Mechatronics and Automation

LAB

Cycle1: Mechatronic product

Objectives: Study of Mechatronic product

1. CD drive, Hard disc drive

Cycle 2: Sensors

Objectives: Identifying the sensors, developing the circuit on bread board and observing its performance.

2. Infrared sensor
3. Ultrasonic
4. LDR
5. Thermocouple
6. Thermistor
7. LM35
8. Strain Gauge
9. Piezoelectric

Cycle 3: Actuators

Objectives: Identifying the type of actuator, their study, developing their basic controller circuit on bread board, observing the performance.

1. DC motor through L298D
2. Stepper motor through microcontroller
3. Stepper motor through IC555
4. RC servo through IC555
5. RC servo through microcontroller

Cycle 4: Hydraulics and Pneumatics

Objectives: Identifying H&P parts, Building their standard circuit and observing their performance

6. Double acting cylinder: auto reverse and speed control of fwd. stroke
7. Double acting cylinder: auto reciprocating and speed control
8. Double acting cylinder: auto reverse and time delay in reverse stroke
9. Automatic motion of double acting cylinder through solenoid operated valve
10. Double acting cylinder using latching
11. Two double acting cylinder sequencing using relay logic
12. Double acting cylinder: auto reverse using pressure control valve

Cycle 5: Controllers

Objectives: Study of controllers available, building simple algorithms

1. Simulation of PLC ladder logic
2. Development of PLC based small automation system
3. Basic programming on Microcontroller

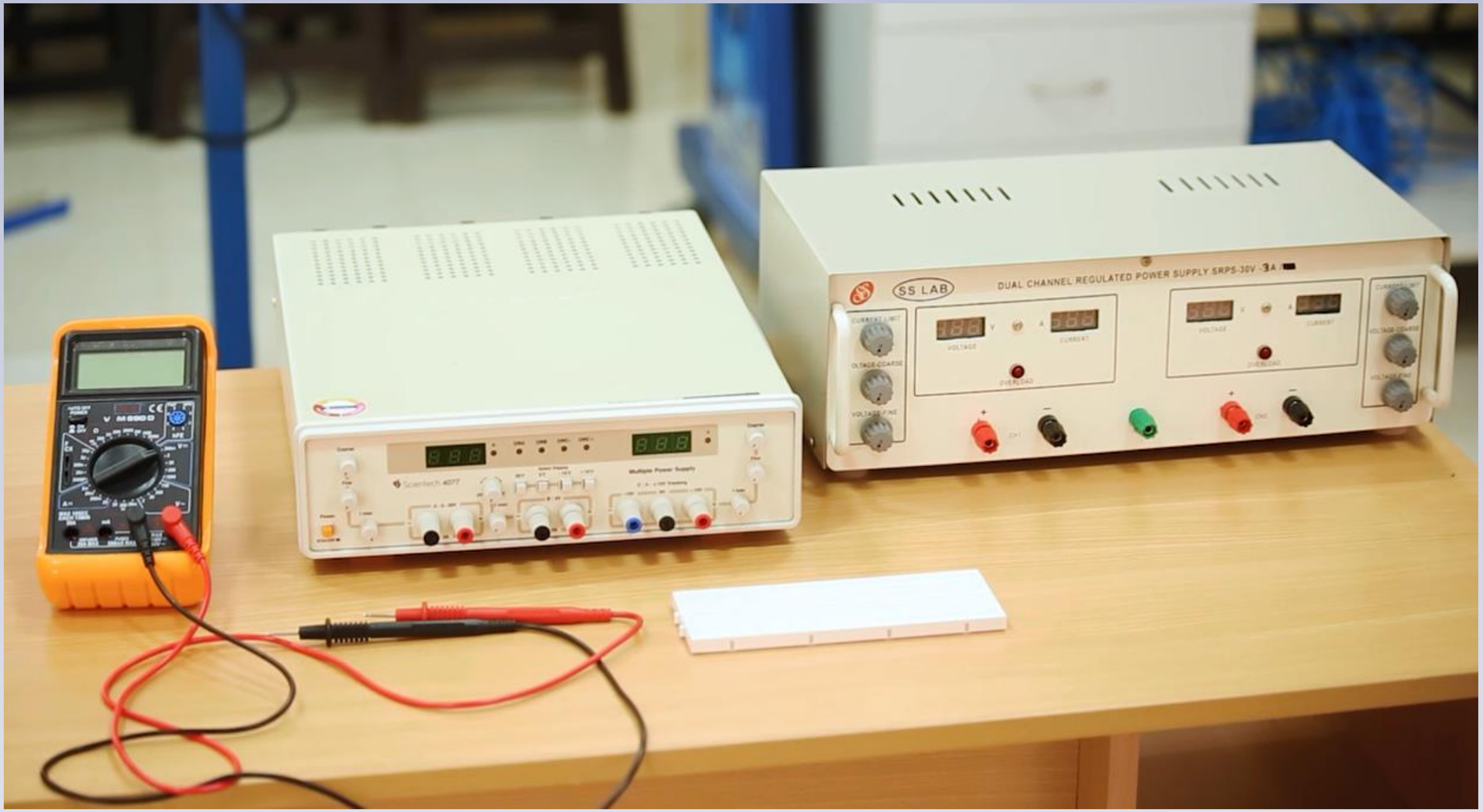
Cycle 6: Programing of industrial manipulator

