

**MISR UNIVERSITY FOR SCIENCE AND TECHNOLOGY**  
**COLLEGE OF ENGINEERING**  
**MECHATRONICS DEPARTMENT**



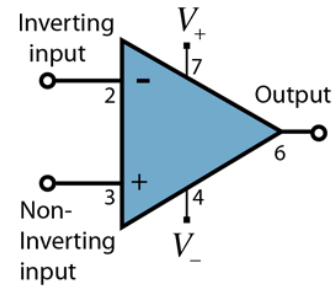
# **MTE 405 SENSORS AND MEASUREMENTS**

**LAB 1 – SPRING 2020**

## Lab 1

# Goals Of The Lab

Introduction to Sensors and Signal Conditioning with Virtual Prototyping



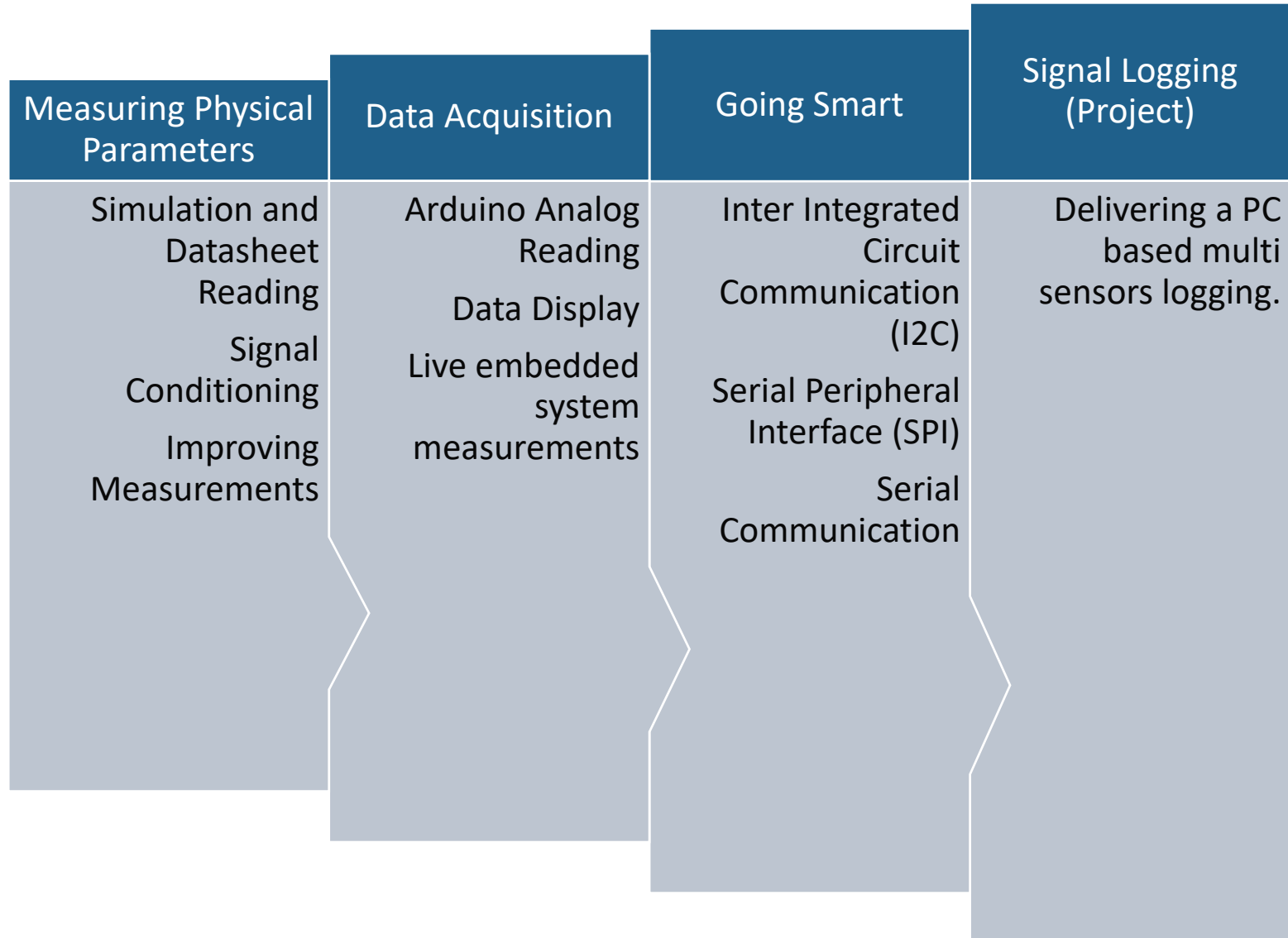
Review on operational amplifiers



Introduction to temperature sensors

# Preliminary Flow Of The Course

Expected Goals Reached



## Lab 1

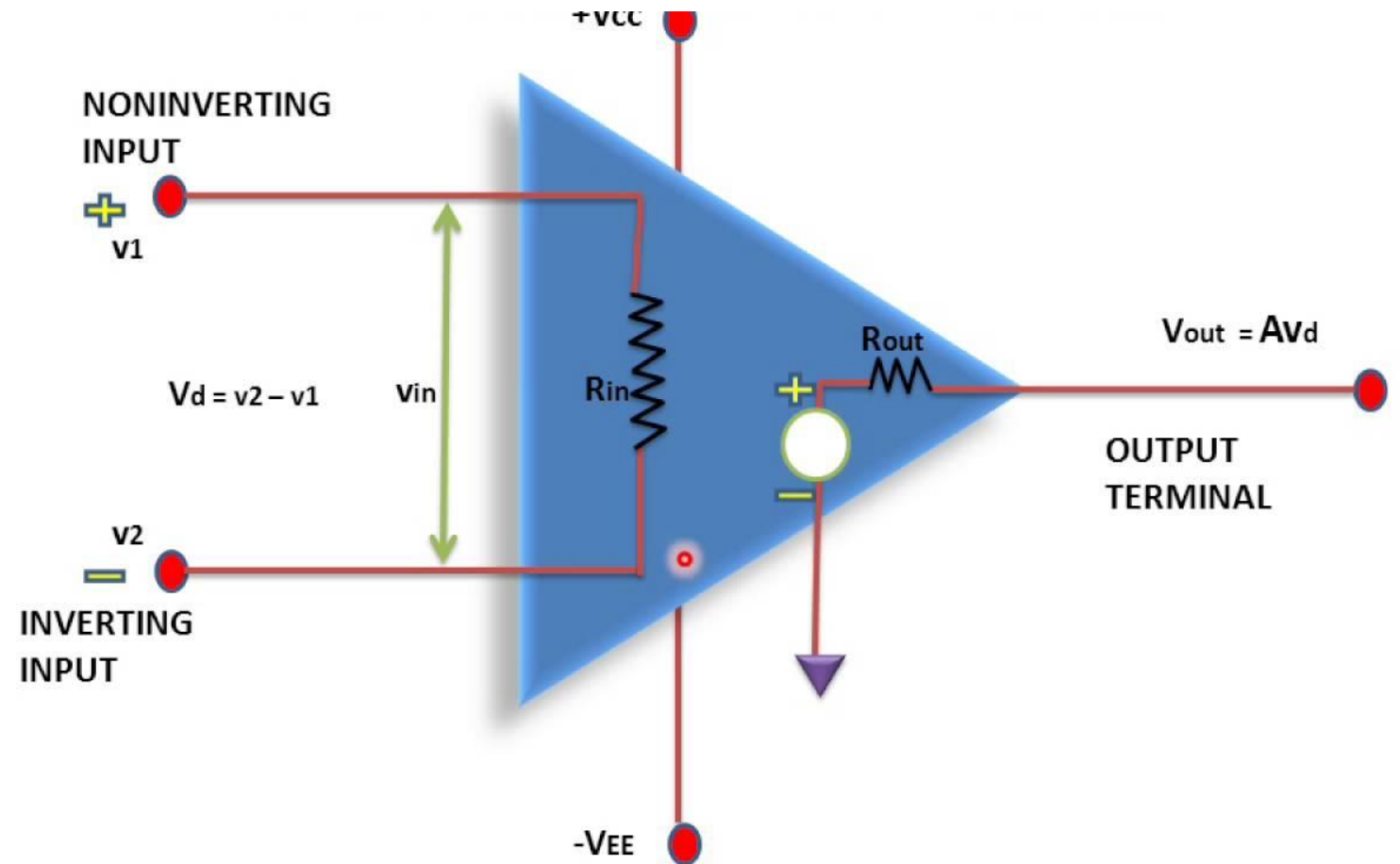
# Signal Conditioning

Review on operational amplifiers

## Commonly Used Configurations

Amplifiers most frequently used :

