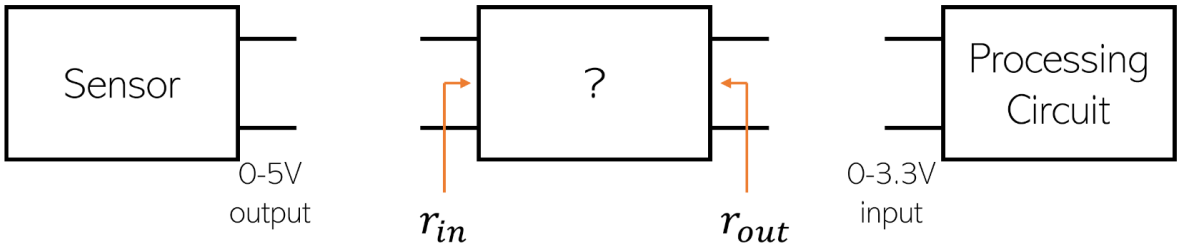
Transducer and Instrumentation – Assignment 03

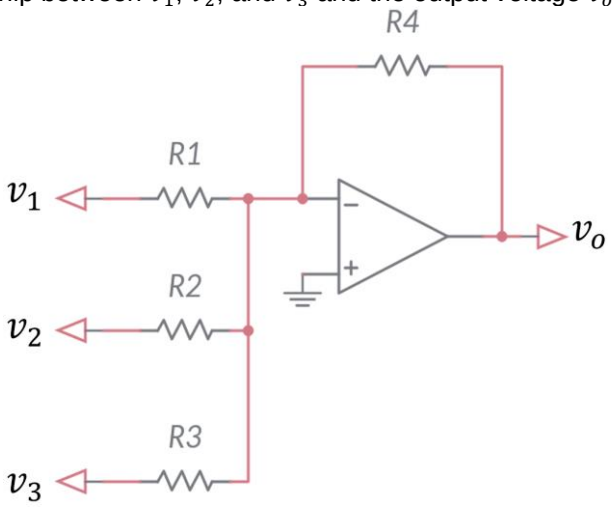
1) A particular sensor gives you output from 0 to 5V for a given range of values of the measurand. The output of this sensor is to be connected to another circuit (Processing Circuit in the figure below) which can strictly take inputs only in the range 0 to 3.3V. You need to attenuate your sensor output from 0-5V to a range 0-3.3V. Come up with a circuit for the box with '?' shown below such that this circuit has high input impedance and low output impedance.



Hint: Voltage divider, voltage follower

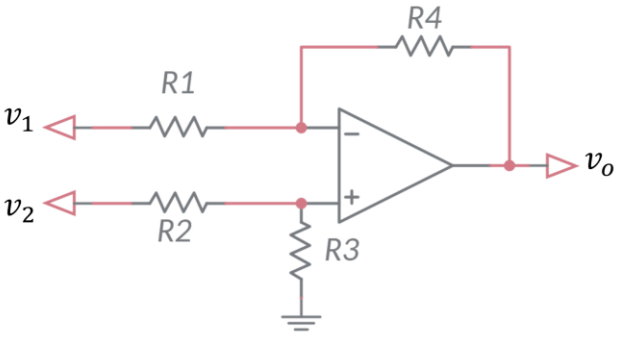
2) Consider the following op-amp circuits. Assuming an ideal op-amp, derive the relationship between the input and the output for the following circuits.

(a) Find the relationship between v_1, v_2, and v_3 and the output voltage v_o.



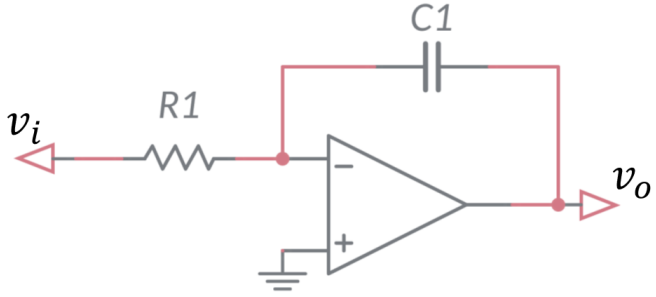
What is the input resistance seen by each input v_1, v_2, and v_3?
What is the output resistance of this circuit?

(b) Find the relationship between v_1, and v_2 and the output voltage v_o.

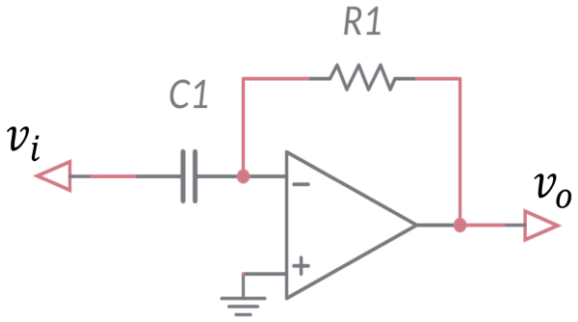


What is the input resistance seen by each input v_1 and v_2?
What is the output resistance of this circuit?

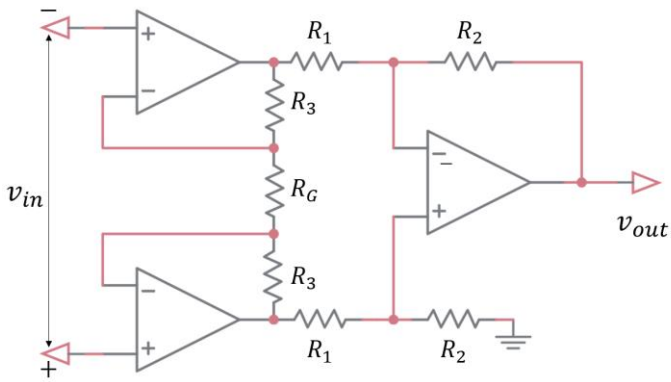
(c) Find the relationship between the input v_i and output v_o.



(d) Find the relationship between the input v_i and output v_o.

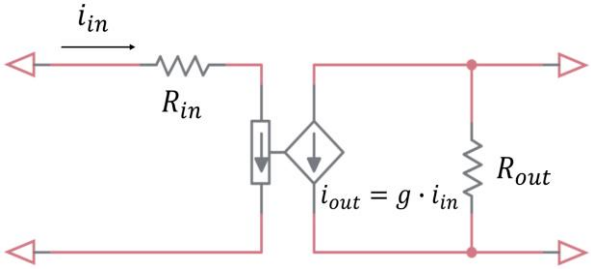


3) Derive the differential gain of the three op-amp instrumentation amplifier.



$$v_{out} = \left(1 + 2\frac{R_3}{R_G}\right)\left(\frac{R_2}{R_1}\right)v_{in}$$

4) Voltage amplifiers are two-port systems whose output voltage is proportional to the input voltage. An ideal voltage amplifier must have infinite input impedance and zero output impedance to prevent any loading at the input and output ports. A current amplifier is a two-port system whose current flowing between its output terminals is proportional to current flowing through its input terminals. The equivalent circuit for a real current amplifier is shown below.



What should be the input and output impedance of a current amplifier to avoid loading at its input and output ports? Draw the equivalent circuit for a real current amplifier and explain your answer.