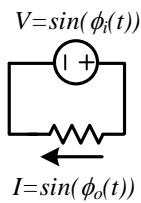


Mid-Term Exam (3 hours)

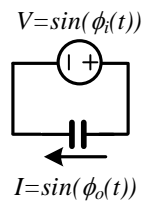
1. [Linearity & Electrical elements] [12pts]

- (a) Suppose the input and the output of a resistor are defined as voltage across the device and temperature of the device, respectively. Is this system linear? Assume that the temperature is proportional to power dissipated in the resistor. [2pts]

- (b) Suppose the input and output of the below circuits are the phase of the voltage and current, respectively. (i.e., input = $\phi_i(t)$, output = $\phi_o(t)$) Is this system linear? Assume $R=1\Omega$, $C=1F$. [4pts]

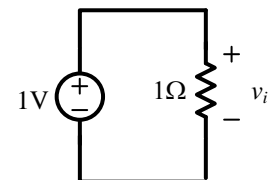
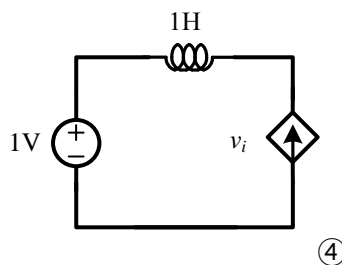
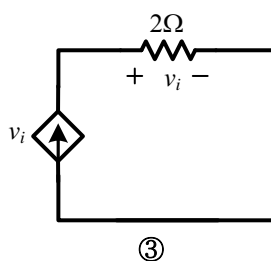
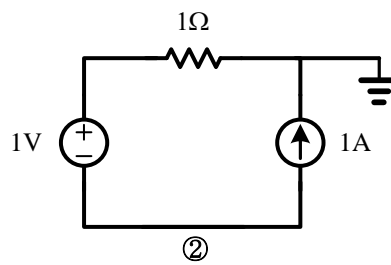
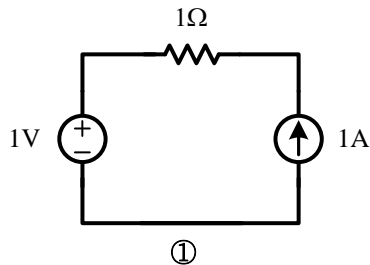


Linear? (Yes, No)



Linear? (Yes, No)

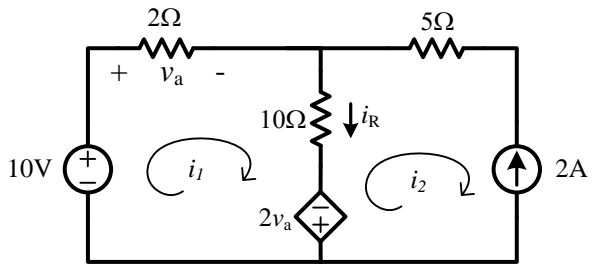
- (c) Please choose the circuits that are physically possible ($0 < v_i < \infty$). [6pts]



Answer: ()

학번(ID): _____ 이름(Name): _____

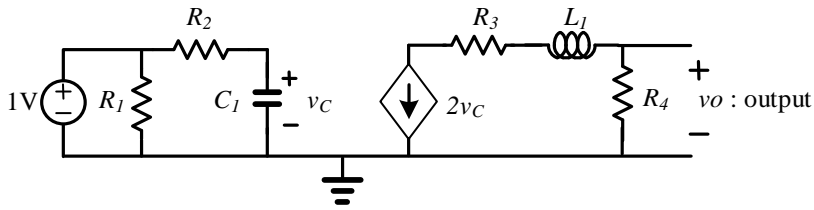
2. Analyze the circuit shown below. [9pts]



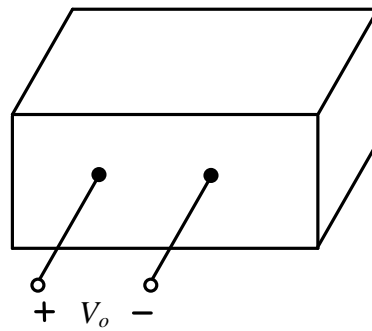
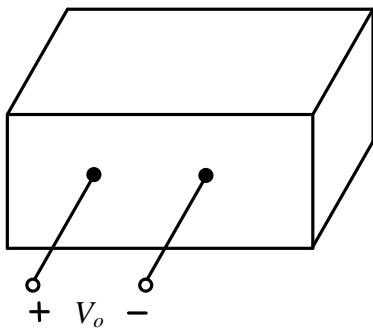
(a) Write down two equations necessary to analyze this circuit. [6pts]

