Homework 1

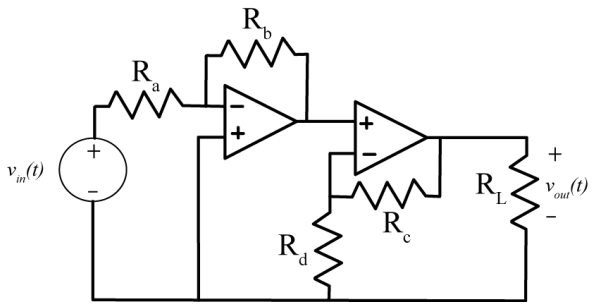
First Order Circuits

Reading: Chapter 1 and 2 of Course Notes

Complete the following problems on engineering paper using the problem solving format and submit the assignment at the beginning of class.

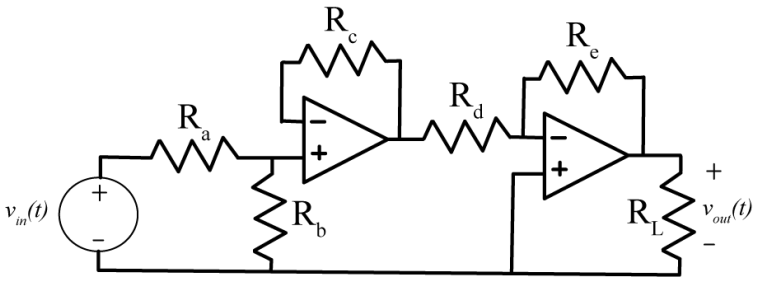
1. Chapter 2, Problem 2.1 from the Course Notes
2. Chapter 2, Problem 2.3 from the Course Notes
3. Assume the following two operational amplifiers are ideal, show that

$$v_{out}(t) = \left(-\frac{R_b}{R_a}\frac{R_c + R_d}{R_d}\right) v_{in}(t)$$

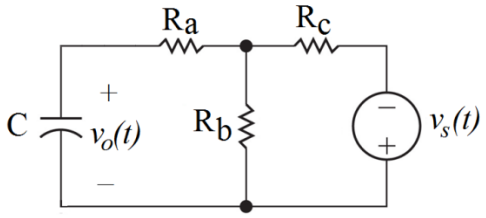


4. Assume the following two operational amplifiers are ideal, show that

$$v_{out}(t) = \left(-\frac{R_e}{R_d}\frac{R_b}{R_a + R_b}\right) v_{in}(t)$$



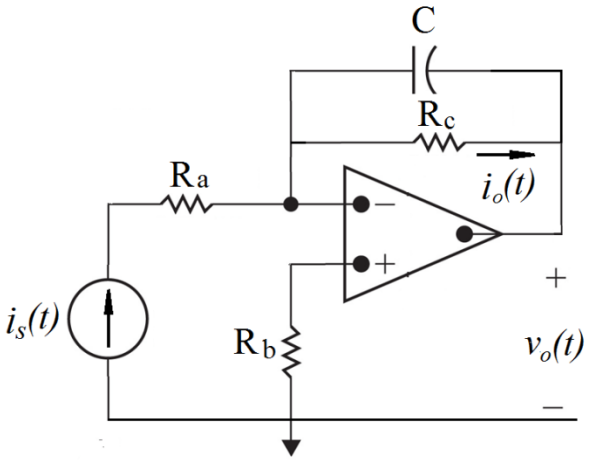
5. For the following circuit, if $v_s(t)$ is the input and $v_o(t)$ is the output,



a. Derive the governing differential equation and write it in standard form.
b. Determine the static gain and time constant from the equation in part (a).
c. Determine the time constant by using the Thevenin equivalent resistance across the capacitor.
d. Determine the static gain by determine the DC voltage across the capacitor.
e. Assume R_a = 8 kΩ, R_b = 160 kΩ, R_c = 40 kΩ and C = 0.25 μF, what is the static gain and the time constant for the circuit?

Scrambled answers: 10 ms, -0.8, 40 kΩ

6. Assume the following operational amplifier is ideal,



a. If the output is $i_o(t)$, derive the governing differential equation and write it in standard form.
b. Determine the static gain and time constant from the equation in part (a).
c. If the output is $v_o(t)$, derive the governing differential equation and write it in standard form.
d. Determine the static gain and time constant from the equation in part (c).
e. Assume C = 500 nF, R_a = 50 kΩ, R_b = 20 kΩ, R_c = 150 kΩ , if the output is $v_o(t)$, what is the static gain and time constant of the circuit?

Scrambled answers: 75 ms, -150k, 1