Sirindhorn International Institute of Technology

Thammasat University at Rangsit

School of Information, Computer and Communication Technology

ECS203: Final Examination

COURSE : ECS203 (Basic Electrical Engineering)
DATE : October 7, 2010
SEMESTER : 1/2010
INSTRUCTOR: Dr. Prapun Suksompong
TIME : 9:00-12:00

Name		ID	
		Seat	

Instructions:

1. Including this cover page, there are 10 pages.
2. **One A4 sheet allowed**. Must be **hand-written**. No small pieces of paper notes glued/attached on top of it. Indicate your name and ID on the upper right corner of the sheet.
3. **Read these instructions and the questions carefully**.
4. **Closed book. Closed notes**.
5. **Basic calculators are permitted**, but borrowing is not allowed.
6. Allocate your time wisely. Some easy questions give many points.
7. Do not cheat. The use of communication devices including mobile phones is prohibited in the examination room.
8. Do not forget to write your **first name and the last three digits of your ID** on each page of your examination paper, starting from page 2.
9. ***Write down all the steps*** that you have done to obtain your answers. You may not get any credit even when your final answer is correct without showing how you get your answer.
10. The answer(s) from earlier part(s) of a question may be useful for subsequent part(s) or question(s). You may refer to your own answer(s) from earlier part(s).
11. Units are important.
12. All phasor should be answered in polar form where the magnitude is positive and the phase is between -180° and 180°.
13. All sinusoid should be answered in the time-dependent cosine form where the amplitude is positive and the phase is between -180° and 180°.
14. Dr. Prapun will visit each exam room regularly. In general, there is no need to ask the proctor to call for Dr. Prapun.
15. ***Do not panic***.

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1. (14 pt) Consider the circuit in Figure 1 below. **Assume** the switch has been **<u>at position 1 for a long time</u>** and moves to position 2 at t = 0 sec.

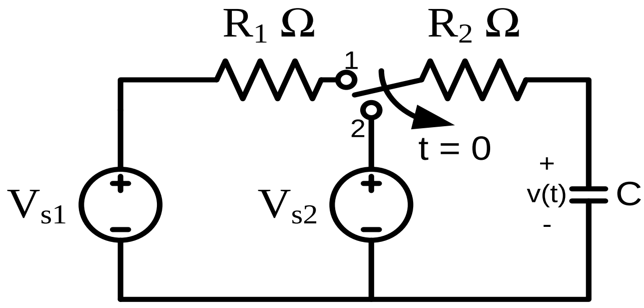

Figure 1

Let

V_{s1} = 5 V, V_{s2} = 0 V, R_1 = 6 Ω, R_2 = 3 Ω, and C = 10 F.

a. (3 pt) Find $v(\mathbf{0}^-)$. Do not forget to justify your answer.

b. (1 pt) Find $v(0)$. Do not forget to justify your answer.

c. (4 pt) Find $v(t)$ for $t > 0$.

d. (3 pt) Evaluate the amount of energy stored in the capacitor at t = 15 sec.

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e. (3 pt) Find $v(t)$ for $t > 0$ if V_{s2} = **10 V** instead of 0 V.

2. (5 pt) Consider the circuit in Figure 2 below. Assume that the switch has been in position 1 during time $t < 0$. Then, during time $t \geq 0$ the **switch changes its position five times**: at $t_1 = 0$, $t_2 = 25$ ms, $t_3 = 50$ ms, $t_4 = 75$ ms, and $t_5 = 100$ ms.

   (At time t_1, the switch changes to position 2. At time t_2, the switch changes back to position 1. At time t_3, the switch changes again to position 2….)

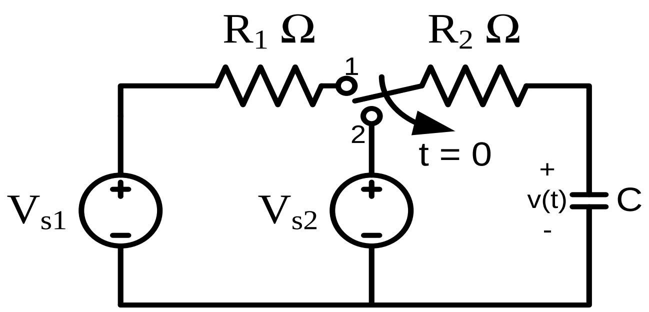

Figure 2

Let

V_{s1} = **7 V**, V_{s2} = **10 V**, $R_1 = 6\ \Omega$, $R_2 = 3\ \Omega$, and C = 10 F.

a. (3 pt) Estimate the value of v(t) at time t = **1 hour**.

b. (2 pt) Estimate the value of the current through the capacitor at time t = **1 hour**.