- Inverting Amplifier.
- Non-Inverting Amplifier.
- Differential
- Amplification of AC signal with single supply.



Lab 1

# Software For Simulation

Needed for all labs



## Electronics Simulation

Proteus 8.7 or higher



## Arduino IDE

For data acquisition labs



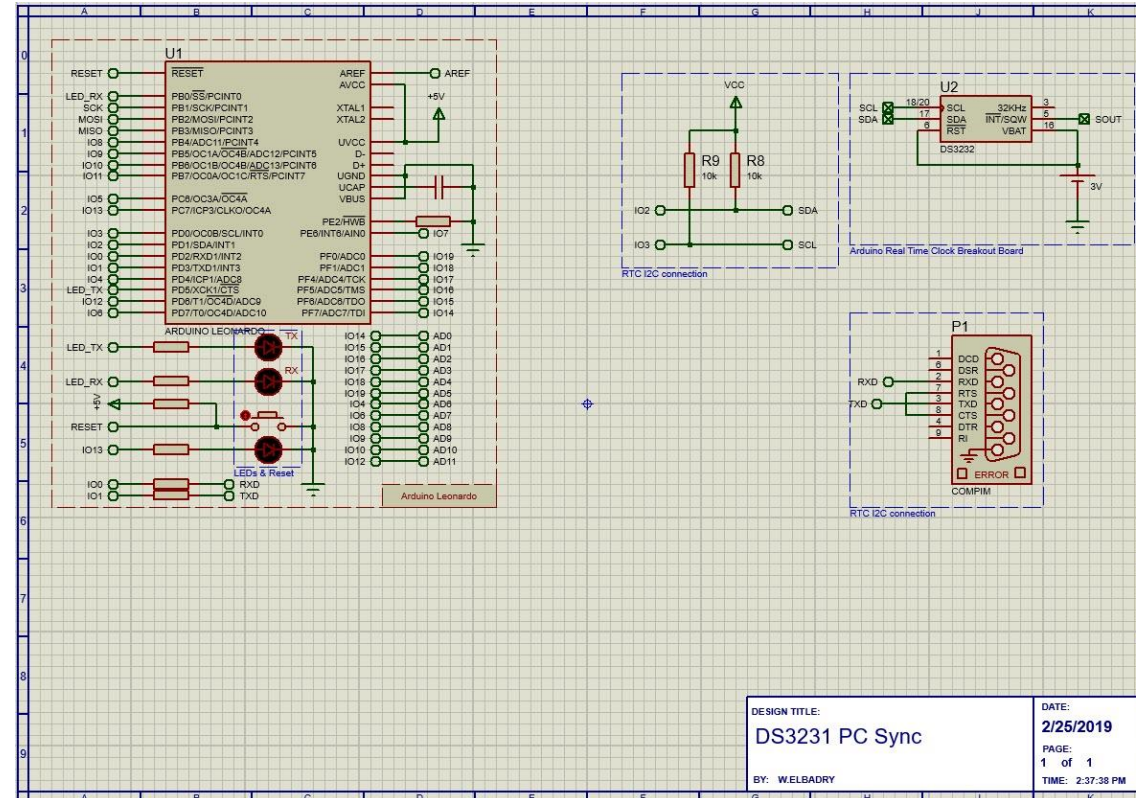
## MATLAB

Optional for data processing

**Student must install software in advance before attending any lab**

# Software For Simulation

Needed for all labs



01

## Electronics Simulation

Proteus 8.7 or higher

**Version 8.9 SP1 is highly recommended  
(not mandatory)**

# Operational Amplifier

- Amplification.
- Attenuation.
- Buffering.
- Filtering (active filters).