4. Programming of Scorbot-ER-4U

Lab session-1

- Lab Team
- Make groups
- Study of basic lab equipment
- Safety instructions

Study of basic lab equipment



Power supply

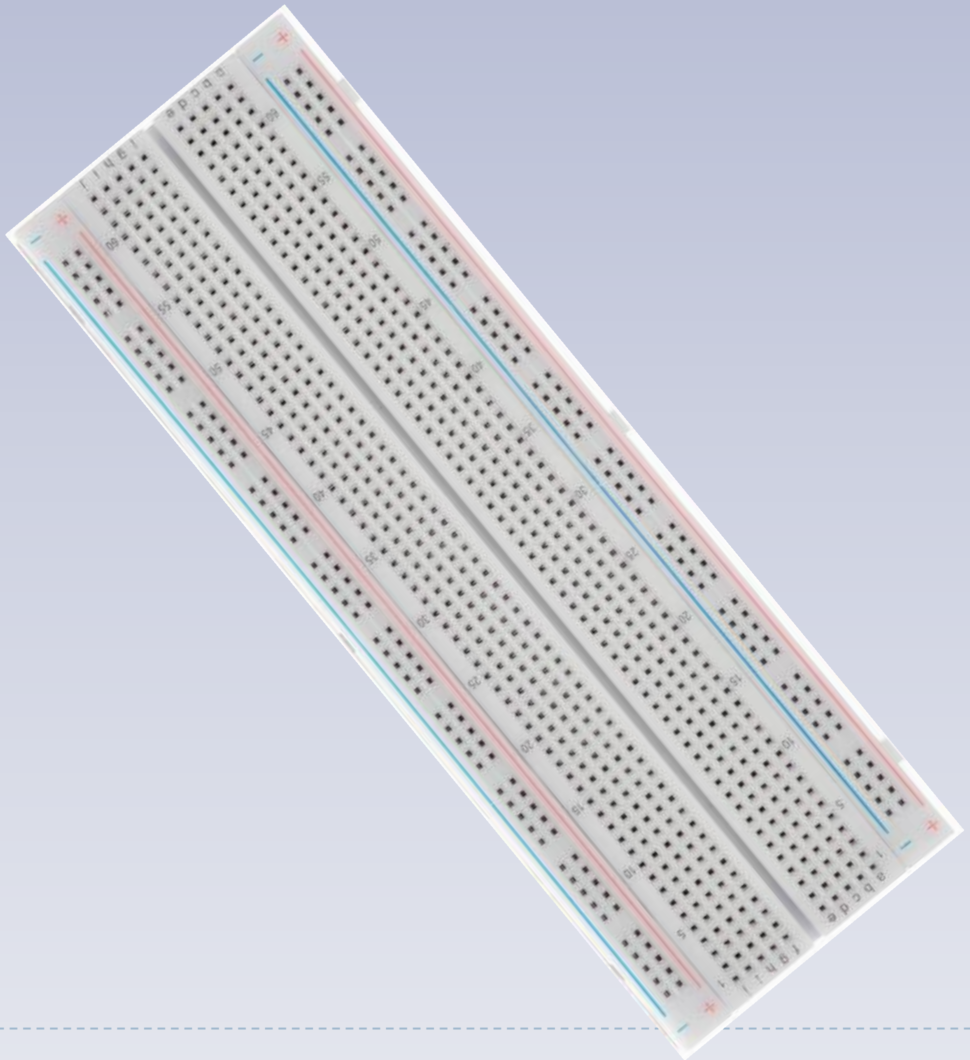
Dual channel power supply

Multiple DC Power Supply
Scientech 4077, 0 - 30V / 2A, ±15V / 1A Tracking, 5V/2A

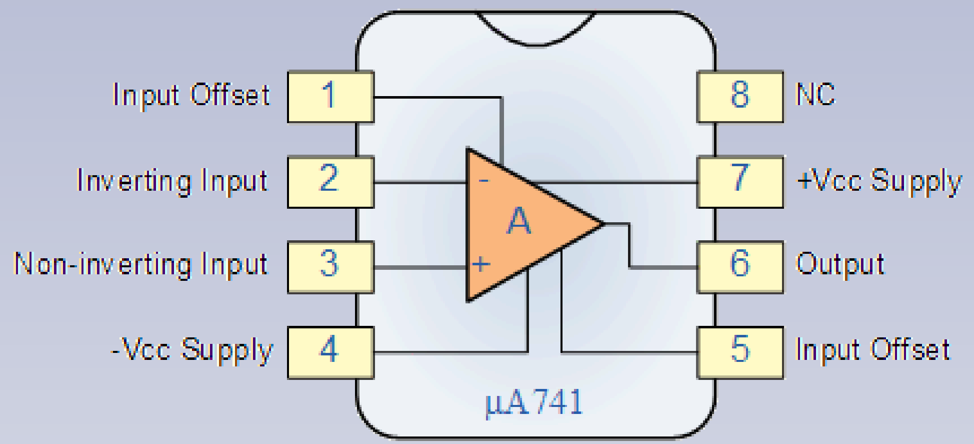
Multi meter

DC Voltage Range	200 mV-1000 V
AC Current Accuracy	± (2 % rdg + 3 digits)
AC Current Range	20mA-20A
Type	Digital Multimeter
Input Impedance	10 M Ohm
Resistance Accuracy	± (1 % rdg + 10 digits)
Capacitance Accuracy	± (4 % rdg + 5 digits)
Capacitance Range	2000pf-200µF
AC Voltage Range	2-750 V
DC Voltage Accuracy	± (0.5 % rdg + 3 digits)
DC Current Accuracy	± (1.8 % rdg + 2 digits)
DC Current Range	2mA-20A
Display Digit	3½
Item Code	V M 890 D
AC Voltage Accuracy	± (1 % rdg + 5 digits)
Resistance Range	200 Ohm-20 Mohm

