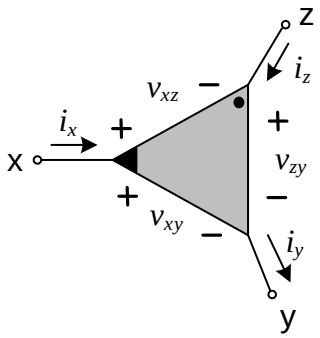
EE201 Circuit Theory
KAIST, Spring 2014

Apr. 22, 2014

학번:_____ 이름:_____

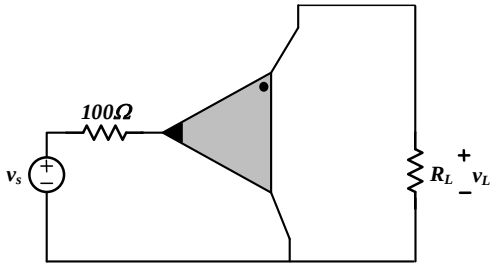
Mid-Term Exam (3 hours)

1. **[Basic Circuit]** Consider the following 3-terminal device which has the following characteristics. [8pts]



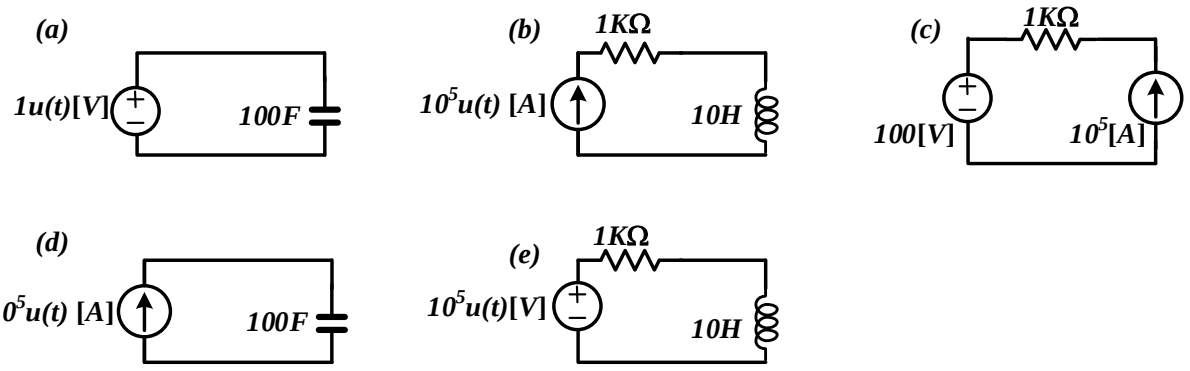
$$i_x = \frac{v_{xy}}{100}$$
$$i_z = 100 i_x$$
$$i_y = i_x + i_z$$

(a) Find v_L/v_s of the below circuit. [4pts]



(b) Draw an equivalent circuit model of the above device using one resistor and one dependent source. Specify the value of resistor and dependent source. [4pts]

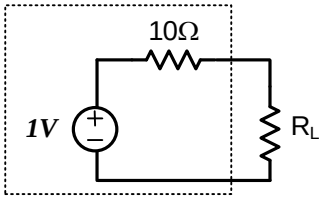
2. Consider the circuits shown below. Which circuits are physically possible without damaging the wire? Assume that wire can handle current up to 10^6A. [5pts]



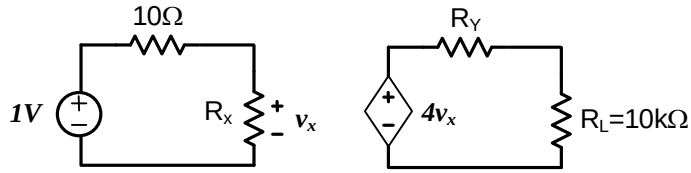
ANS: _____,_____,_____,_____,_____

3. Consider the circuit shown below. [12pts]

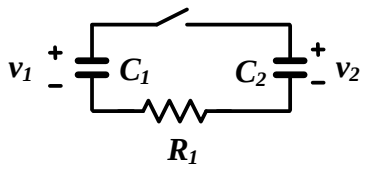
(a) Suppose the supply and the resistor in the dotted box represents a battery. What is the maximum power that can be drawn from this battery and what is the value of R_L for this condition? [2pts]



(b) Find values of R_X and R_Y between 0.1Ω ~ 1MΩ, so that power is delivered to the load is maximum. [4pts]



For (c) and (d), consider the circuit shown below. The switch turns on at t=0. Assume that that C_1 and C_2 have initial voltages of V_i and 0, respectively.

