Electrical Circuits LAB #6 – Operational Amplifier

Objectives

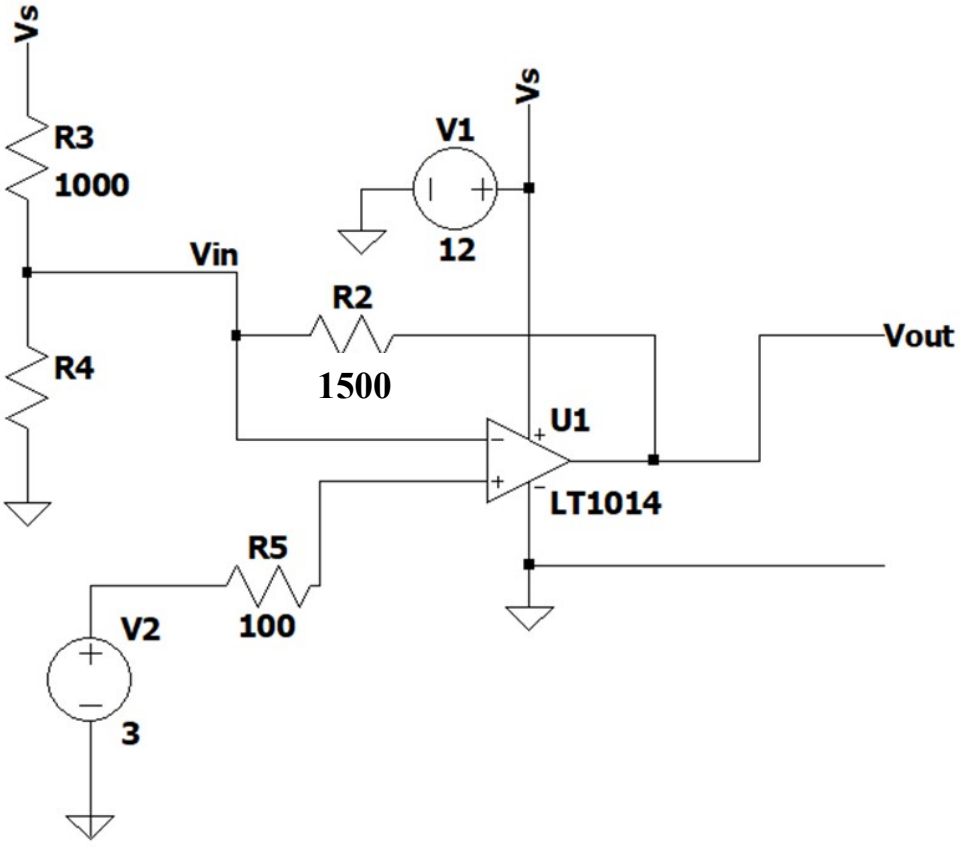
Understand and use Operational Amplifier (OpAmp) to design and analyze a voltage level detector.

Preparation

Complete the following steps before starting to work on the experiments in this lab:

1) Complete Lab 5 and associated report.
2) Read textbook, watch lecture videos, and complete homework in Chapter 5 "Operational Amplifier".
3) Watch this video covering DC Sweep simulation at https://youtu.be/9o3Bc9mwz00

Experiment 1



a) Use the ideal Op Amp model to derive Vout equation in terms of R_4 for the above circuit. Use the equation to create a table of Vout and R_4 as resistor value changes from 100 Ω to 1000 Ω by 100Ω increments.

b) Use the DC model of LT1014 Op Amp to derive Vout equation in terms of R_4 for the above circuit. Uses the equation to create a table of Vout and R_4 as resistor value changes from 100 Ω to 1000 Ω by 100Ω increments.

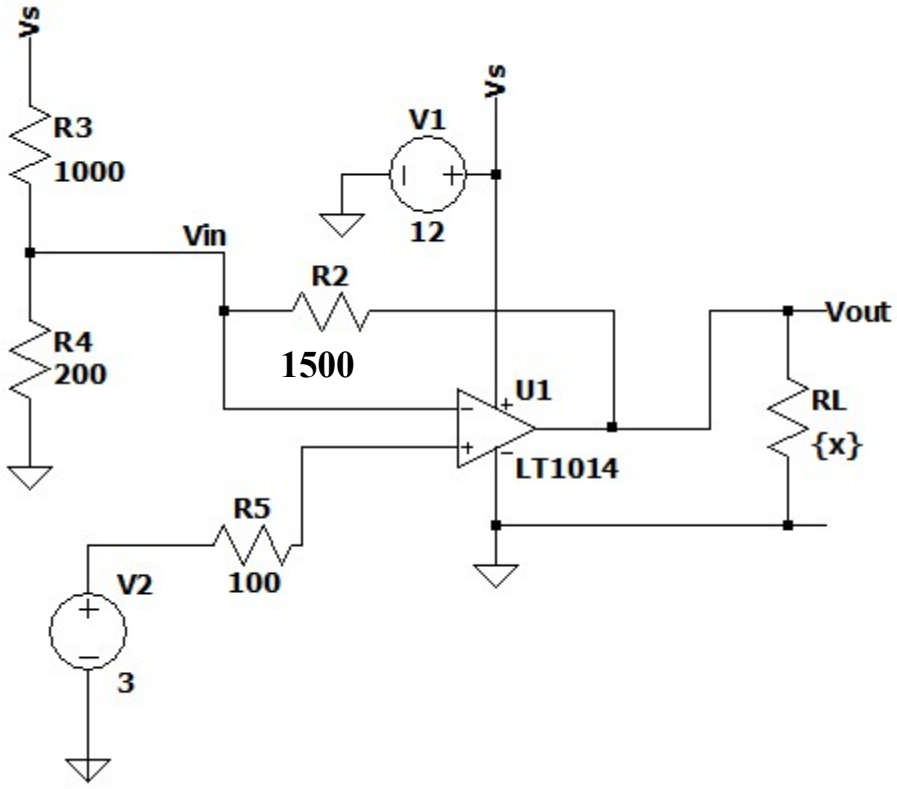
Hint: $R_o = 50\ \Omega$, $R_i = 300\ M\Omega$, $A = 10^6$

