CENG4480 Homework 1

Due: Oct. 28, 2019

Q1 (10%) Given a circuit as shown in Figure 1, input $V_I = 1V$, the resistors $R_1 = R_2 = 10k\Omega$, the variable resistor $R_p = 20k\Omega$.

1. when the sliding of the variable resistor is connected to A, calculate V_O.
2. when the sliding of the variable resistor is connected to B, calculate V_O.
3. when the sliding of the variable resistor is connected to C (midpoint), calculate V_O.

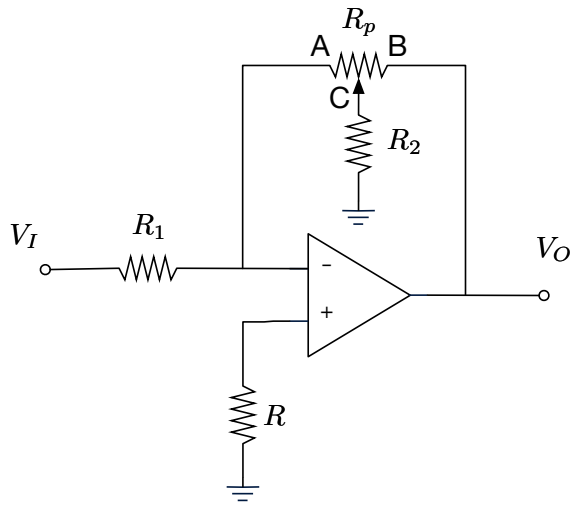

Figure 1: Q1 circuit

Q2 (10%) Given a differential circuit as shown in Figure 2, determine the mathematical relationship among V_O, V_{I1} and V_{I2}.

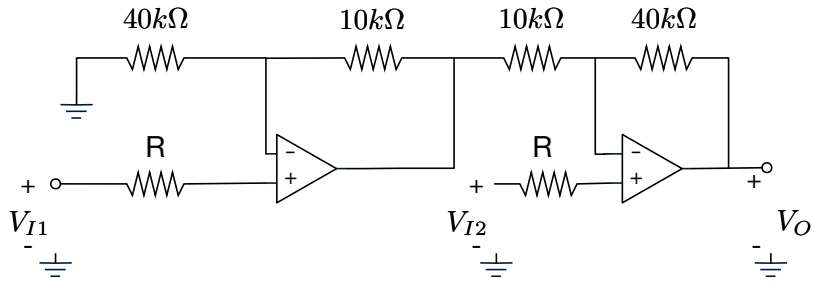

Figure 2: Q2 circuit

Q3 (10%) Given the inverting amplifier as shown in Figure 3, its supply voltage is $\pm 15V$.

1. Compute and sketch transmission curve between u_i and u_o.

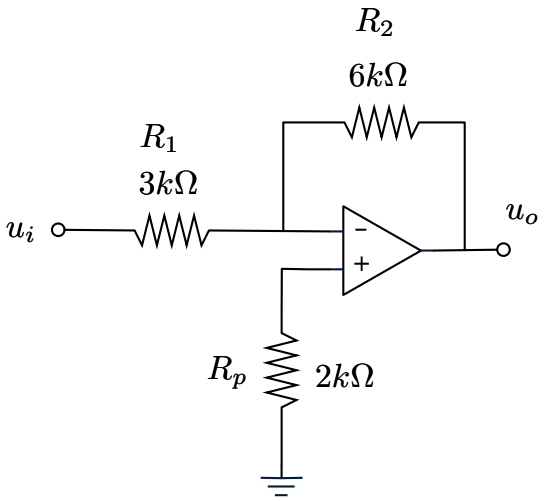

Figure 3: Inverting Amplifier.

2. The input signal is given to be $u_i = 5sin\omega t(V)$, sketch the waveform of u_o.

Q4 (15%) A differential integrator is shown in Figure 4.

1. Determine the relationship among u_{i1}, u_{i2} and u_o.
2. If we want $u_o = 0V$ when $u_{i2} = 1V$, determine u_{i1}
3. When $t = 0$, $u_{i2} = 1V$, $u_{i1} = 0V$, $u_o = 0V$, determine u_o when $t = 10s$.

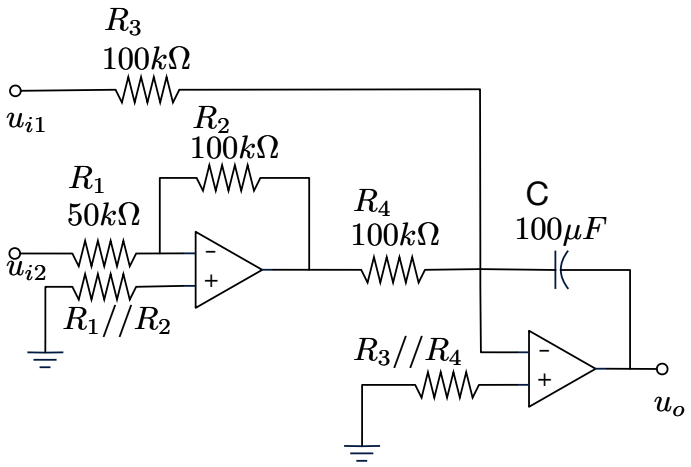

Figure 4: A differential integrator.