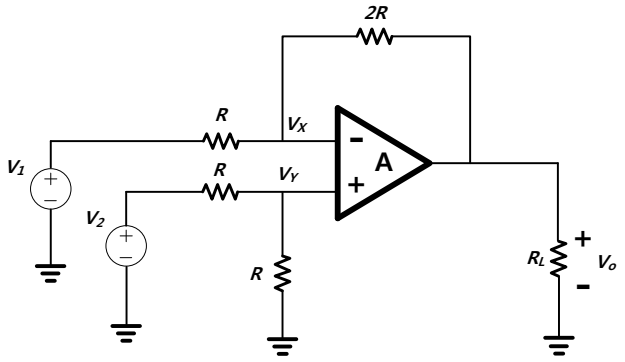


$$v_1(0) = V_i$$
$$v_2(0) = 0$$

(c) What should be the value of C_2 and R_1 such that maximum energy is delivered to C_2 at steady-state? Express your answer using C_1 and/or V_i. [3pts]

(d) Suppose $C_2 = 0.5C_1$ and the switch has a resistance of R_S when it is turned on. What is the energy lost through R_1 and R_S as the circuit reaches steady-state? Express your answer using C_1 and/or V_i. [3pts]

4. For (a)~(c), consider the circuit shown below. [19pts]



(a) Assume that the opamp is ideal. (i.e. A=∞). Express v_O in terms of v_1 and v_2 . [4pts]

(b) Suppose A < ∞. How does the gain $|v_O/v_1|$ change compared to your answer in (a)? [2pts]

(i) Increases (ii) Decreases (iii) Stays the same

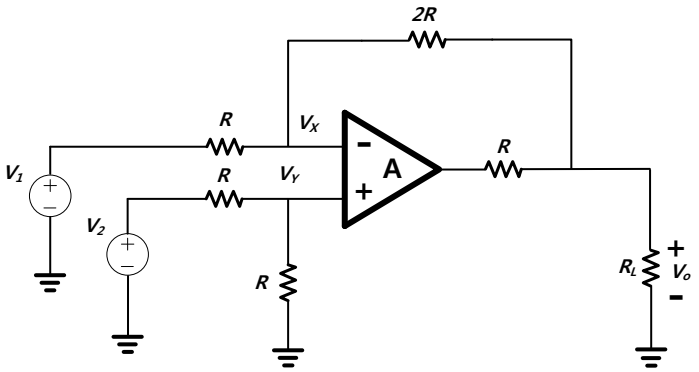
(c) Suppose A < ∞. What is the relation between V_X and V_Y? [2pts]

(i) $V_X = V_Y$ (ii) $V_X \neq V_Y$

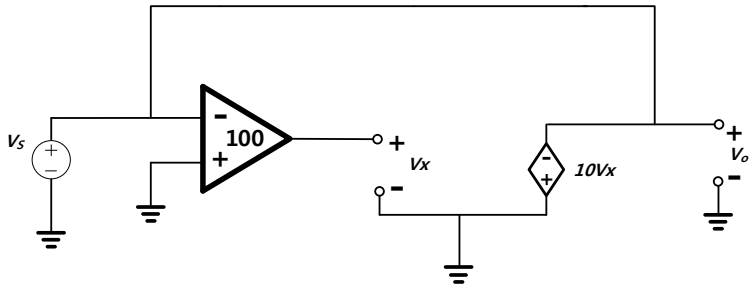
(d) Suppose A = ∞ in the below circuit. How does the gain $|v_O/v_X|$ change compared to your answer in (a) and what is the relation between V_X and V_Y ? [4pts]