Bread board

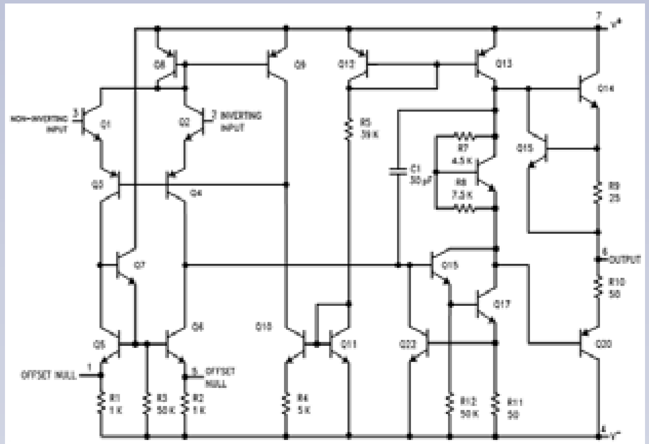


Study of basic configuration of OpAmp

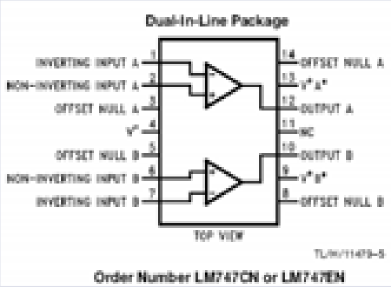


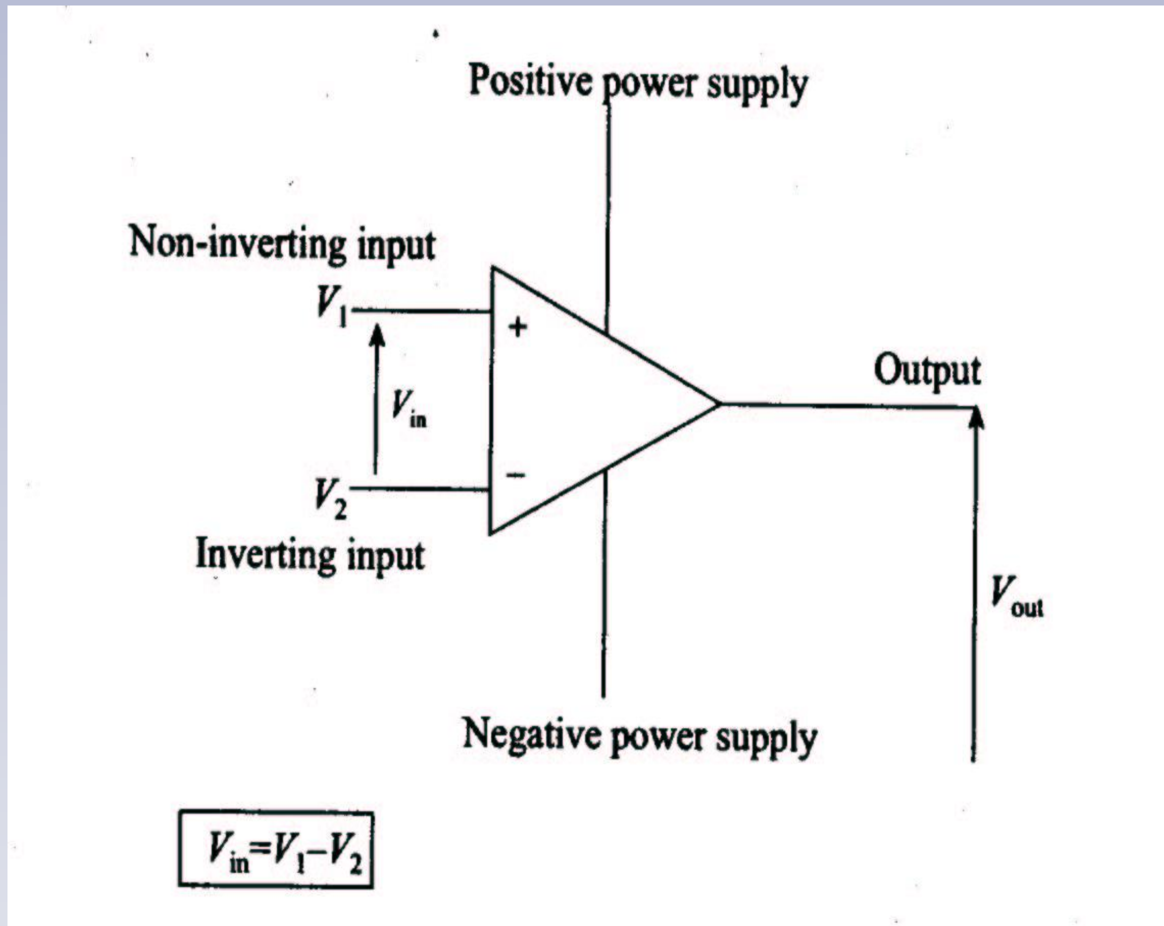
Pin configuration of IC 741

- Op Amp is a versatile IC consisting of may internal transistors, resistors, and capacitors manufactured into a single chip



- A DIP (dual-in-line package) LM741 op amp




Positive power supply
Non-inverting input
V_1
+
V_{in}
−
V_2
Inverting input
Output
V_{out}
Negative power supply
$V_{in}=V_1-V_2$