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3. (10 pt) Consider the circuit in Figure 3 below. Assume the switch has been at position 1 for a long time and moves to position 2 **at t = 5 sec.**

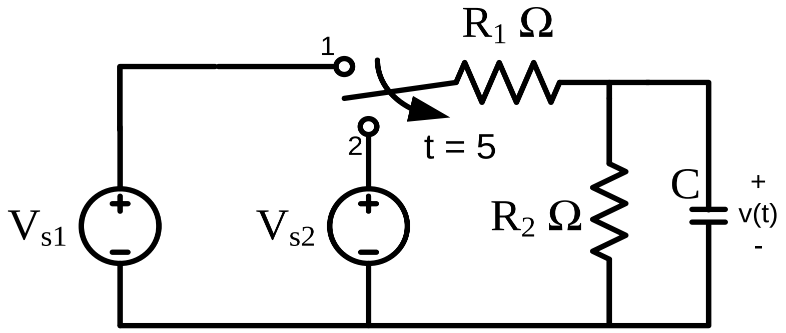

Figure 3

Let

V_{s1} = 16 V, V_{s2} = 8 V, R_1 = 3 Ω, R_2 = 5 Ω, and C = 8 F.

a. (3 pt) Find *v*(0).

b. (2 pt) Find *v*(5).

c. (4 pt) Find *v*(*t*).

d. (1 pt) Evaluate *v*(*t*) at t = 7.

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4. (5 pt) Simplify $x(t) = 7\cos(t - 777^\circ) - 7\sin(t - 77^\circ)$. (Your answer should be a time-dependent sinusoid in standard form.)

5. (5 pt) Find the sinusoid $x(t)$ which is represented by a phasor **X** = $-7 + 7j$. Assume $\omega = 100$ rad/s. (Your answer should be a time-dependent sinusoid in standard form.)

6. (38 pt) In this question, you **must** use the specified techniques to solve the problem. There will be **no credit** given if you do not follow the instructions. As always, your score depends strongly on your explanation of your answer. If the explanation is incomplete, zero score may be given even when the final answer is correct.

   Consider the circuit below.

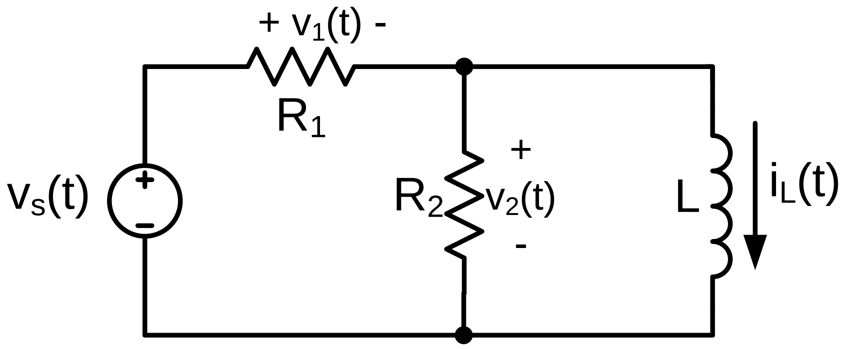

Figure 4

   Suppose

$$v_s(t) = 7\cos(200t + 30^\circ) \text{ V},$$

$$R_1 = 6\ \Omega,\ R_2 = 4\ \Omega, \text{ and } L = 5 \text{ mH}.$$

   a. (1 pt) Find $\mathbf{V_s}$ (which is the phasor representation of $v_s(t)$).

b. (2 pt) Find the impedance of the inductor.

c. (8 pt) Use mesh analysis to **<u>find all mesh currents</u>** (in the clockwise direction) in phasor form.

d. (2 pt) Use the mesh current(s) to find the current $i_L(t)$ through the inductor.

e. (6 pt) Use **<u>nodal analysis</u>** to find the voltage $v_2(t)$ across the resistor R_2.

f. (4 pt) Find the voltage $v_1(t)$ across the resistor R_1.

g. (5 pt) Use source transformation(s) and/or impedance combination(s) to transform

the part of the circuit to the left of the inductor

into

a phasor voltage source $\mathbf{V_A}$ in series with an impedance $\mathbf{Z_A}$.

h. (3 pt) Use $\mathbf{V_A}$, $\mathbf{Z_A}$, and the impedance of the inductor to find $i_L(t)$.

i. (1 pt) Find the instantaneous power absorbed by R_1

j. (1 pt) Find the average power absorbed by R_1

k. (2 pt) Find the average power absorbed by L

l. (3 pt) Find the average power **absorbed** by the voltage source.

7. (9 pt) Consider the circuit in Figure 5 below.

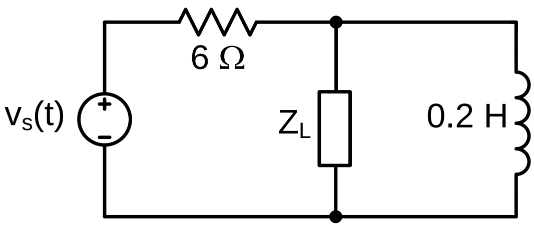

Figure 5

Suppose

$$v_s(t) = 7\cos\left(200t + 30^{\circ}\right)\ \text{V},$$

a. (4 pt) Determine the **load impedance** Z_L for maximum power transfer (to Z_L).