- Gain $|v_O/v_X|$: (i) Increases (ii) Decreases (iii) Stays the same

- Relation between V_X and V_Y : (i) $V_X = V_Y$ (ii) $V_X \neq V_Y$



(e) Find the gain, $|v_O/v_S|$ of the below circuit. [3pts]



(f) In this course, we learned a feedback circuit using an opamp that provides a voltage gain of 2. Why don't people just design an open-loop amplifier that has a gain of 2 without using feedback? Please fill in the below. [4pts]

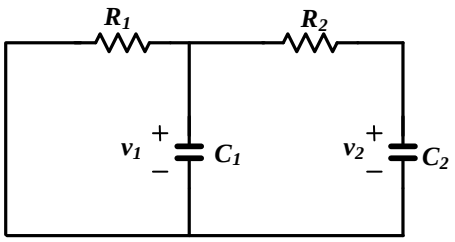
In a feedback circuit, feedback factor(β) is _____than 1 and thus, it can be made _____. The open-loop amplifier in the feedback circuit should have _____.

First blank: (i) smaller (ii) larger

Second blank: (i) very accurately (ii) with low power consumption (iii) with low-cost

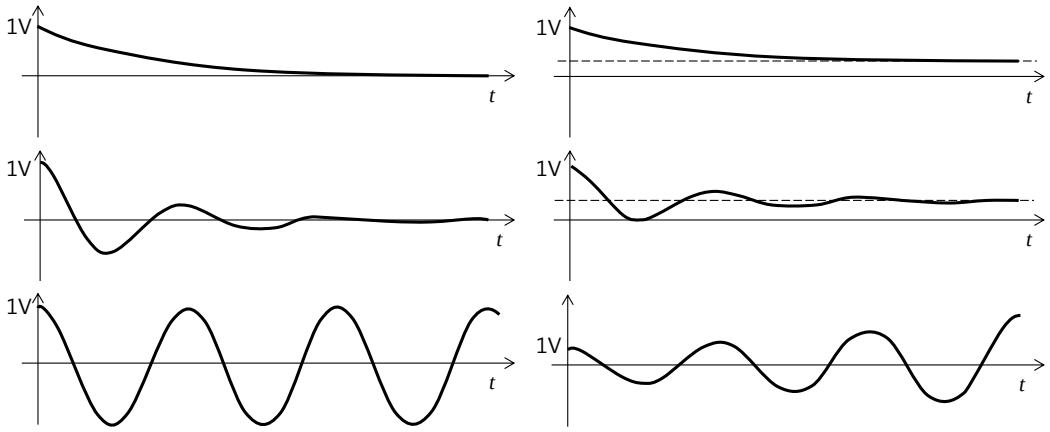
Third blank: (i) large gain and high power consumption.
(ii) large gain and low power consumption.
(iii) small gain and low-power consumption
(iv) small and accurate gain
(v) large gain and can be inaccurate.

5. Consider the circuit shown below [8pts]

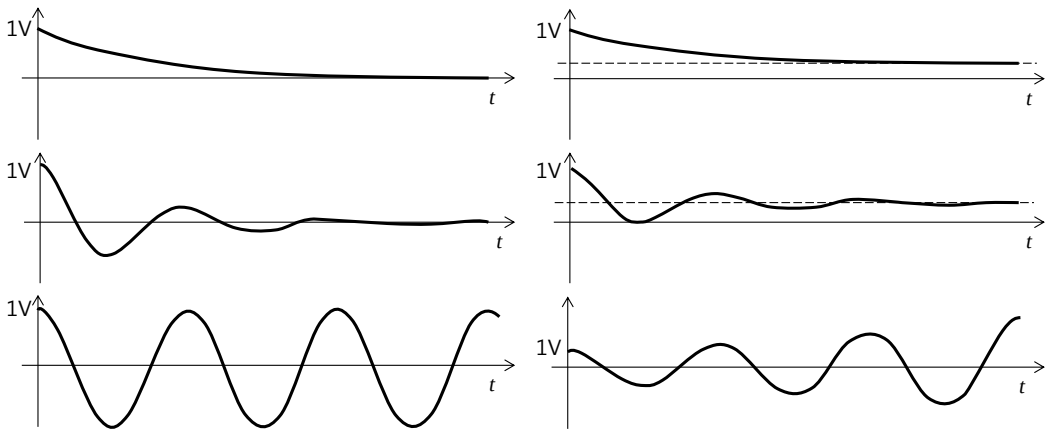


(a) Assume $R_1=R_2=1\Omega$ and $C_1=C_2=1F$. Write down one differential equation for v_1 that describes this circuit. (Do NOT include v_2 in your equation.) [4pts]