Golden Rules

- 1 *The output attempts to do whatever is necessary to make the voltage difference between the two inputs zero.*

$$V+ = V-$$

- 2 *The inputs draw no current.*

$$i+ = i- = 0$$

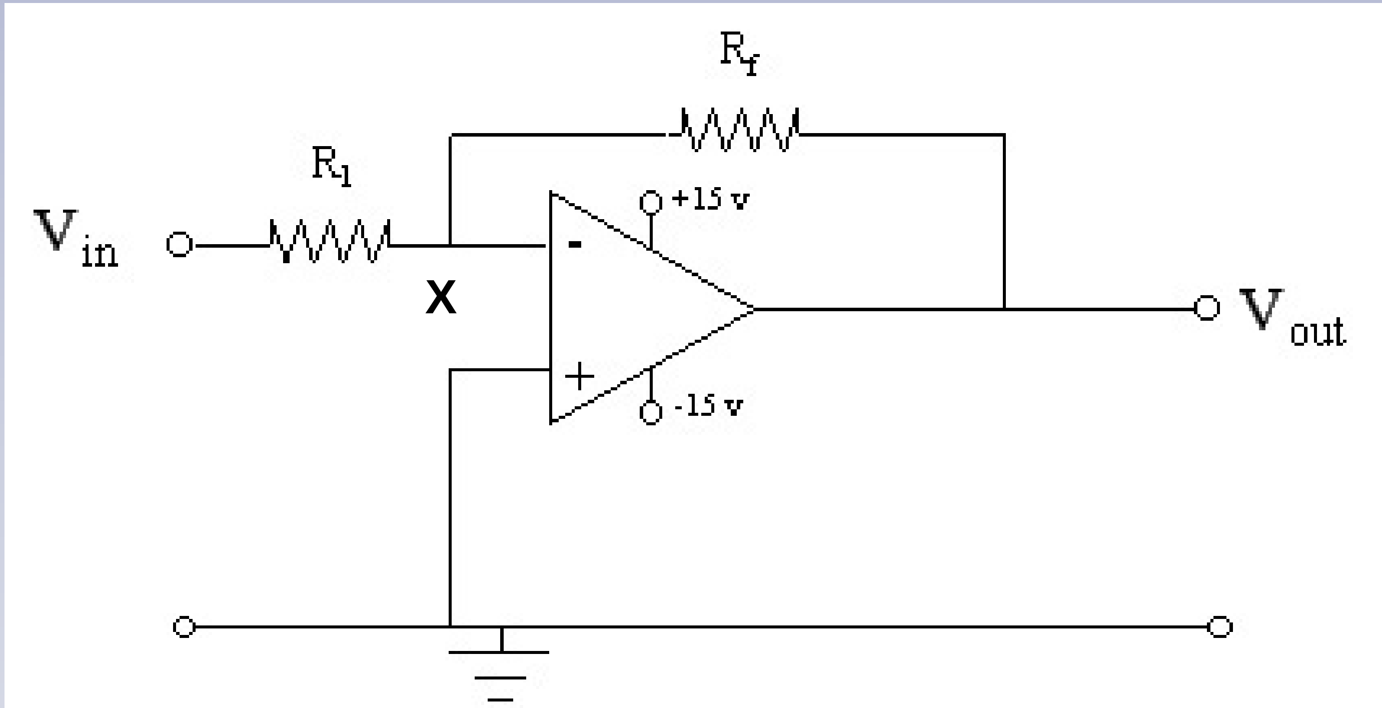
The Operational Amplifier

- An operational amplifier is modeled as a voltage controlled voltage source.
- An operational amplifier has a very high input impedance and a very high gain.
- Op amps can be configured in many different ways using resistors and other components.
- Most configurations use feedback.

Applications:

- Amplifiers provide gains in voltage or current.
- Op amps can convert current to voltage.
- Op amps can provide a buffer between two circuits.
- Op amps can be used to implement integrators and differentiators.

Inverting Amplifier



$V_{in} = I\,R_1$

$V_X - V_{out} = I\,R_f$

$V_X = 0$

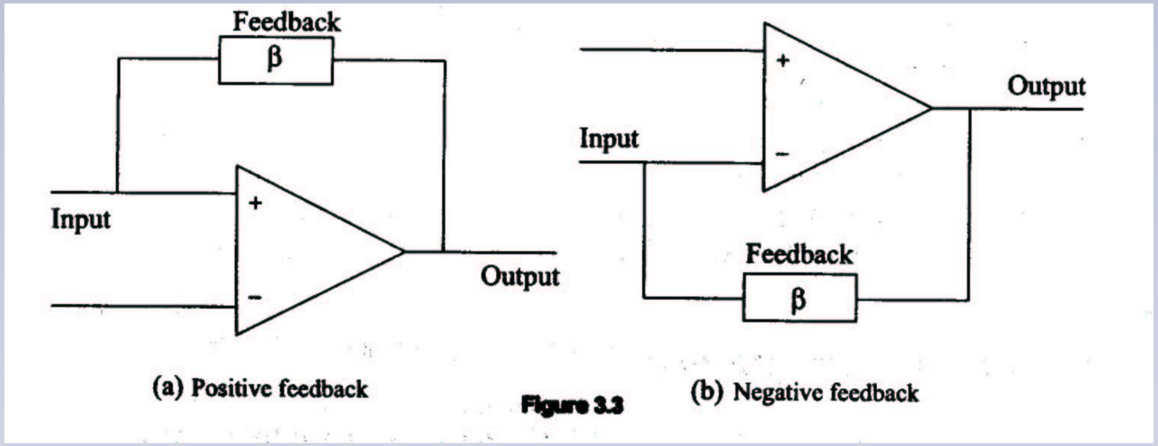
$V_{out} = -\,I\,R_f$

$V_{out}\ /\ Vin = -\,(Rf/\,R1)$

$Vout = Vin \times -\ (Rf/R1)$

$Gain = (Rf\ /\ R1)$

Positive and Negative Feedback

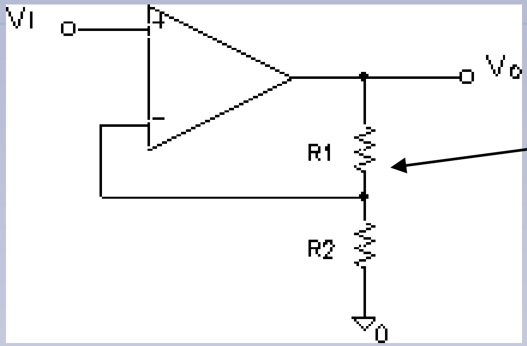


- Connecting the output to the positive input is positive feedback
- Connecting the output to the negative input is negative feedback