(b) Find i_R and the mesh currents i_1 and i_2 . [3pts]

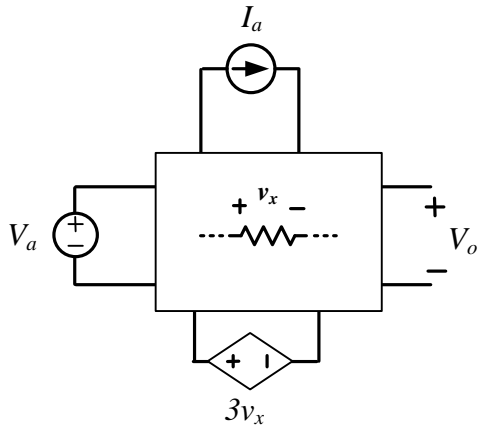
3. [Thevenin & Norton] [8pts]



- (a) Find the Thevenin equivalent of the above circuit seen from the output at DC. [5pts]
- (b) Suppose there are two boxes with two electrical outputs. One has a Thevenin equivalent circuit of the above circuit, and the other has the Norton equivalent. Please describe how you can distinguish Norton and Thevenin between these two boxes. [3pts]



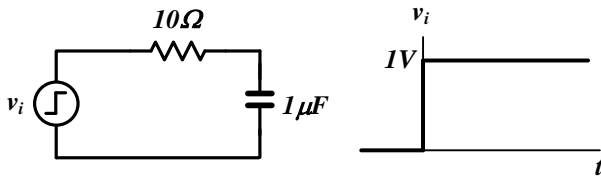
4. Please consider the circuit shown below. The rectangular box consists of resistors, capacitors and inductors only. Note that a dependent source is affected by one of the resistor in the box. [9pts]



- (a) Suppose that $V_o = 0.5\text{V}$ when $(V_a, I_a) = (2\text{V}, 3\text{A})$ and $V_o = 1\text{V}$ when $(V_a, I_a) = (3\text{V}, 4\text{A})$, respectively. What is the value of V_o when $(V_a, I_a) = (1\text{V}, 2\text{A})$? If it is not solvable, explain why. [5pts]
- (b) Suppose the dependent source is changed to $3v_x^2$. Repeat (a). If it is not solvable, explain why. [4pts]

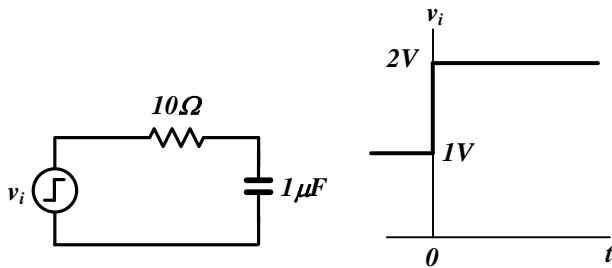
5. Please consider the circuit shown below. Assume that the circuit reaches steady-state when calculating energy. [12pts]

For (a) ~ (c), consider the circuit shown below. Assume that the initial charge in the capacitor is zero.



- (a) What is the energy stored in the capacitor? [2pts]
- (b) What is the energy drawn from the source? [2pts]
- (c) What is the energy absorbed (dissipated) in the resistor? [2pts]

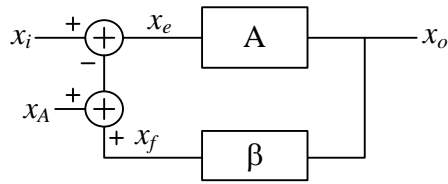
For (d) ~ (e), consider the circuit shown below. Assume that the initial voltage across the capacitor is 1V.