## Where :

$V_i$  ... *Input voltage*

$V_o$  ... *Output voltage*

$G$  ... *Amplifier Gain*

$f_c$  ... *Cutoff frequency*

$R$  and  $C$  ... *filter parameters*

$$V_o = V_i * G, G > 1$$

$$V_o = V_i * G, G < 1$$

$$V_o = V_i * G, G = 1$$

$$V_o = V_i * G, f_c = \frac{1}{j\omega RC}$$

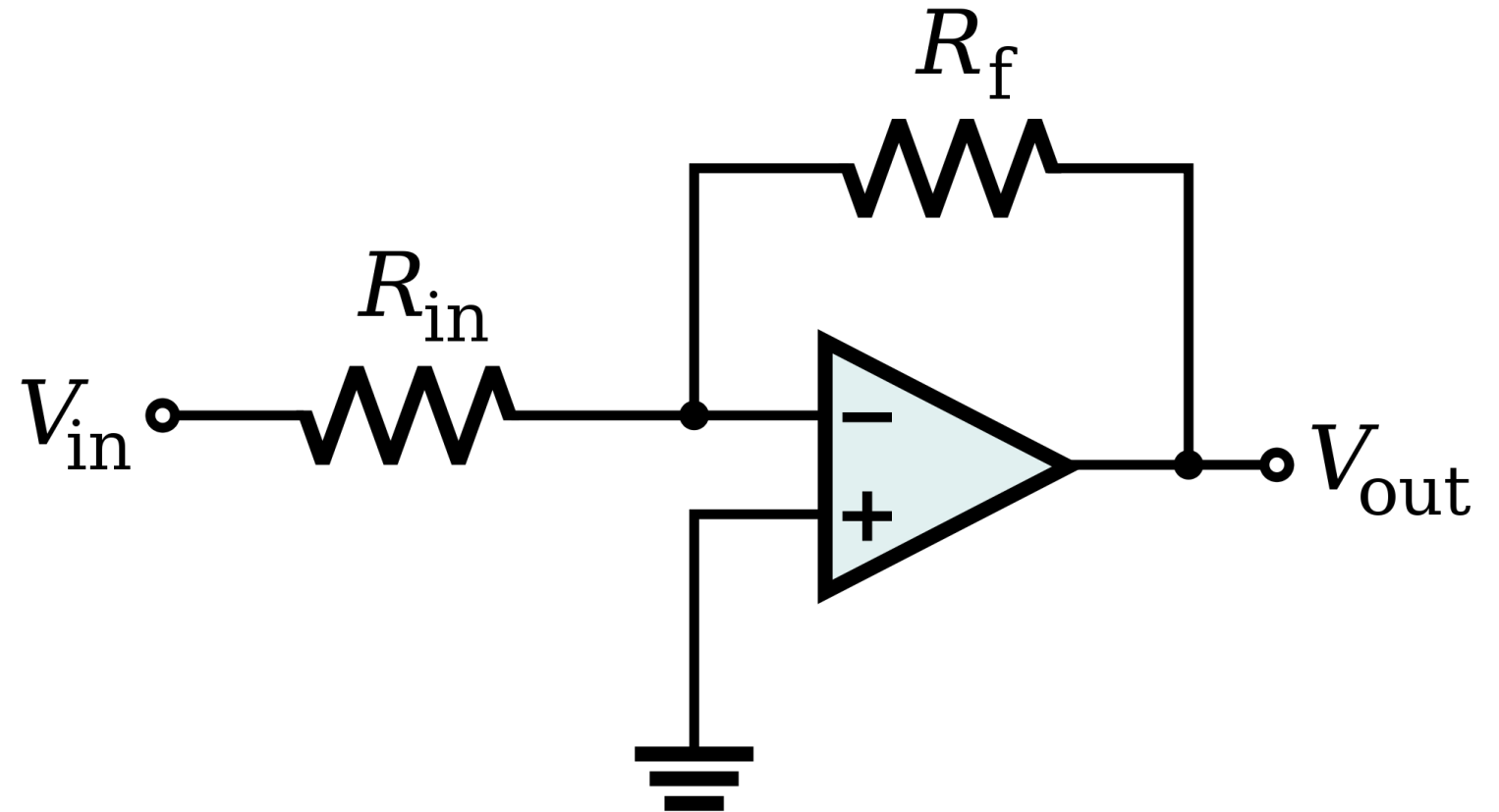
## Lab 1

# Signal Conditioning

## Exercise 1

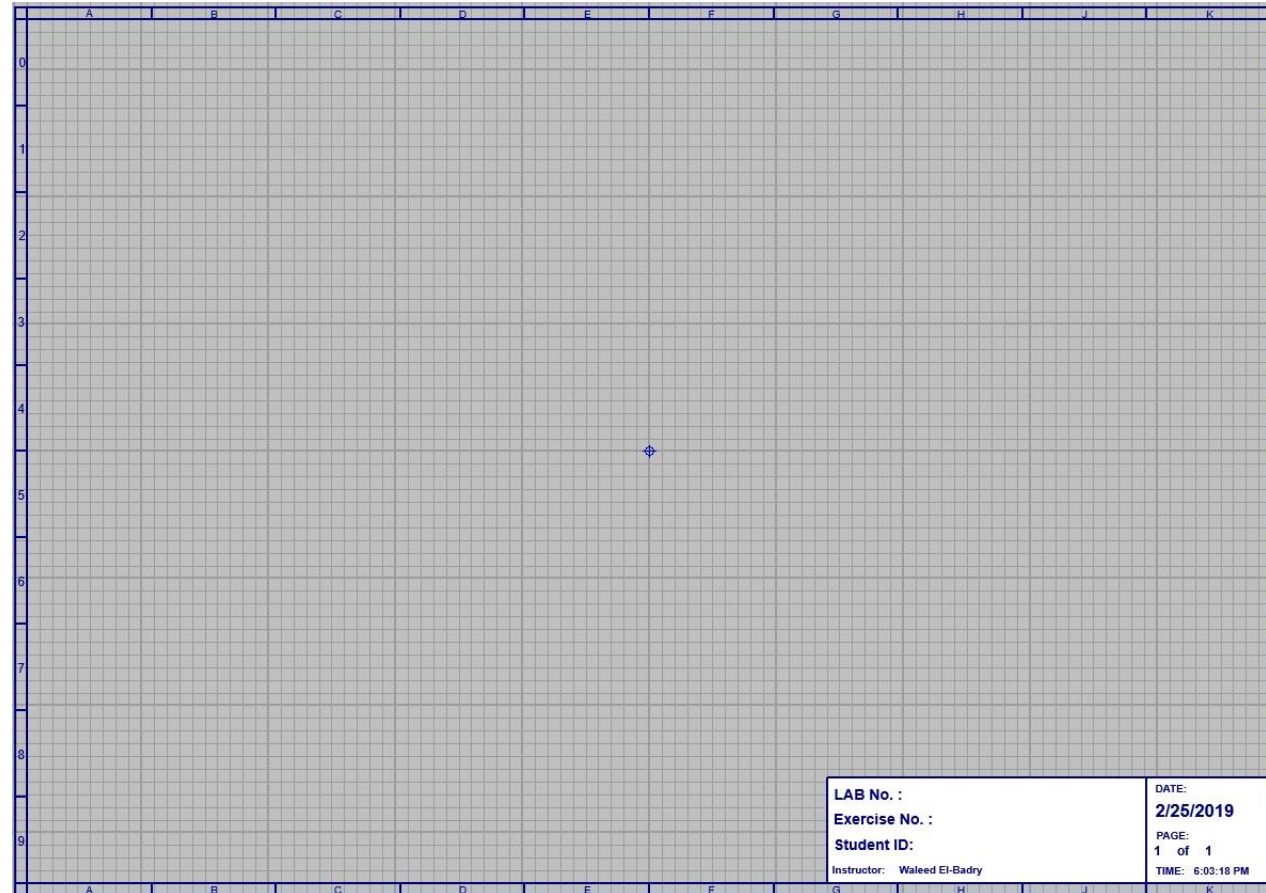
### Inverting Amplifier

1. Amplification.
2. Attenuation.
3. Buffering





# Proteus Course Template

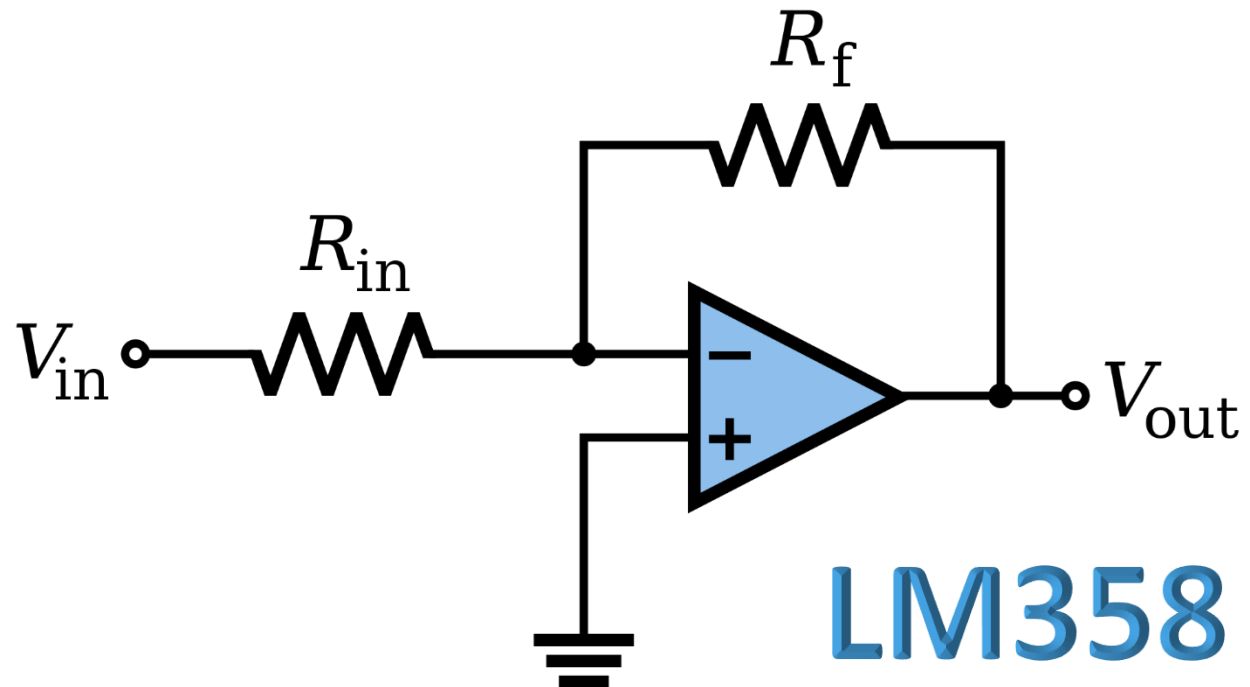


MTE 405 Template (*available on course repository*)

## Exercise 1 – Inverting Amplifier

Using Proteus ISIS schematic capture, apply inverting amplifier circuits with  $G = 10$ ,  $0.1$  and  $1$  respectively

$$V_o = - \frac{R_f}{R_i} V_i$$



# Exercise 1 – Inverting Amplifier

Product  
FolderSample &  
BuyTechnical  
DocumentsTools &  
SoftwareSupport &  
Community**LM158-N, LM258-N, LM2904-N, LM358-N**

SNOSBT3I – JANUARY 2000 – REVISED DECEMBER 2014

## LMx58-N Low-Power, Dual-Operational Amplifiers

### 1 Features

- Available in 8-Bump DSBGA Chip-Sized Package, (See AN-1112, [SNVA009](#))
- Internally Frequency Compensated for Unity Gain
- Large DC Voltage Gain: 100 dB
- Wide Bandwidth (Unity Gain): 1 MHz (Temperature Compensated)
- Wide Power Supply Range:
  - Single Supply: 3V to 32V
  - Or Dual Supplies:  $\pm 1.5\text{V}$  to  $\pm 16\text{V}$
- Very Low Supply Current Drain (500  $\mu\text{A}$ )—Essentially Independent of Supply Voltage

