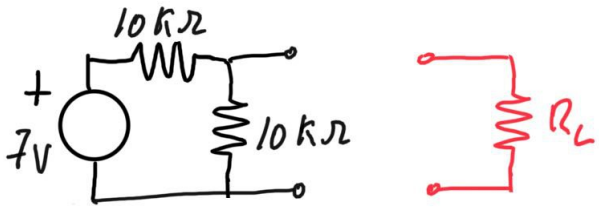
Circuit Theory
Final examination. June 23, 2022

Time limit: 2 hours. Revision day; July 4

Each equation, or group of equations, **must be preceded by a brief explanation** of what you want to do.

1 Problem: (15 %)

Consider the connection of the generator (on the left made of three elements) with the load (on the right).



a) Compute the value of R_L in order to transfer the maximum power from the generator to the load. Use this value in the following questions.

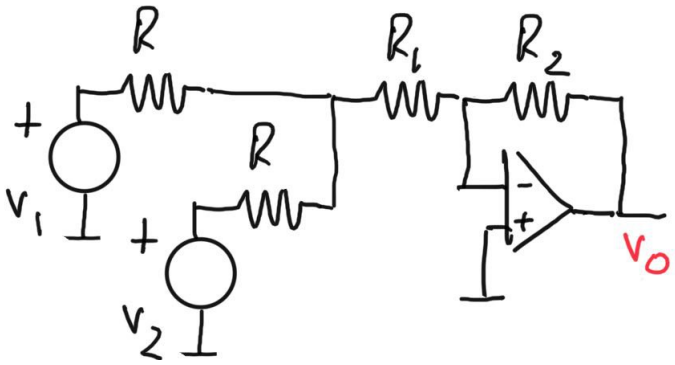
b) Compute the power transferred to the load.

c) Compute the power at each one of the three elements of the generator.

2 Problem (15 %)

a) Determine v_o.

b) Give values to the resistances, in order to have $v_o = -(v_1 + v_2)$.

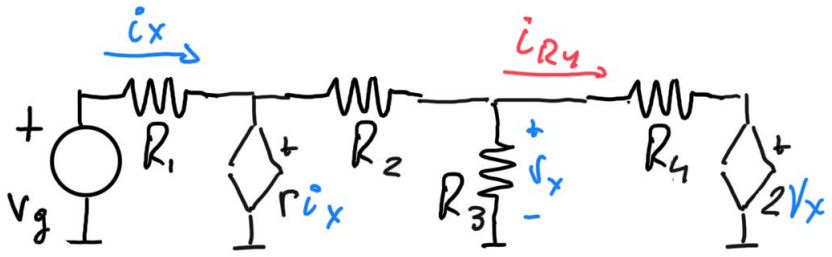


3 Problem: (15 %)

a) First, Use the nodal analysis to determine the voltage v_x.

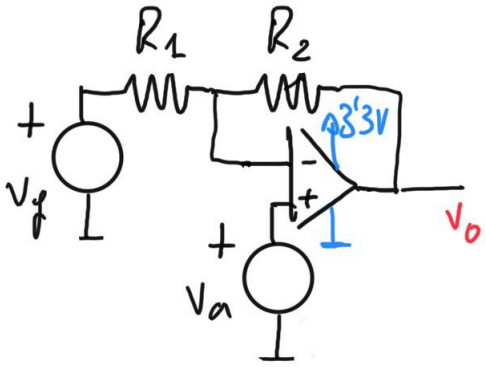
b) Next, determine i_{R_4}.

c) Finally compute i_{R_4} when $v_g = 10\,\text{V}$ ans $R_1 = R_2 = R_3 = R_4 = r = 1\,\text{k}\Omega$.



4 Problem: (15 %)

Use the following circuit as a *signal conditioner* to condition an audio signal v_g that takes values from $-0.5\,\text{V}$ to $+0.5\,\text{V}$. The goal is that $v_o = +3v_g + 1.65$ or $v_o = -3v_g + 1.65$. Note that the OA is powered at $3.3\,\text{V}$ and $0\,\text{V}$.



a) First, give values to R_1, R_2 and V_a. If $v_g = 0.5 * cos(2\pi 10t)$, draw the output v_o.

b) Next, consider the use of the power source of the OA (of $3.3\,\text{V}$) to avoid the use of v_a.

5 Problem: (20 %)

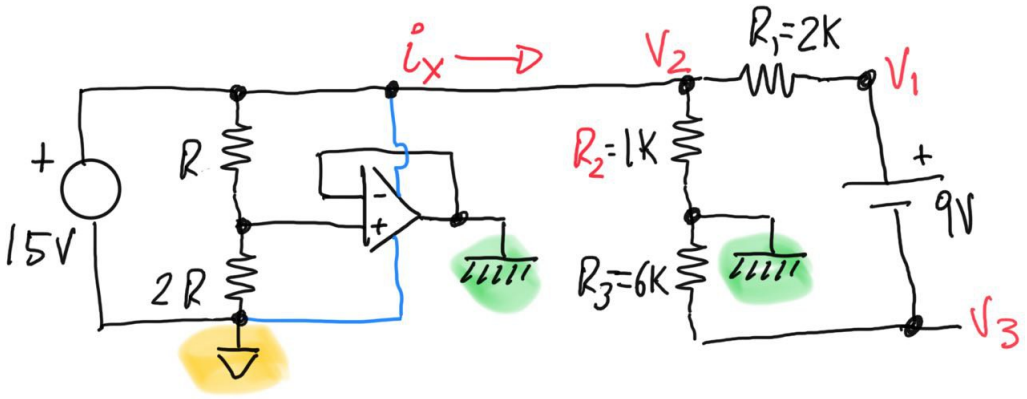
a) Compute the voltage at v_1, v_2 and v_3 with respect to the reference in yellow.

b) Compute the voltage at v_1, v_2 and v_3 with respect to the reference in green.

c) Compute the currents through R_1, R_2 and R_3. Draw the direction in the circuit.

d) Compute i_x.

e) Give a value to R_2 in order to have $i_x = 0$.



6 Problem: (20 %)

a) Draw $v_o(t)$, between $t = 0$ and $t = 3\,\text{ms}$, considering $R_1 = 1.5\,\text{k}\Omega$, $R_2 = 3\,\text{k}\Omega$, $C_1 = 1.5\,\mu\text{F}$ and $C_2 = 3\,\mu\text{F}$. Compute $v_o(t)$ at $t = 0$, $t = 1\,\text{ms}$, $t = 2\,\text{ms}$ and $t = 3\,\text{ms}$.

b) Calculate the total energy stored by both capacitors at the instant when this energy is at its maximum.

c) Compute when the LED will be turned ON and OFF.