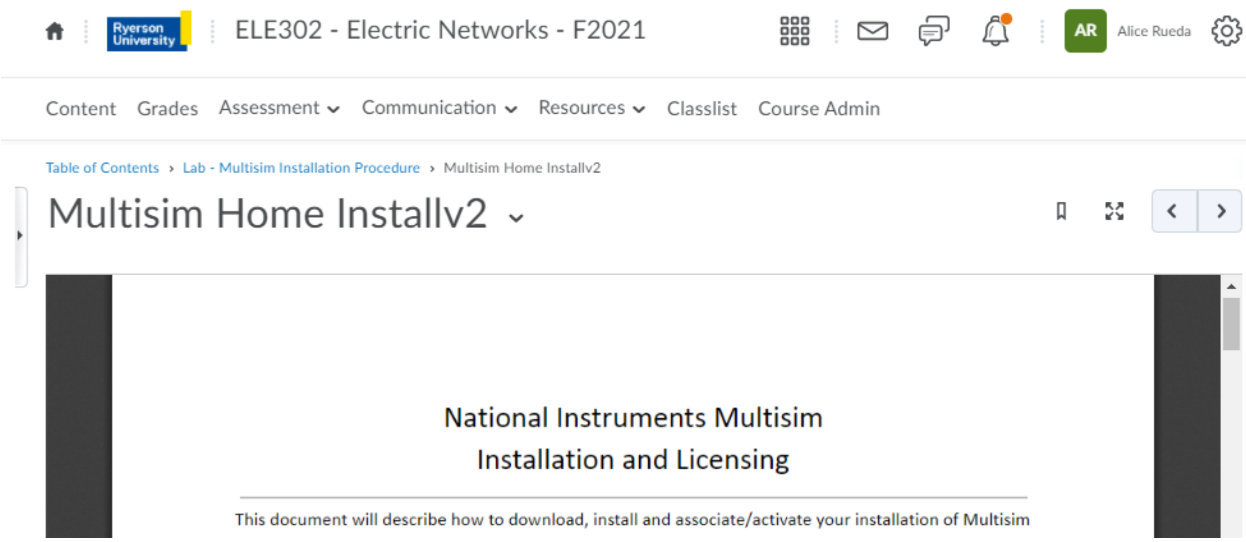
Simulation Tool

Due to Covid, ELE 302 lab will be online using Multisim. If you have not already done so, please follow the instructions on D2L to install multisim.



If you have encountered any problems besides IPv6, please contact Mr. Jason Naughton directly (jnaughto@ryerson.ca).

Regarding to the Labs

<u>Mark Allocation</u>

There are three parts for each lab. They are Pre-lab, Lab, and Post-lab (Q&A at the back). Each part is allocated with:

- Pre-lab: 3/10
- Lab: 5/10 (Individual demonstrations required)
- Post-lab (Q&A): 2/10

<u>Lab Guidelines</u>

- Sign the attendance sheet
- Experiments conducted in your assigned section will be graded
- Fall 2021: Students will work individually
- Hand-in your work by the end of the lab INDIVIDUALLY
- Post-Lab (Q&A) is to be handed in the following week to your TA INDIVIDUALLY

Experiment #1

In this lab, you will study the differences between open-loop voltage gain of the non-ideal Op-Amp and closed-loop voltage gain of inverting and non-inverting amplifier circuits. This lab content is covered in Chapter 5 Operational Amplifiers.

IMPORTANT:
- Please make sure that your simulation environment has the Maximum time step (TMAX)" to 10e-5 **for all labs**. So, we all use the same sampling.
- Always use nodal analysis for Op-Amp circuits.

Prelab Tips

Step 2 (a). Finding the $A_V=V_O/V_I$, R_I and R_O of the amplifier circuit
Hints: Use $1V_P$ as your voltage source $v_I(t)$.
- Use nodal analysis to find the current going into the circuit, i(t)
- $R_I = v_I(t)/i(t)$
- The nodal analysis will also give you V_O. Use V_O to calculate your A_V
- To find Ro, you need to apply Thevenin's Theorem from Chapter 4 to find R_O
  - Add 1V voltage source to the output
  - Zero out independent source
  - Calculate the current from the 1V voltage source (I_{TH}), $R_O=R_{TH}= 1V/I_{TH}$~0.09 Ω (something every small.)

Lab Session 1

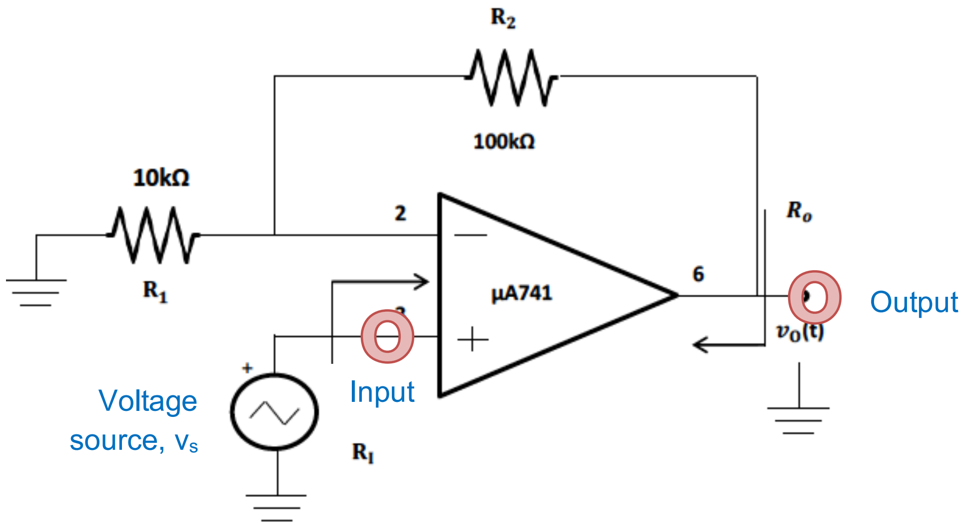
The first part of the lab covers open-loop voltage gain and the non-inverting amplifier.

Open-loop voltage gain

Given open-loop voltage $A=0.5x10^6$, v_+ is the voltage at the positive pin, and v_- is the voltage at the negative pin

$$v_o = Av_d(v_+ - v_-)$$

Non-inverting amplifier



Using nodal analysis at node 2:

$$v_o = \left(1 + \frac{R_2}{R_1}\right) v_I$$

To measure R_O, you need to measure v_{O_NL} and v_{O_L}.

- v_{O_NL}: As it is, open circuit at the output pin
- v_{O_L}: Add a load resistor at the output pin (6), then measure the voltage

Then, use equation given in step 6 to calculate R_O.

To measure R_I, you need to add a resistor (2MΩ) between the voltage source (v_S) and the input (v_I). Use equation given in step 7 to calculate R_I.