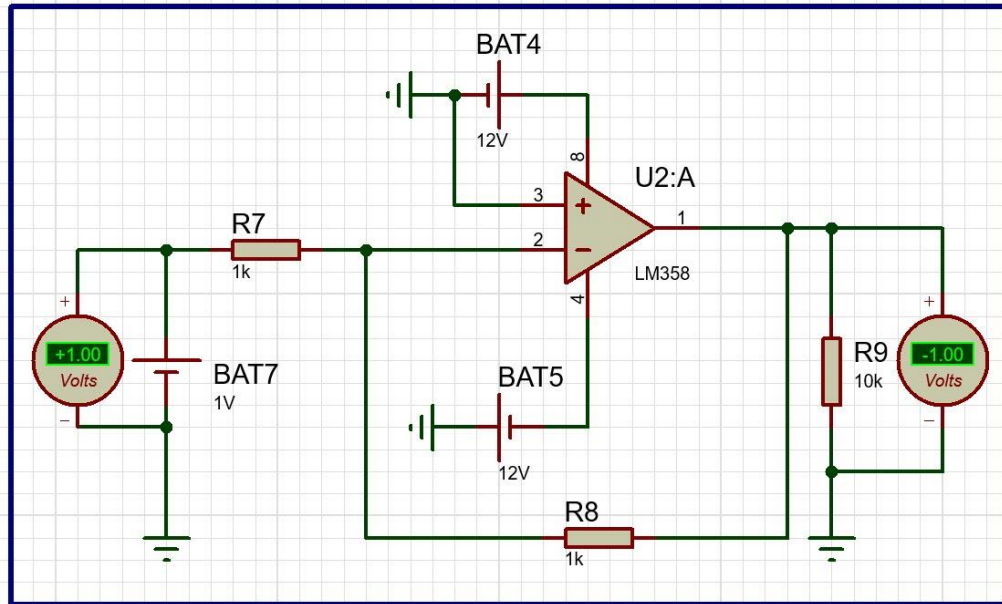
### 3 Description

The LM158 series consists of two independent, high gain, internally frequency compensated operational amplifiers which were designed specifically to operate from a single power supply over a wide range of voltages. Operation from split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage.

Application areas include transducer amplifiers, dc gain blocks and all the conventional op-amp circuits which now can be more easily implemented in single power supply systems. For example, the LM158 series can be directly operated off of the standard

## Lab 1

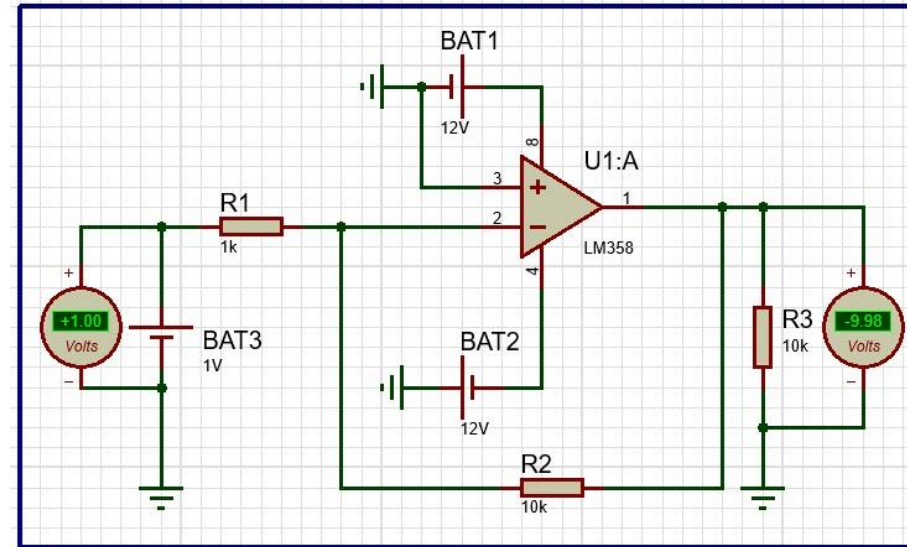
# Exercise 1 – Inverting Amplifier



Inverting Amplifier

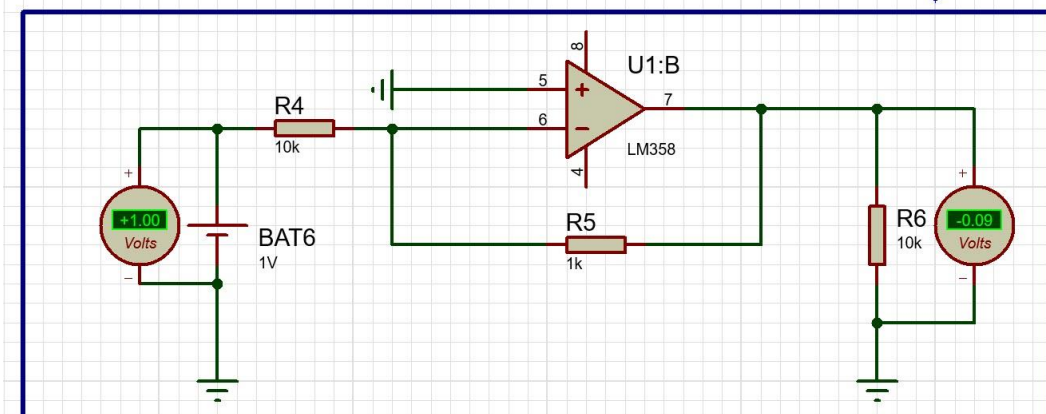
$G = 1$

- Why there is a loss in output voltage ?
- Does the output voltage vary with load ?
- What is the constraint of using inverting configuration ?