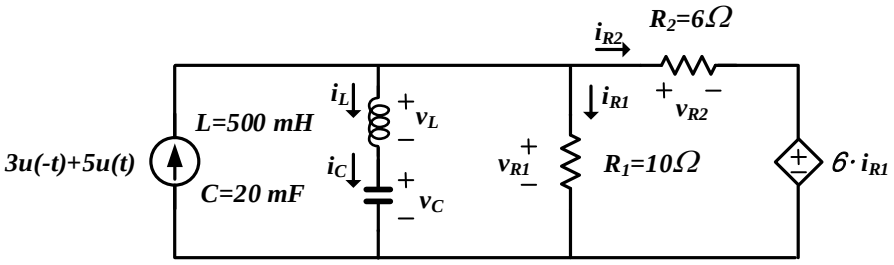
(b) Suppose there is initial voltage of 1V on C_1 and 0V on C_2. Which of the below can be a solution to this circuit?[2pts]



(c) Suppose there is initial voltage of 1V on C_1 and 0V on C_2. Which of the below can be a solution to this circuit if R_1, R_2 and C_1, C_2 can be any positive value. (Choose all that applies.) [2pts]



6. Consider the circuit shown below. [16pts]



(a) Fill in the table below. [8pts]

$v_L(0^-)$	$i_L(0^-)$	$v_{R1}(0^-)$	$v_C(0^-)$
$i_{R1}(0^-)$	$i_C(0^+)$	$i_{R1}(0^+)$	$i_{R2}(0^+)$
$v_C(0^+)$	$v_{R1}(0^+)$	$v_{R2}(0^+)$	$v_L(0^+)$
$\frac{dv_C}{dt}(0^+)$	$\frac{di_L}{dt}(0^+)$	$\frac{di_{R1}}{dt}(0^+)$	$\frac{di_{R2}}{dt}(0^+)$

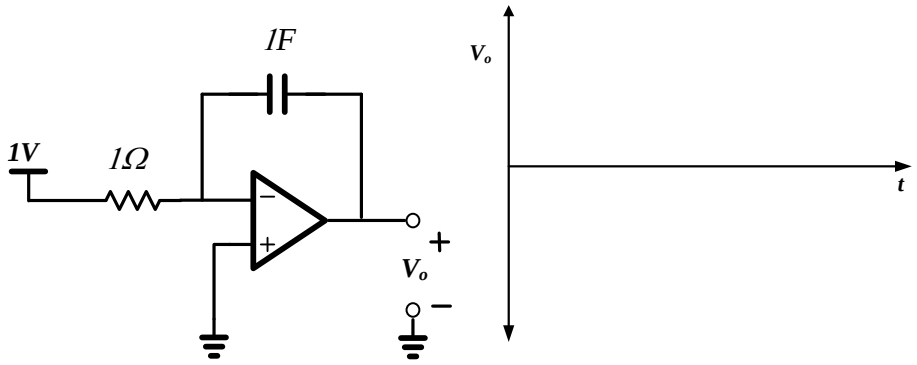
(b) Find $i_L(t)$ for t>0. [6pts]

(c) What kind of response does this circuit have? [2pts]

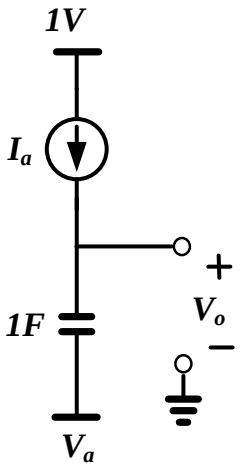
(i) Overdamped (ii) Underdamped (iii) Critically-damped