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b. (3 pt) In the lab, how can you build the optimal Z_L which you got in part (a) from a combination of resistor/inductor/capacitor? **Draw and explain** your answer. Indicate the values of each component (in Ω/H/F).

c. (2 pt) Calculate the **maximum power** absorbed by the load Z_L.

8. (3 pt) What is seriously wrong with Figure 6 below. Justify your answer.

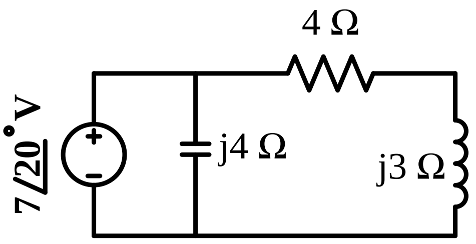

Figure 6

9. (4 pt) Consider the circuit in Figure 7.

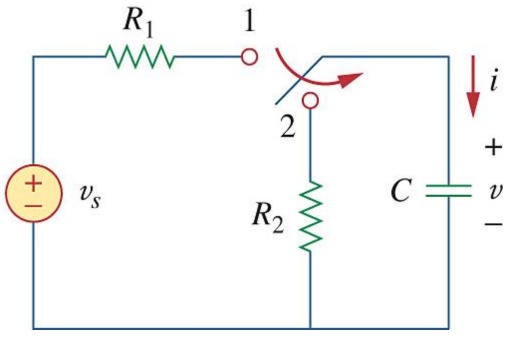

Figure 7

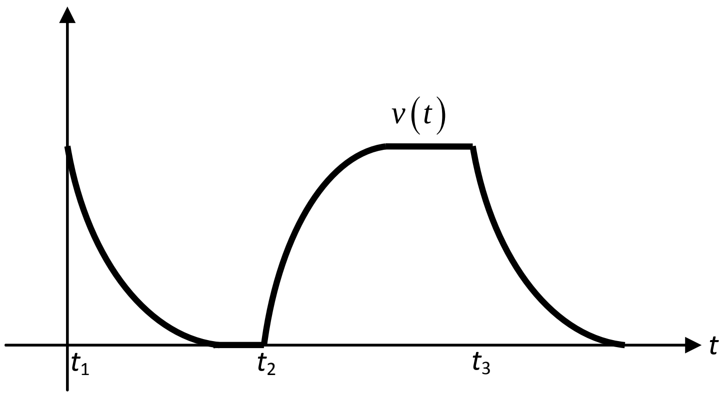

Figure 8

Assume that the switch has been in position 1 during time $t < 0$. Then, during time $t \geq 0$ the switch changes its position three times: at t_1, t_2, t_3.
(At time t_1, the switch changes to position 2. At time t_2, the switch changes back to position 1. At time t_3, the switch changes again to position 2.)

Figure 8 shows the voltage $v(t)$ for time $t > 0$.

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If the capacitance value C is **decreased** by 10%, how would the plot in Figure 8 change? **Provide some explanation and sketch** the plot of the new $v(t)$ directly in Figure 8. Assume the same initial voltage at time t_1.

10. (6 pt) Consider the op-amp circuit in Figure 9 below. All voltages are represented by their phasors.

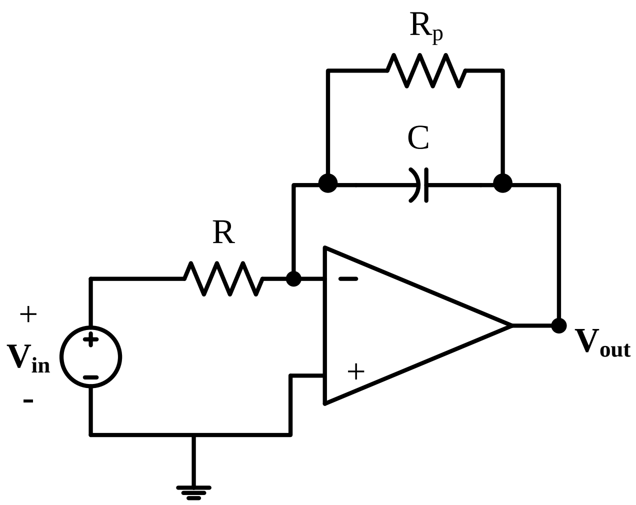

Figure 9

a. (5 pt) Find the gain $\left|\frac{\mathbf{V_{out}}}{\mathbf{V_{in}}}\right|$ in terms of ω, R, C, R_p.

b. (1 pt) Find the gain $\left|\frac{\mathbf{V_{out}}}{\mathbf{V_{in}}}\right|$ when ω = 0 rad/s.

11. (1 pt) Do not forget to **submit your formula sheet with your final exam**.