equal to sL. Show that the amplitude of the voltage across the inductor Va is V*(sL||R3 / (sL||R3 + R1||R2). (|| means in parallel)



5. Problem 4.54 is a series RLC circuit. Solve for the amplitude answer for an input of 12*exp(st). Then show your answer with s=j*3

6. Problem 4.55 is a parallel RLC circuit. Solve for the amplitude answer for an input of 10*exp(st). Then show your answer with s=j*2