Inverting Amplifier

$G = 10$



Inverting Amplifier

$G = 0.1$

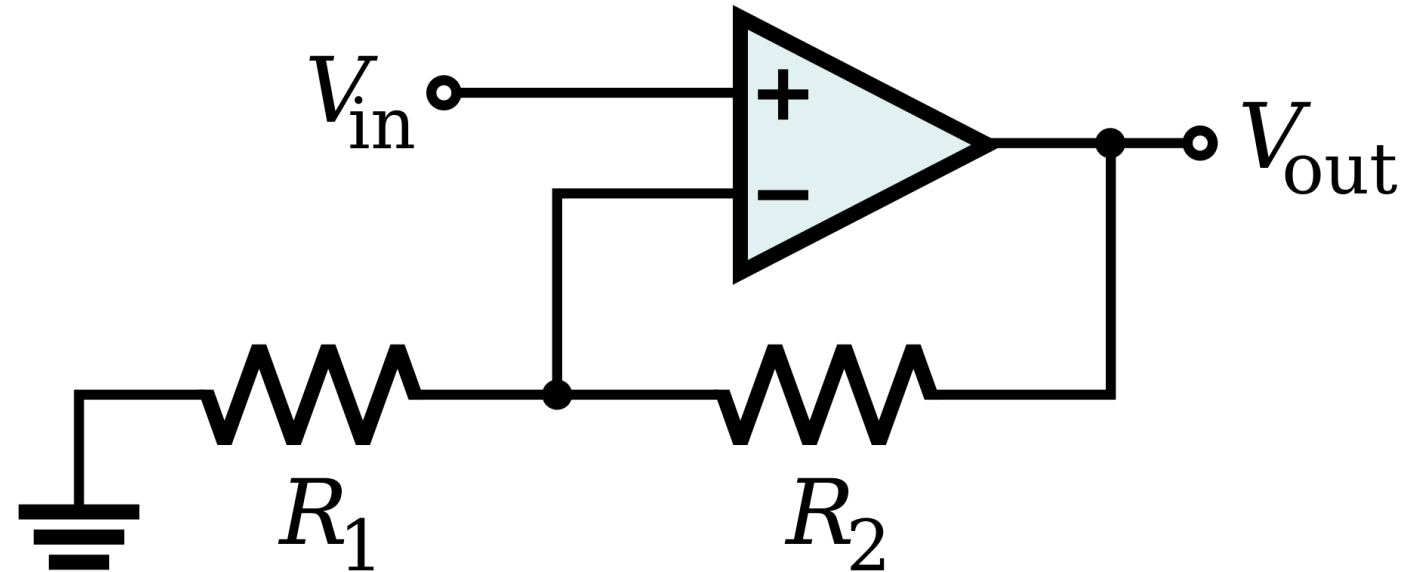
## Lab 1

# Signal Conditioning

## Exercise 2

### Non-Inverting Amplifier

1. Amplification.
2. Attenuation.
3. Buffering

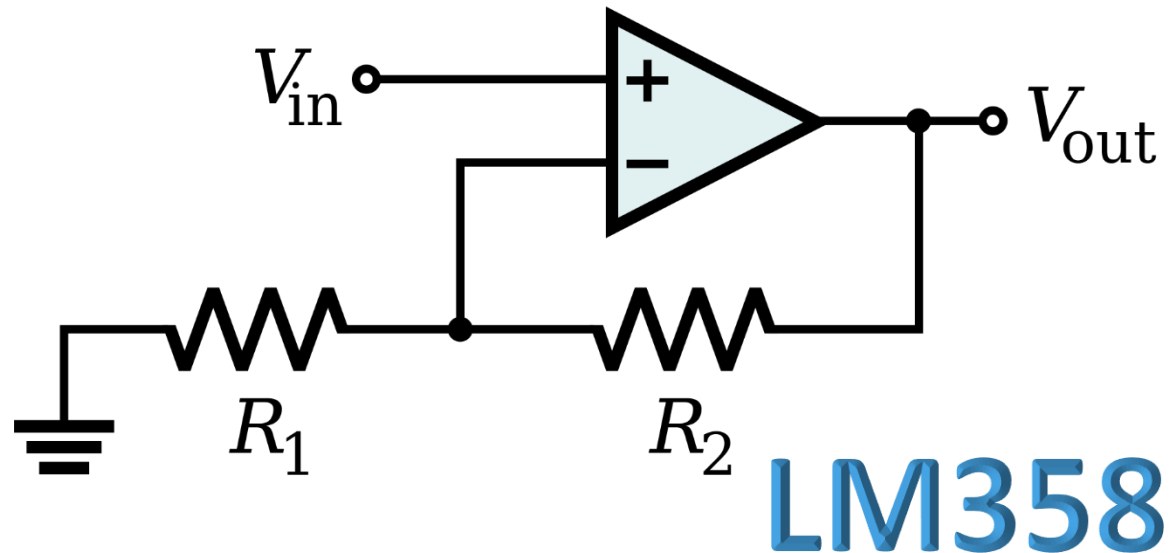




## Exercise 2 – Non-Inverting Amplifier

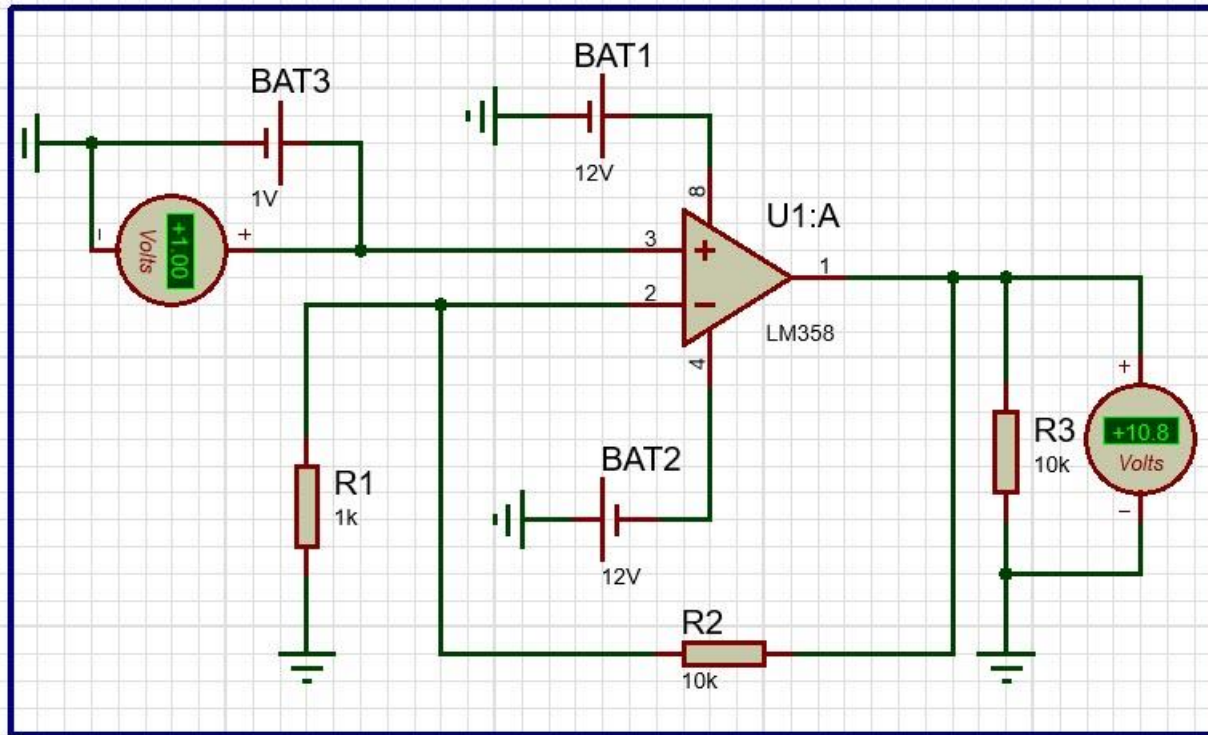
Using Proteus ISIS schematic capture, apply non-inverting amplifier circuits with  $G = 10$  and  $G = 1$  respectively