- (d) What is the energy stored in the capacitor? [2pts]
- (e) What is the energy drawn from the source? [2pts]
- (f) What is the energy absorbed (dissipated) in the resistor? [2pts]

6. [Opamp and Feedback] [13pts]

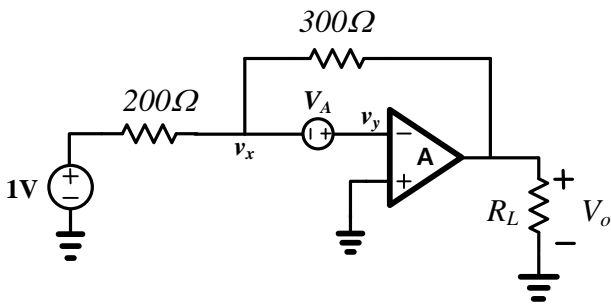
(a) Consider the block diagram below. [3pts]



i. Express x_e in terms of x_i , x_A , A and β . [2pts]

ii. What happens to x_e as A goes to infinity? [1pt]

For (b) ~ (e), consider the circuit shown below. Assume that the opamp is ideal. (i.e. $A = \infty$)



(b) Suppose $V_A=0$ and $R_L = 100\Omega$. What is V_o ? [3pts]

(c) Suppose $V_A \neq 0$ and $R_L = 100\Omega$. [5pts]

i. Which of the following is true? [2pts]

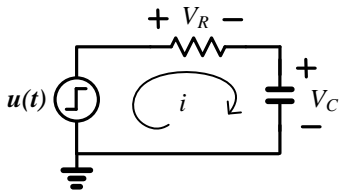
- ① $v_x=0$ ② $v_y=0$ ③ none of the above.

ii. Express V_o in terms of V_A . [3pts]

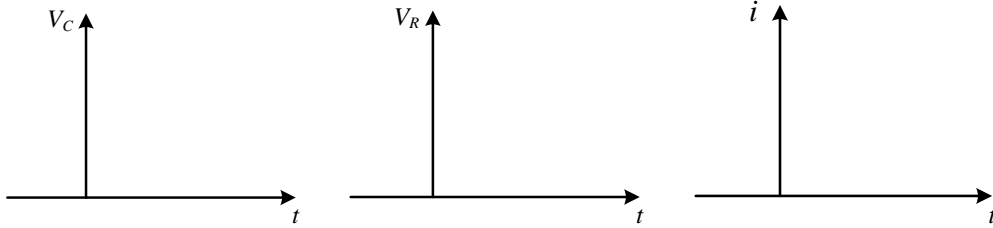
(d) What is the value of R_L that results in maximum power transfer? Assume $V_A = 0$. [2pts]

- ① 200Ω ② 300Ω ③ 120Ω ④ 500Ω ⑤ There is no specific value that results in maximum power transfer.

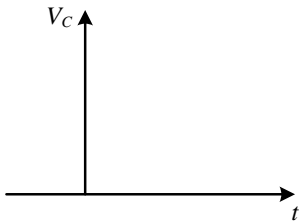
7. [RC Circuit] [16pts]



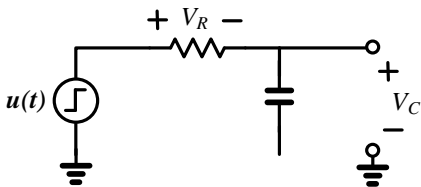
- (a) Draw the voltage V_C , V_R and the current i when step input is applied for the above circuit. Assume that the initial charge in the capacitor is zero. Draw the answer both when $t > 0$ and $t < 0$. [6pts]



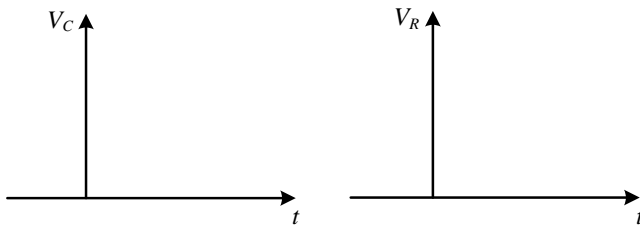
- (b) Suppose the initial charge is $0.5V$. Draw V_C . [2pts]



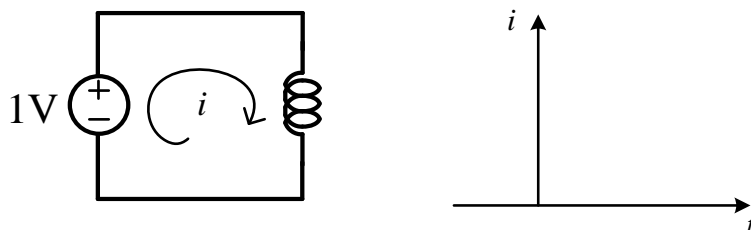
Suppose the circuit is cut and the ground is removed from the capacitor, as shown below.