Q5 (20%) Given a low-pass filter as shown in Figure 5.

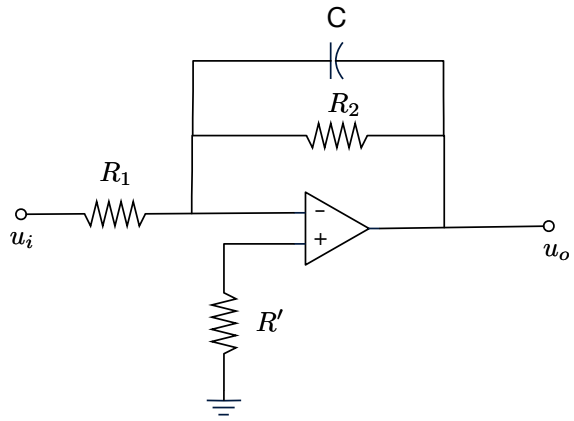

Figure 5: A low-pass filter.

1. If $R_1 = 10K\Omega$, $R_2 = 100K\Omega$, determine low-frequency gain $A_u(dB)$;
2. If cutoff frequency $f_c = 5Hz$, determine C value.

Q6 (10%) Determine the output voltage (i.e. the mathematical expression of $u_o(t)$) for the differentiator circuit of Figure 6 if the input is a triangular wave of amplitude $\pm 0.2V$ and frequency $1Kz$. Assume $C = 0.1\mu F$, $R_1 = 200\Omega$, $R_2 = 10k\Omega$, $R_3 = 1\Omega$, $R_p = 1k\Omega$ and ideal op-amp. The triangular wave starts at $t = 0$ and therefore $u_o(0) = 0$.

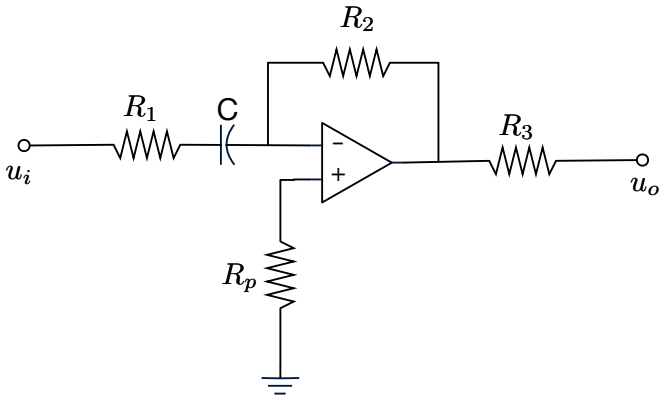

Figure 6: A differentiator circuit.

Q7 (10%) An ADC is used to sample an analog signal.

1. If the maximum frequency of the analog signal is $10kHz$, determine the minimum sampling frequency.
2. As shown in Figure 7, if the ADC is integrating ADC with 10 bits and clock frequency is $1MHz$, determine the maximum conversion frequency.

Q8 (10%) Let us consider the Schmitt Trigger shown in Figure 8.

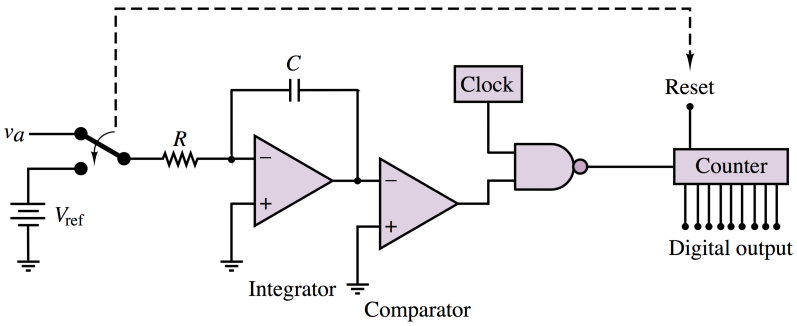

Figure 7: Integrating ADC.

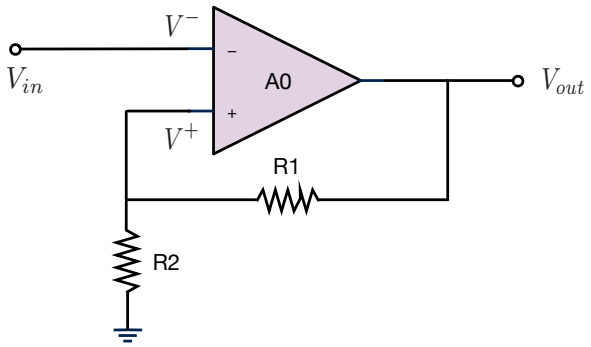

Figure 8: Schmitt Trigger.

1. Due to the manufacturing defects, a parasitic resister R_3 occurs between the output node and ground, calculate the reference voltages.
2. If the parasitic device is a capacitor C, sketch v_{out} versus v_{in}. Label the key coordinates on the curve.