$$V_o = \left( 1 + \frac{R_2}{R_1} \right) V_i$$



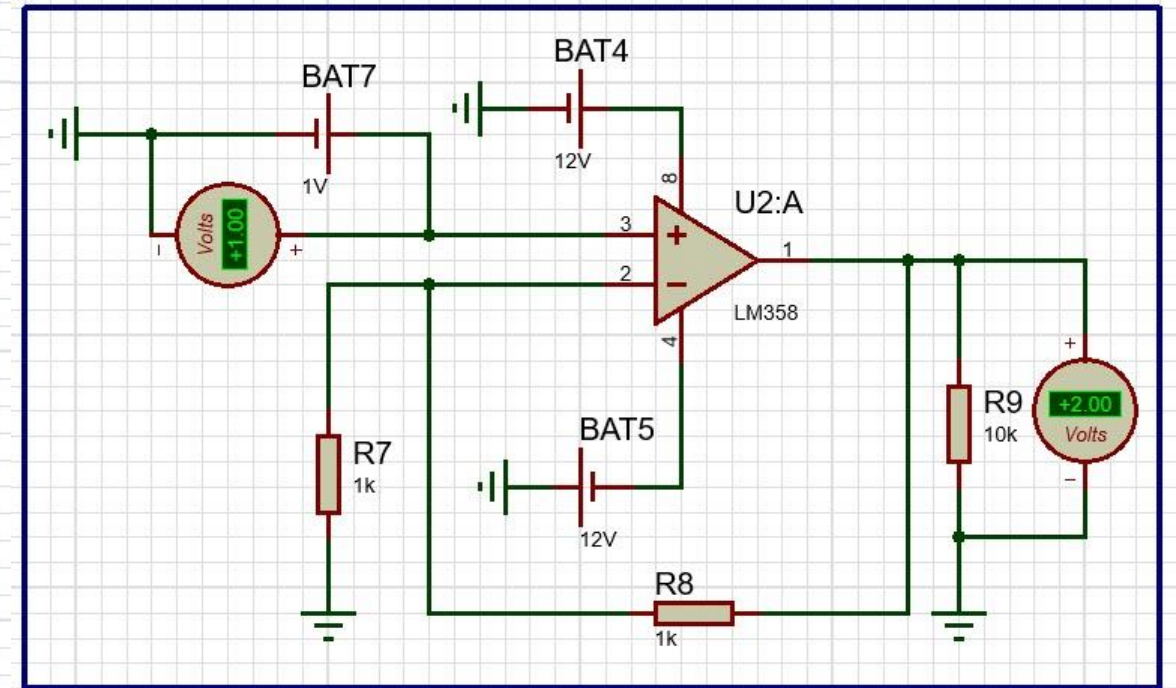
## Lab 1

# Exercise 2 – Non-Inverting Amplifier



Non-Inverting Amplifier

$$G = 10$$



Non-Inverting Amplifier

$$G = 1$$

- Is it better than non-inverting ?
- Do you notice any disadvantage ?