Applications of OP-AMP

- Adder
- Integrator
- Differentiator
- Differential Amplifier
- Logarithmic Amplifier
- Comparator
- Buffer/follower

Op-Amp Configurations



V_2

- Non-Inverting Amplifier
  - The circuit amplifies the input voltage without inverting the signal
  - No voltage difference between inputs

$$V_1 = V_2$$

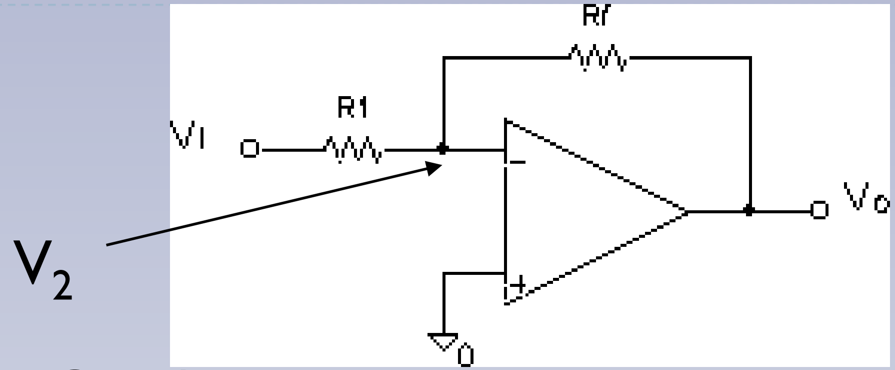
  - Resistors act like voltage divider

$$V_2 = \frac{R_2}{R_1 + R_2} V_O$$

- Combining the two equations for the voltages gives us the relationship between input and output

$$V_{OUT} = V_{IN}\left(1 + \frac{R_1}{R_2}\right)$$

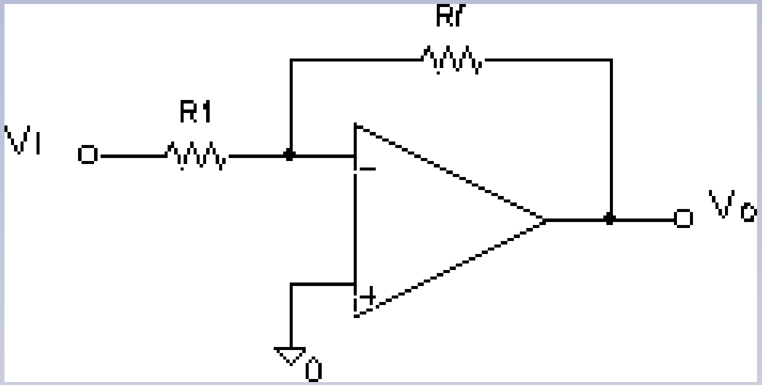
Op-Amp Configurations



- Inverting Op-Amp
  - Current through R1 equals the current through Rf
  - No current in the inputs
  - The voltage at both inputs is zero

$$V_2 = 0$$

Op-Amp Configurations



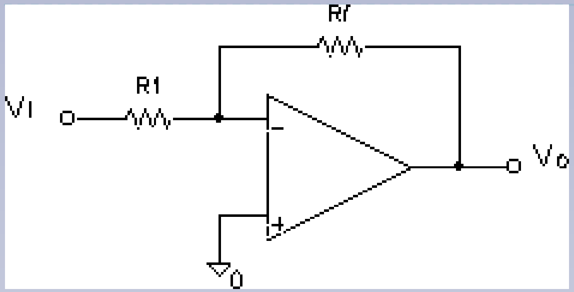
- Current through R1

$$I_1 = \frac{V_1 - 0}{R_1} = \frac{V_1}{R_1}$$

- Current through Rf

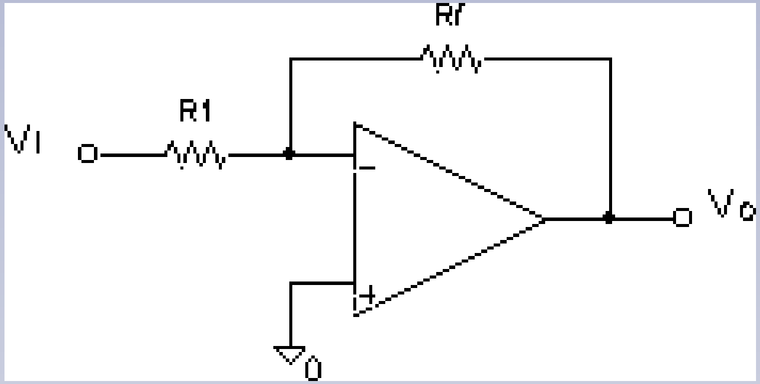
$$I_2 = -\frac{V_O - 0}{R_f} = -\frac{V_O}{R_f}$$

Op-Amp Configurations



- Why the minus sign for the current through Rf?
  - The convention for Ohm’s Law is that the current flows from the high voltage to the low voltage for a resistor
  - Here the current flows from the low voltage (ground) to the high voltage (VO)