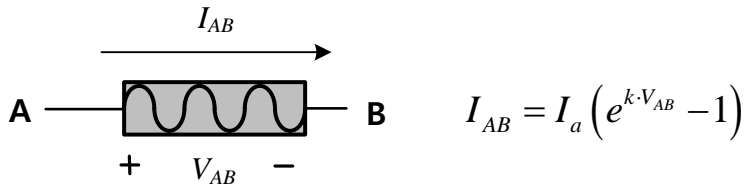
- (c) Repeat (a) for the circuit shown in right. [6pts]



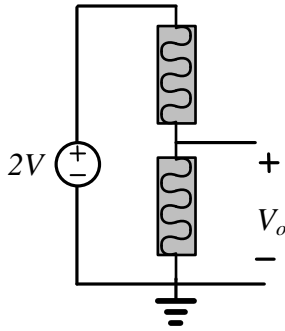
- (d) Draw the output current i in the below figure. Assume that initial current is zero. [2pts]



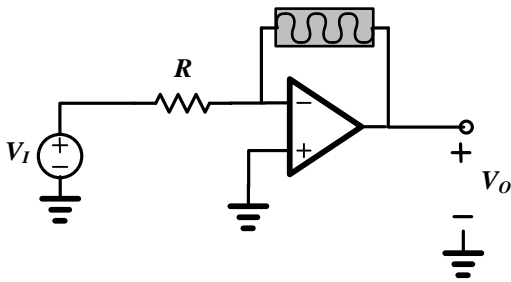
8. Consider the following 2-terminal device which has the following characteristics. [13pts]



- (a) What is the output voltage, V_o , of the below circuit? Assume $I_a=10^{-6}$ (A) and $k=0.5(V^{-1})$ [3pts]



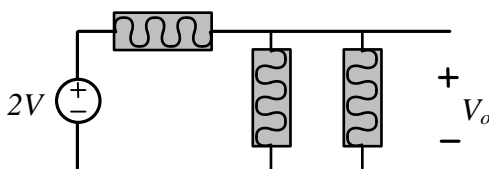
- (b) Analyze the circuit shown below. Assume that the opamp is ideal. [5pts]



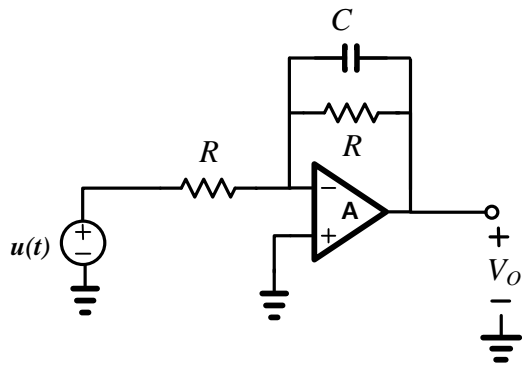
- i. Is the circuit in a positive feedback or negative feedback? If the circuit does not operate properly, please fix the circuit so that it is stable. [1pt]
- ii. Write down the equation for KCL. Express your answer in terms of V_o , V_I , R , k and I_a . [2pts]
- iii. Express V_o in terms of V_I , R , k and I_a . [2pts]

- (c) What is the approximate output voltage, V_o ? In order to calculate the approximate V_o , please assume that

$I_{AB} \cong I_a e^{k \cdot V_{AB}}$. Assume $I_a=10^{-6}$ (A) and $k=0.5(V^{-1})$ [5pts]



9. [RC Circuit] [8pts]



- (a) What is the time-constant of the above circuit? [3pts]
- (b) Draw a circuit that exhibits the same output voltage as the above circuit using a capacitor, a resistor, and a unit-step voltage source. [5pts]



학번(ID): _____ 이름(Name): _____

EE201 Circuit Theory
KAIST, Fall 2013
Prof. SeongHwan Cho

Oct 25, 2013

#1	#2	#3	#4	#5	#6	#7	#8	#9	Total
/12	/9	/8	/9	/12	/13	/16	/13	/8	/100