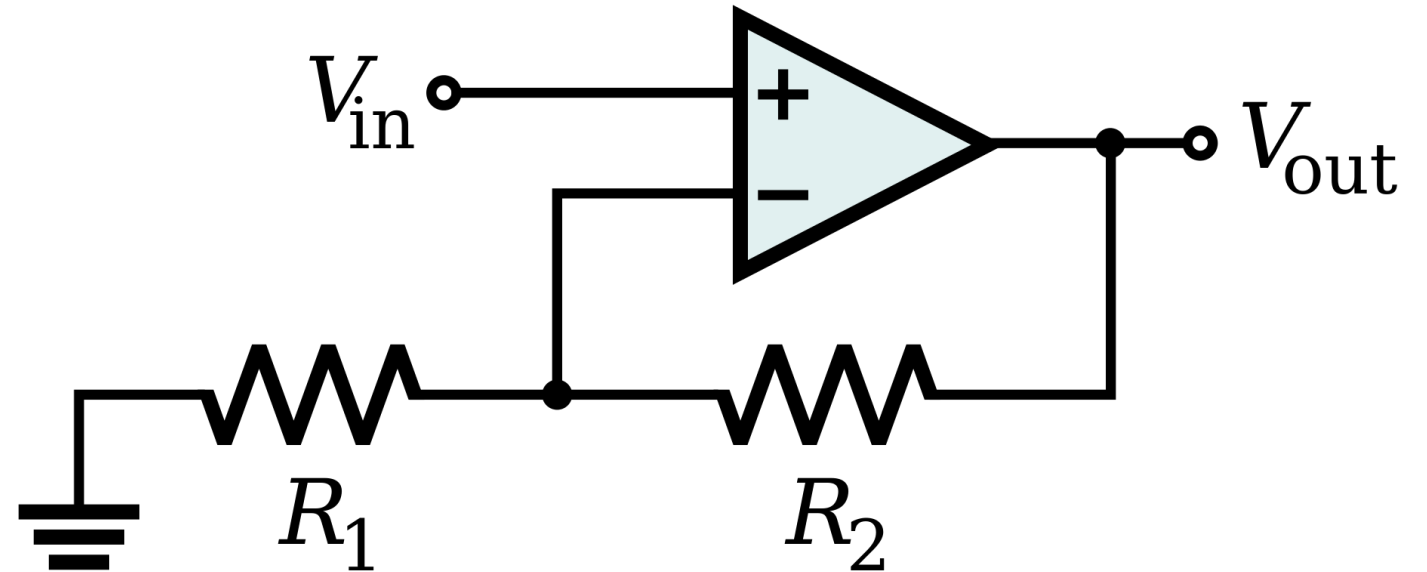
## Lab 1

# Signal Conditioning

## Exercise 3

### Differential Amplifier

1. Difference to Single Ended
2. Attenuation.
3. Amplification
4. Buffering

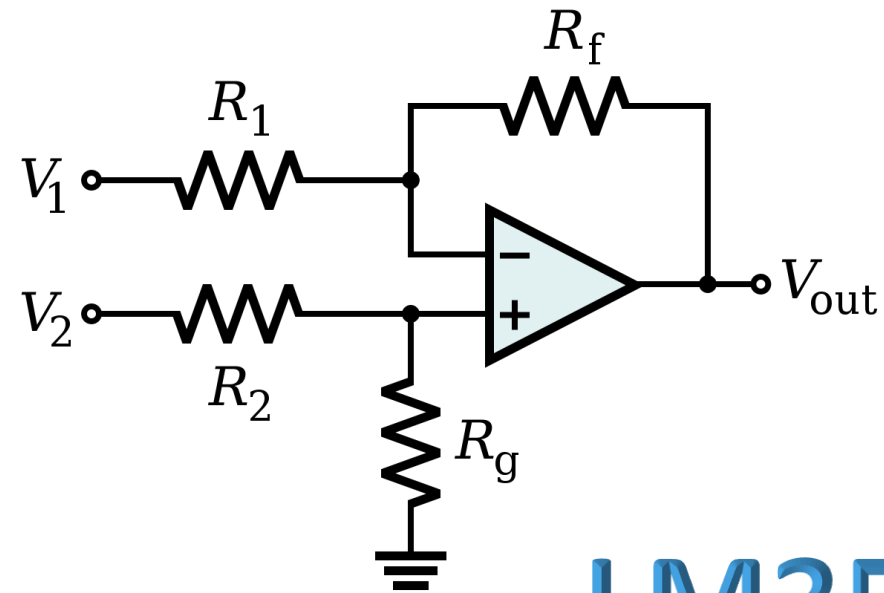




## Exercise 3 – Differential Amplifier

Using Proteus ISIS schematic capture, apply differential amplifier circuits with  $G = 10$

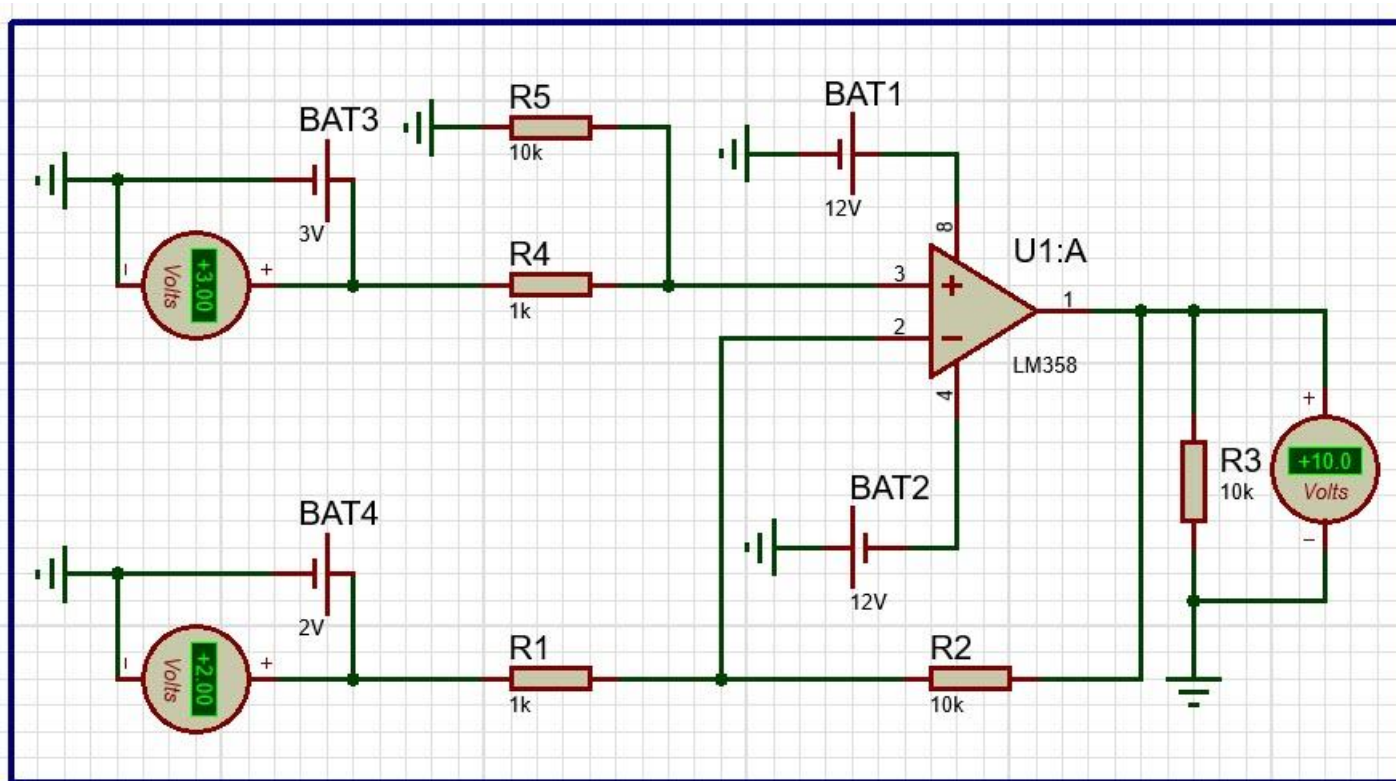
$$V_o = \frac{R_f}{R_1} (V_2 - V_1)$$



**LM358**

## Lab 1

# Exercise 3 – Differential Amplifier



Differential Amplifier

$G = 10$

- Did you get the concept of differential to single ended ?
- We will need this configuration when using Wheatstone bridge ?

**END OF LAB 1**