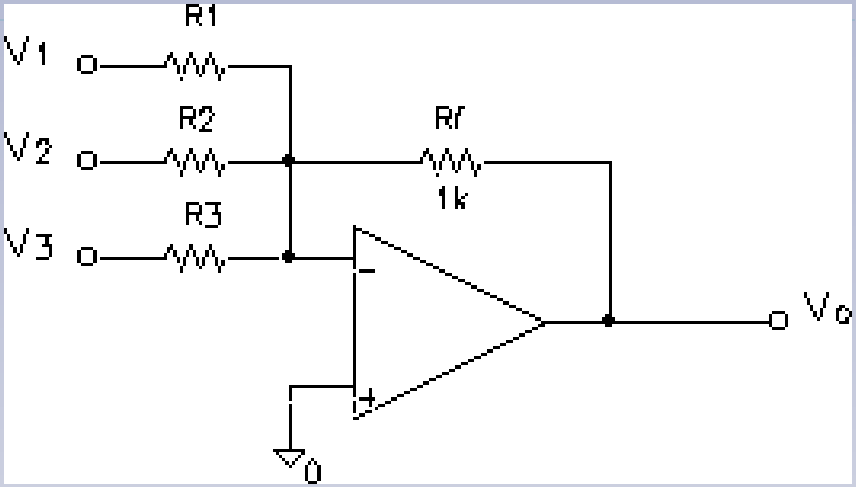
Op-Amp Configurations



- The current through R1 must equal the current through Rf since there is no current in the inputs.
- Combining the two equations for the currents

$$V_{OUT} = -V_{IN} \frac{R_f}{R_1}$$

Op-Amp Configurations

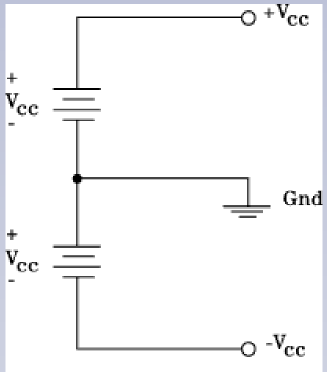


- Inverting Summing Amplifier
  - Each input resistor contributes to the current.

$$V_{OUT} = -V_1 \frac{R_f}{R_1} - V_2 \frac{R_f}{R_2} - V_3 \frac{R_f}{R_3}$$

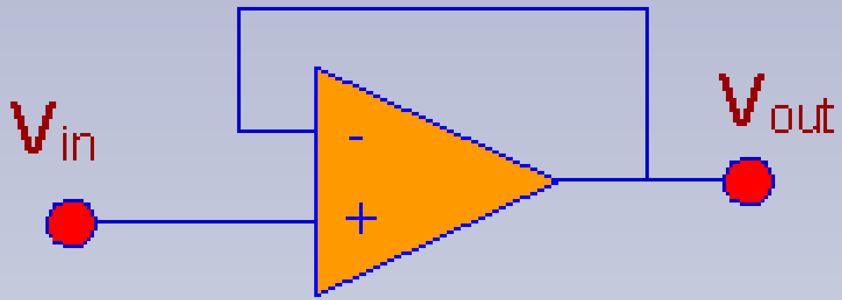
Op-Amps: Practical Issues

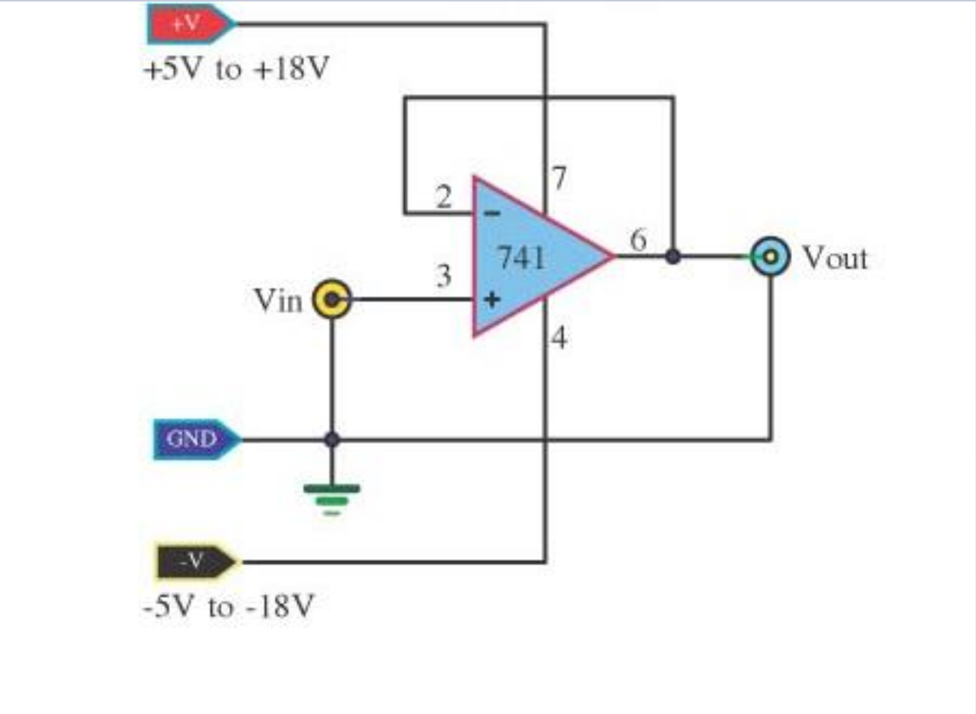
- Op-Amps require power
  - 741 requires plus and minus 15V
  - Others may require only positive or both positive and negative voltages
  - Output voltage is limited to
  - Usually filter capacitors are connected to power to reduce noise