7. Assume that the opamp is ideal and initial charge of the capacitor is 0. [15pts]

(a) Sketch $V_o(t)$ for $t>0$. [4pts]



(b) Find the values of Va and Ia such that the above two circuits are identical. [4pts]



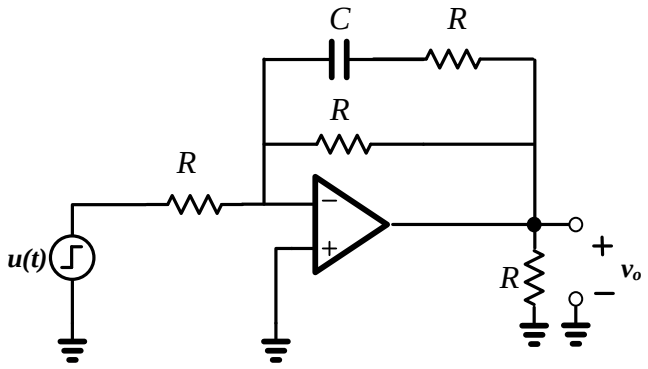
(c) Suppose that the opamp has finite gain of ***G***. Derive an expression of V_O (t) as a function of ***G***. [7pts]

8. Assume that the opamp is ideal and initial charge of the capacitor is 0 [10pts] (Hint: Use 7(b))

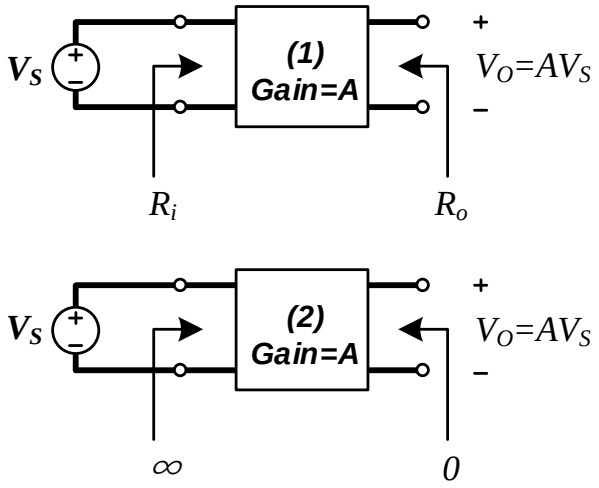
(a) What is the time-constant of the below circuit? [2pts]

(b) Find the values of $v_o(0)$ and $v_o(\infty)$ [4pts]

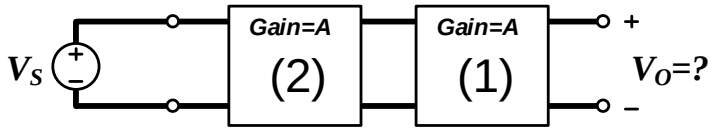
(c) Find an expression for $v_o(t)$. Assume that initial charge on the capacitor is 0. [4pts]

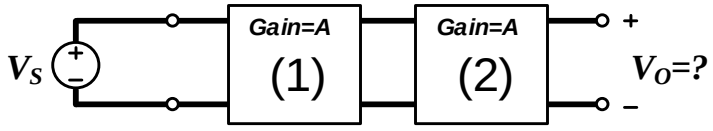


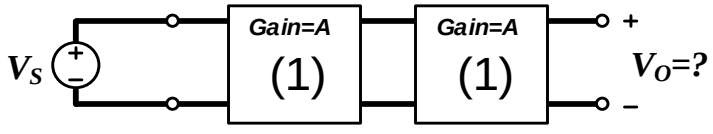
9. Consider the below system which has a voltage gain of A and some input and output resistances. [7pts]



Find the gain of the below cascaded networks. Express your answer using A, R_i and R_O.







학번(ID):_____ 이름(Name):_____

#1	#2	#3	#4	#5	#6	#7	#8	#8	Total
/8	/5	/12	/19	/8	/16	/15	/10	/7	/100