c) Use LTspice and LT1014 Op Amp device to create a table of Vout and R_4 as resistor value changes from 100 Ω to 1000 Ω by 100Ω increments.
Hint: use .STEP directive

d) Identify values of R4 that result in differences between the Vout values from part a-c exceeding 1%. For these cases, explain the reason for the differences.

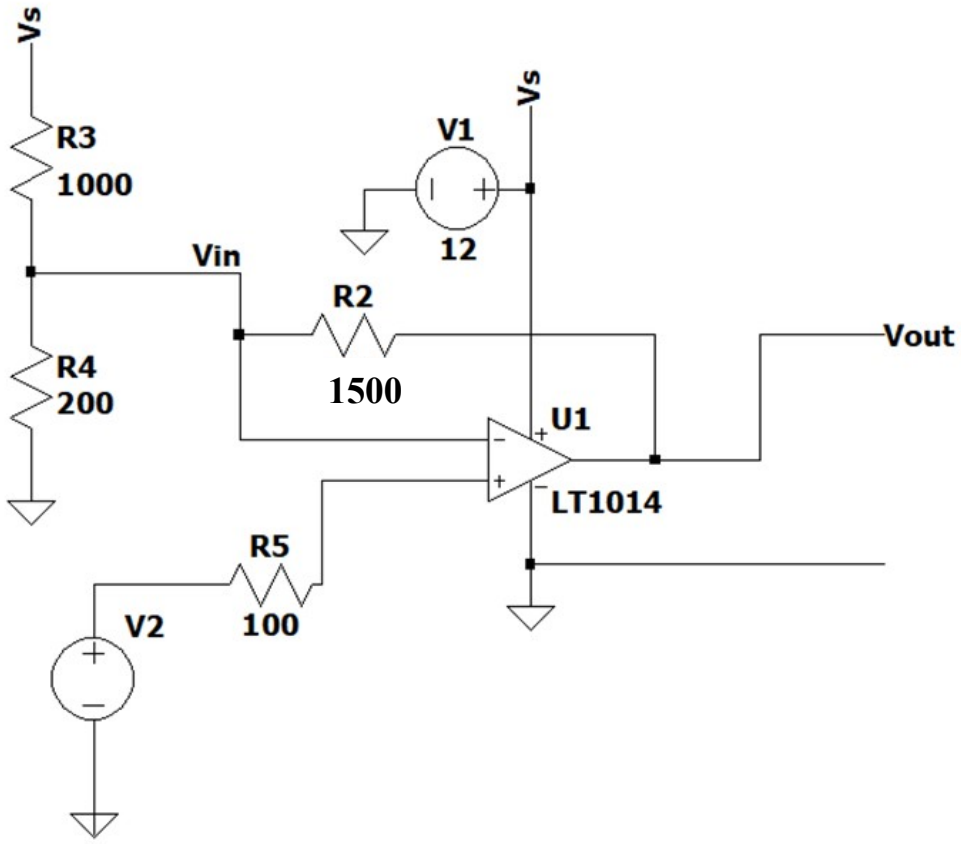
Experiment 2

One of the advantages of Op Amps is that it has low output resistance (typically less than 100 Ω) which means that output is not as sensitive to R_L as a typical resistive network such as a voltage divider. Use LTspice to support the previous statement by graphing the Vout as R_L changes from 1 KΩ to 1 MΩ in the following circuit.



Experiment 3

For the following circuit, use LTspice DC Sweep Simulation to vary the value of V2 from 0 to 12 V in 0.1 increment to generate Vout vs. V2 graph. Explain changes in value of Vout in the graph based on your understanding of Op Amp operation.



Report Requirements

This lab and associated report must be completed individually. All reports must be computer printed (Formulas and Diagrams may be hand drawn) and at minimum:

For each experiment include:

- Clear problem statement in your words.
- Answer to any specific experiment questions (if any)
- Identify the theory or process and associated calculations
- Documents resulting circuit schematics from LTspice, simulation output and additional tables, timing diagram or chart required by the experiment.

For the whole report include:

- A Cover page with your name, class, lab and completion date.
- A Lessons Learned section which summarizes your learning from this lab in 5 sentences or more.
- A New Experiment section that has description of a new experiment and the experiment's results. Experiment should be related to material covered in class but not simply variation of the existing lab experiments.