$$-V_{CC} < V_{OUT} < +V_{CC}$$

Voltage follower /Buffer

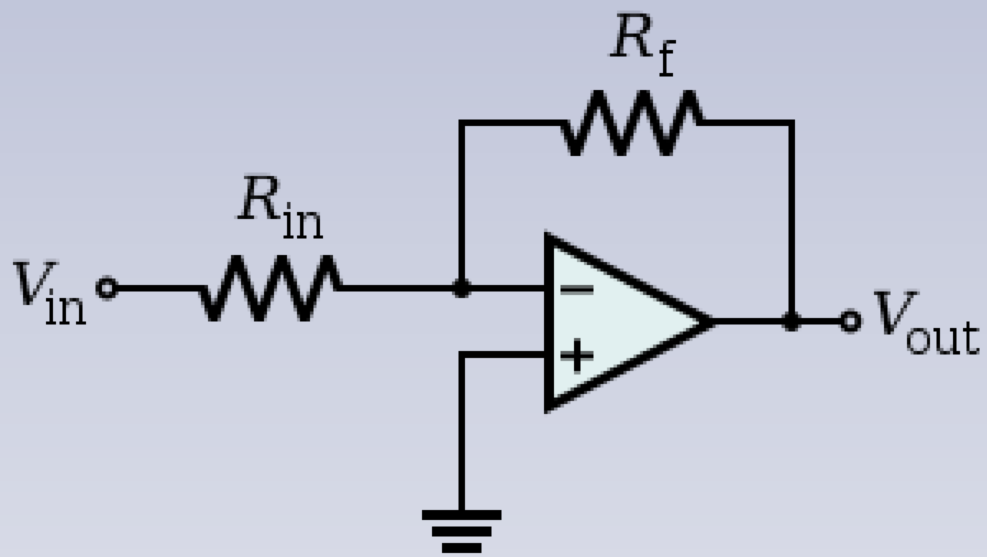




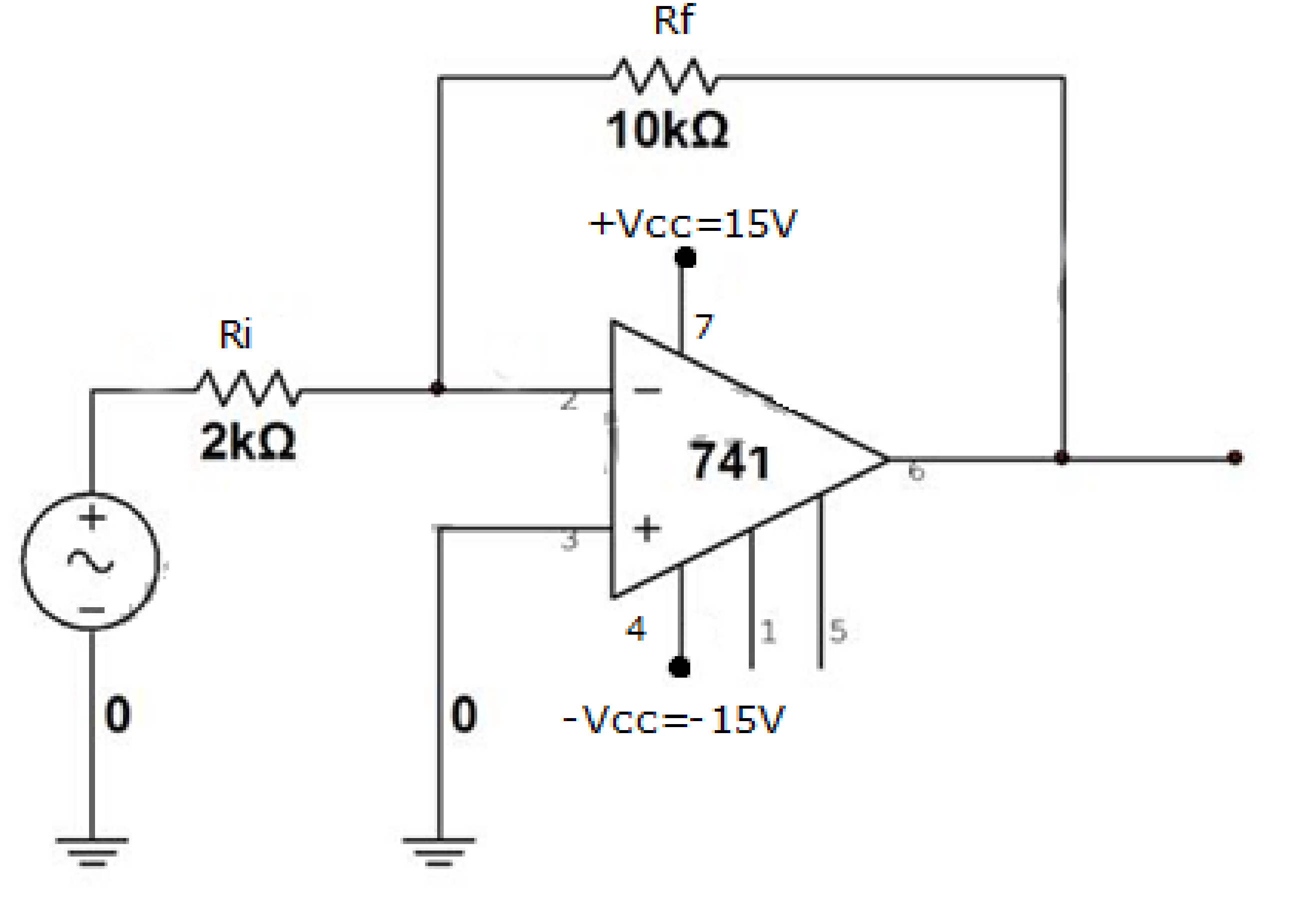
Observation Table 1

S. No.	V_{in} (DC Voltage)	V_{out}	Remark
1			
2			
3			

Inverting amplifier



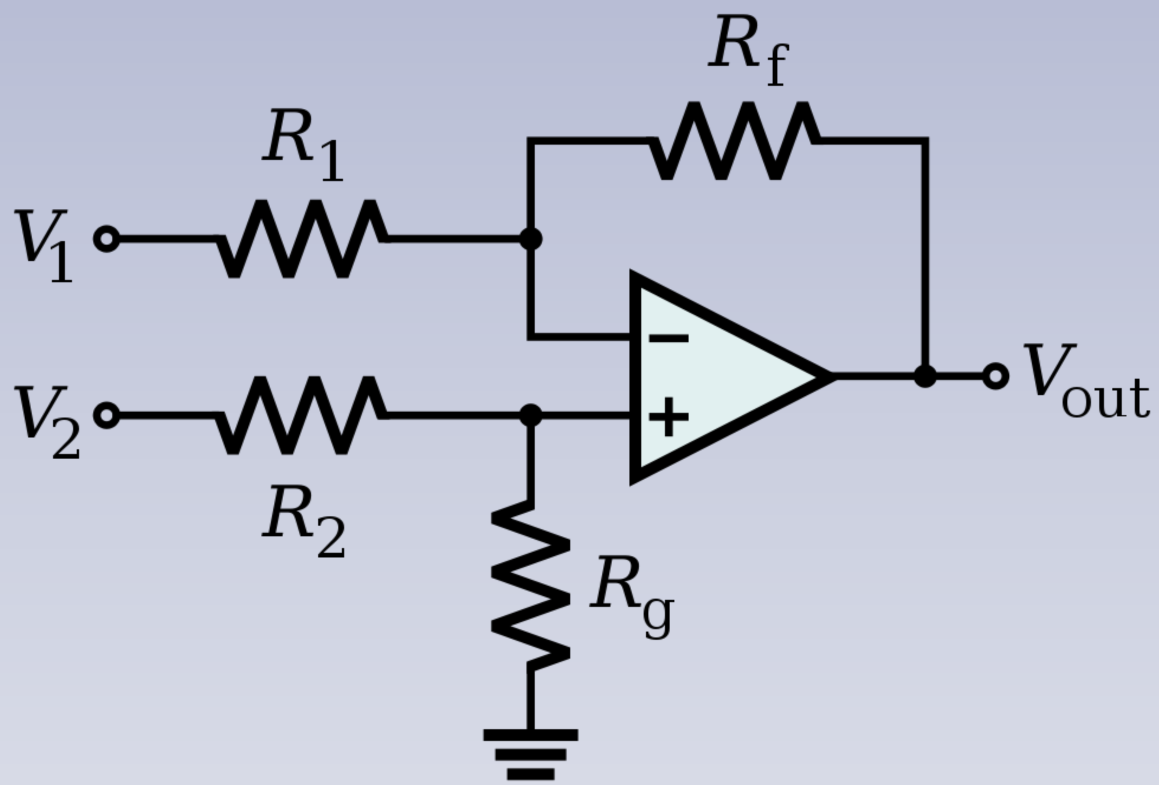
Inverting amplifier



Observation Table

S.No	V_{in}	V_{out}	R_{in}	R_f	Gain=V_{out}/V_{in}	Gain=R_f/R_{in}	Remark
1	10 mV/1KHz		1KΩ	1KΩ			
2	100 mV/10KHz		1KΩ	1KΩ			
3	10 mV/1KHz		1KΩ	100KΩ			
4	100 mV/10KHz		1KΩ	10KΩ			
