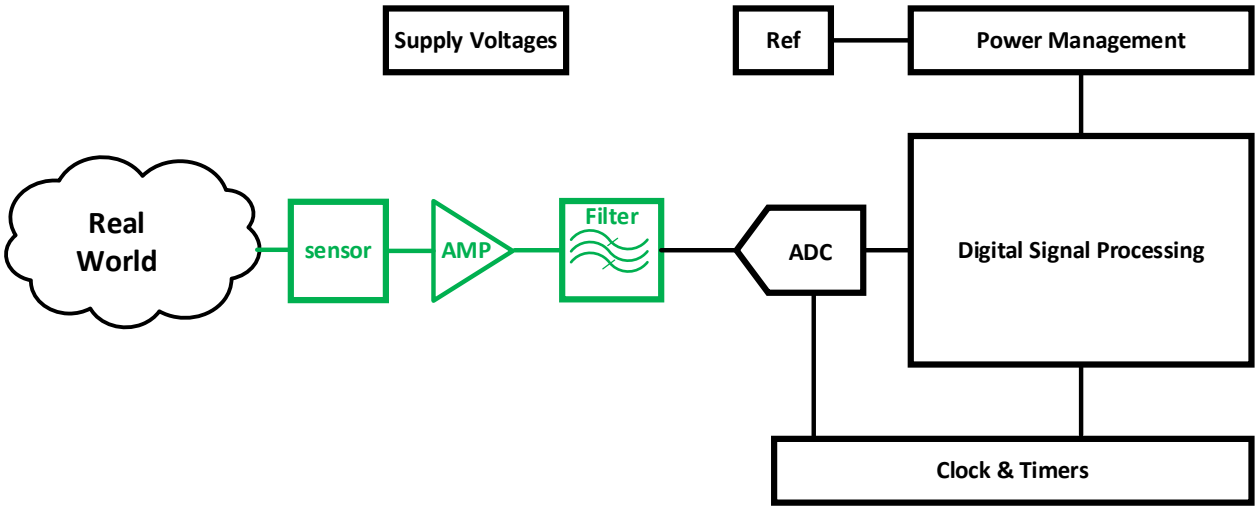
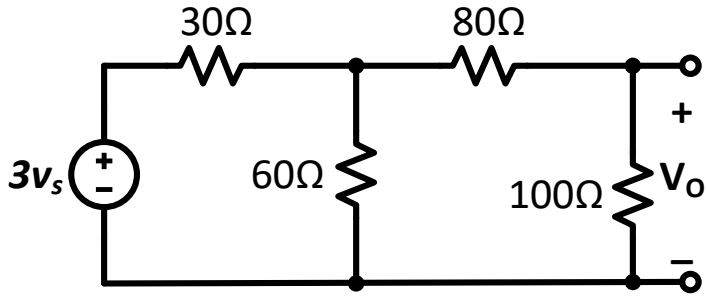
Spring 2024 – ECE 3020
Homework 6

Due: 02/21/2024

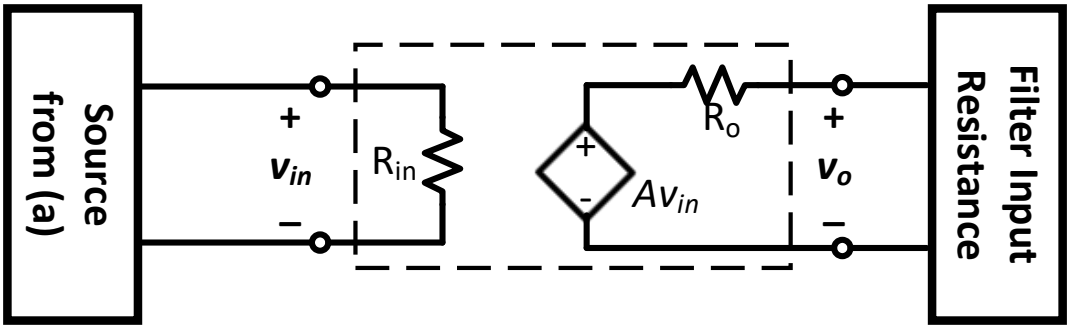
1. An electronics design engineer is tasked with building the analog front end (highlighted green) of an ECG system shown below:



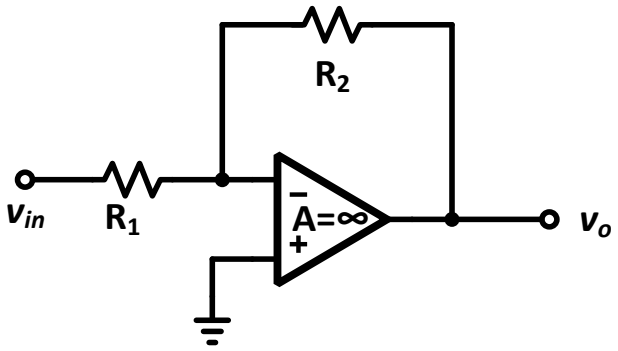
a. If the sensor interface looks the circuits below, convert it into a Thevenin source.



b. Use the Thevenin source derived in a), to source the voltage amplifier model below. Assuming the filter has an input resistance of R_L (10kΩ), what is the expression for the amplifier gain (v_o/v_s)? What should R_{in} and R_o be for maximum gain?



c. Now replace the amplifier model with an inverting op-amp based amplifier. Choose the resistor ratios to obtain a nominal gain of -10V/V. If the loss from the Thevenin source to the inverting amplifier is to be 1%, what should the value of R_1 be?



d. If the op-amp has an input offset of 3mV, Calculate the output offset.

e. Now, consider the op-amp having finite gain and bandwidth such that $A = A_0/(1+s/w_p)$. If $A_0 = 1000$V/V and $w_p = 2\pi * f_p$ where $f_p = 435.2$ Hz. What is the new closed-loop gain and bandwidth?

f. Plot the open-loop and closed-loop gains from (e) using Bode plots. Annotate the DC gains, corner frequencies and unity gain frequencies of the open and closed loop gains?

g. What is the maximum usable frequency of the analog front-end?