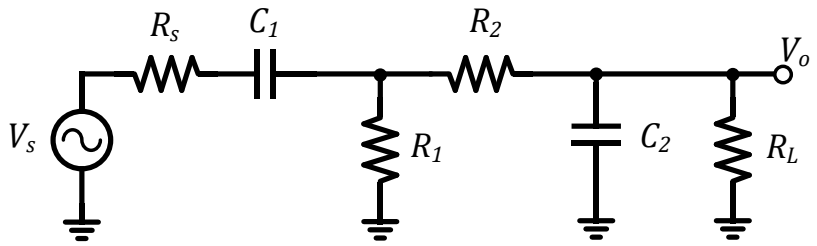
EE 538 Spring 2020
Analog Circuits for Sensor Systems
University of Washington Electrical & Computer Engineering

Instructor: Jason Silver
Homework #1 (40 points)
Due Wednesday, April 8, Submit on Canvas

Please show your work.

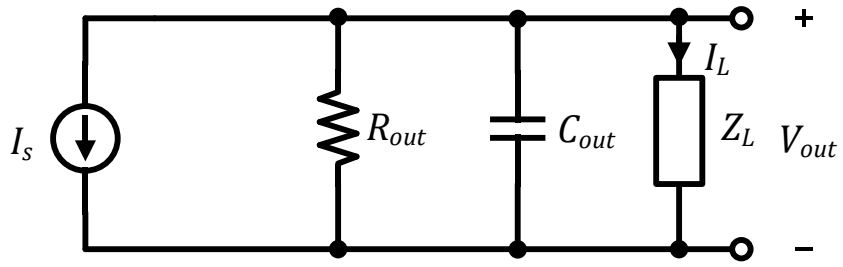
Problem 1: Circuit loading, filtering



Design the bandpass RC filter to achieve >20dB attenuation at 1MHz and less than 0.1dB attenuation from 1 Hz to 10 kHz.

a) First, ignoring loading effects, determine 3dB frequencies ($f_{3dB,HP}$ and $f_{3db,LP}$) that meet the specifications.
b) With R_s = 100Ω and R_L = 10MΩ, choose R_1, R_2, C_1, and C_2 to minimize loading effects.
c) Simulate the frequency response (V_o/V_s) in Ltspice and plot it together with the ideal response in MATLAB/Python.

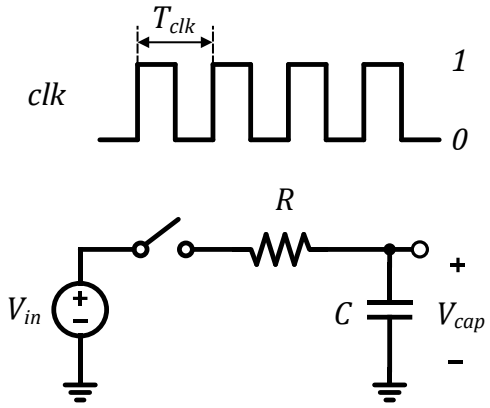
Problem 2: Current sources, frequency response, loading



Use the circuit and variables (no values) for the following.

a) Sketch the frequency response (magnitude and phase) V_{out}/I_s *for* $Z_L \to \infty$.
b) Sketch the frequency response (magnitude and phase) V_{out}/I_s together with the unloaded response (part a) for the two conditions
    1. $Z_L = C_L$
    2. $Z_L = R_L$
c) Sketch the transient response of V_{out} for I_s as a current step from 0 to I_{max} ($Z_L \to \infty$).

Problem 3: Sampling, settling, power dissipation



The clock waveform shown above is used to drive the switch open and closed ($clk = 1 \rightarrow$ switch closed, $clk = 0 \rightarrow$ switch open). T_{clk} is the clock period (50% duty cycle), where $T_{clk} = 1/f_{clk}$. V_{in} = 1V, R = 100 Ω, and C = 10 pF

a) What is the maximum clock frequency, f_{clk}, that allows 0.1% settling precision of V_{cap} each period?
b) Given this clock frequency, what is the average current delivered to the capacitor?
c) Verify your answers to a) and b) using Ltspice. To do this using a DC source fo V_{in}, you need to use an initial condition (0V) on V_{cap}. Include any relevant plots in your submission.
d) Perform an AC simulation on the circuit in Ltspice (switch closed). Relate the frequency response to the settling time and include any relevant plots.