5	100 mV DC		1KΩ	10KΩ			
6	500 mV DC		1KΩ	10KΩ			
7	1 V DC		1KΩ	20KΩ			

Differential Amplifier



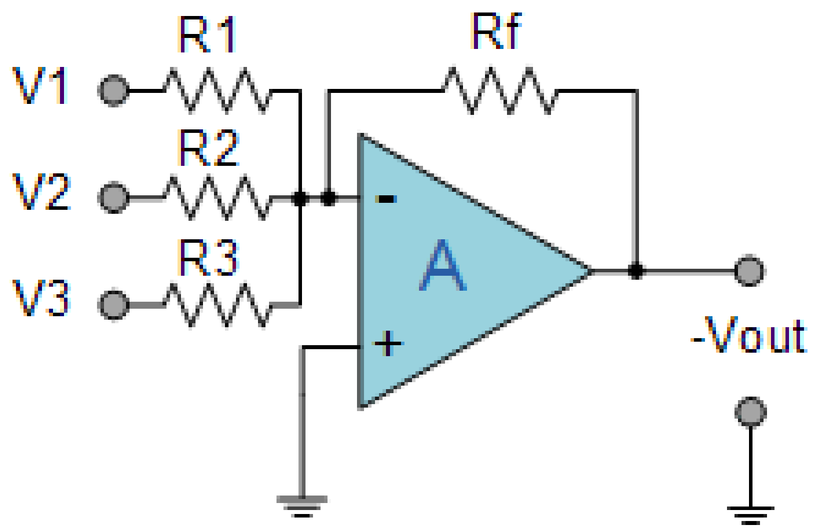
If $R_1 = R_2$
and $R_f = R_g$:

$$V_{out} = \frac{R_f}{R_1}\,(V_2 - V_1)$$

S.No	V_1 (DC V)	V_2 (DC V)	R_1	R_2	R_f	R_g	V_{out}
1							
2							
3							
4							

Summing Amplifier

Summing Op-amp



$$Vout = -\left(\frac{Rf}{R1}V1 + \frac{Rf}{R2}V2 + \frac{Rf}{R3}V3\right)$$

S.No	Summing Op-amp			R_1	R_2	R_3	R_f	V_{out}
	V_1	V_2	V_3					
1								
2								
3								
4								