Instituto Politécnico Nacional

Ingeniería en Sistemas Computacionales

Laboratorio de Instrumentación

Practica N° 3 “Acondicionamiento de Sensores Generadores con Amplificador de Instrumentación”

Nombre del Alumno:

Jesús Alberto García Valencia.
José Antonio Mora Guzmán.
Karla Patricia Noroña Cabeza.

Grupo: 3CV14.

Profesor:Jose Luis Aguilar Hernandez.

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Objective

The student will learn to use the generator transducers, as well as to calibrate the different components of a measurement system, in order to find the voltage value corresponding to the variable under measurement.

Equipment employed

- Computer
- Software tool for electronic circuit simulation (Multisim or PROTEUS).
- Internet connection.

Introduction

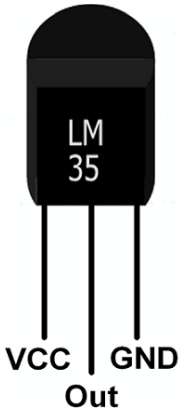
LM35 Precision Centigrade Temperature Sensors

The LM35 series are precision integrated-circuit temperature devices with an output voltage linearly proportional to the Centigrade temperature. The LM35 device is rated to operate over a −55°C to 150°C temperature range. Also the device does not require any external calibration or trimming to provide typical accuracies.

The low-output impedance, linear output, and precise inherent calibration of the LM35 device makes interfacing to readout or control circuitry especially easy.

The device is used with single power supplies, or with plus and minus supplies. It has very low self-heating.

The descriptions of its pins is



The features of the LM35 make it suitable for many general temperature sensing applications as: Basic Centigrade Temperature Sensor, Two-Wire Remote Temperature Sensor (Grounded Sensor), Two-Wire Remote Temperature Sensor (Output Referred to

Ground), Fahrenheit Thermometer, .Centigrade Thermometer (Analog Meter), Temperature to Digital Converter, etc.

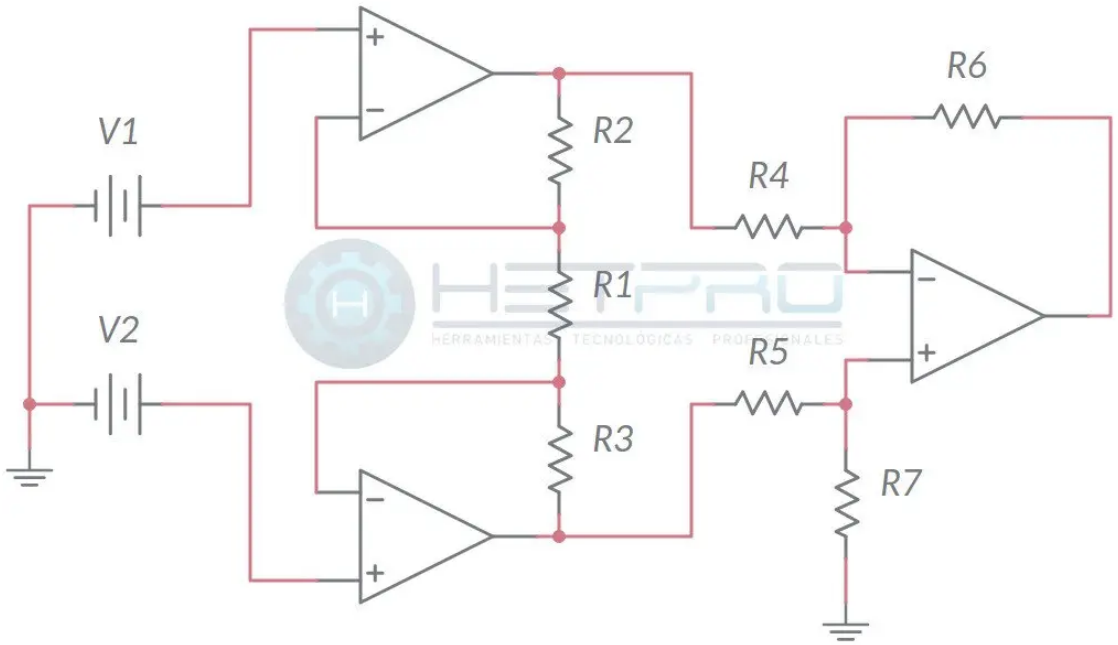
Instrumentation amplifier

The instrumentation amplifier is a differential mode operational amplifier with controlled gain. The advantage of using this arrangement instead of the traditional one, is the high input impedance and the simplified gain control. The greatest disadvantage is the impedance dependency on one of the input resistances.In an ideal case, the impedance of the amplifier tends to be infinite. For this case we can describe the relation between the input and output voltage like:

$$V_o = (1 + \frac{2}{a})(V_2 - V_1)$$

Where

$$a = \frac{R_1}{R_x}$$



And

$$R_x = R_2 = R_3 = R_4 = R_5 = R_6 = R_7$$

Development

1. Sensor conditioned generator with discrete Instrumentation Amplifier.

Gain Av (RG setting)	**LM35 Sensor Temperature (ºC)**	**E2 (Volts) measured**	**Vsal(Volts) measured**
	25°	0.25	0.25
	50°	0.50	0.50
1	75°	0.75	0.76
	25°	0.25	0.51
	50°	0.50	1.01
2	75°	0.75	1.51
	25°	0.25	0.76
	50°	0.50	1.51
3	75°	0.75	2.26

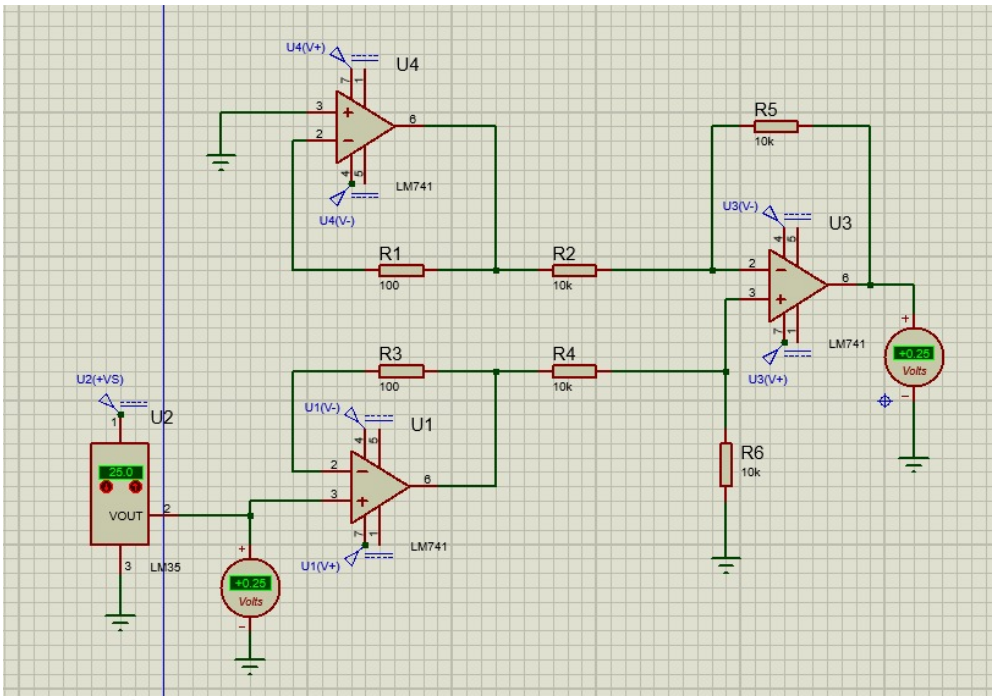
Table 1

2. Sensor generador acondicionado con el AD620, AI en CI.

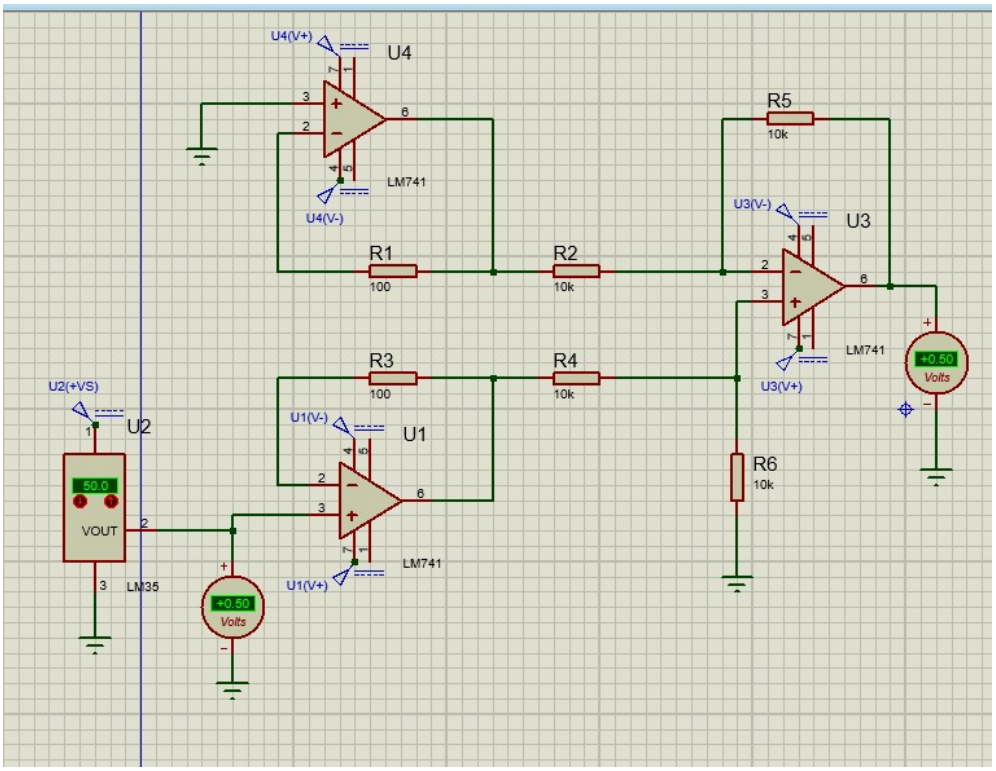
Gain Av (RG setting)	**LM35 Sensor Temperature (ºC)**	**E2 (Volts) measured**	**Vsal(Volts) measured**
	25°	0.25	0.25
	50°	0.50	0.50
1	75°	0.75	0.75
	25°	0.25	0.50
	50°	0.50	1.00
2	75°	0.75	1.50
	25°	0.25	0.75
	50°	0.50	1.50
3	75°	0.75	2.24

Table 2

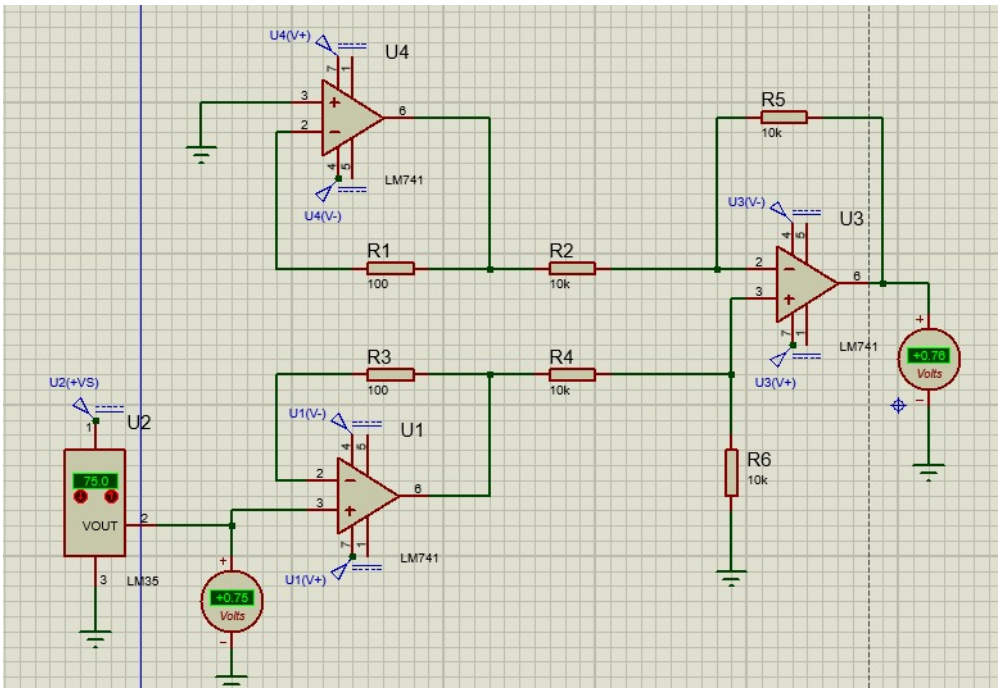
Evidence circuit 1



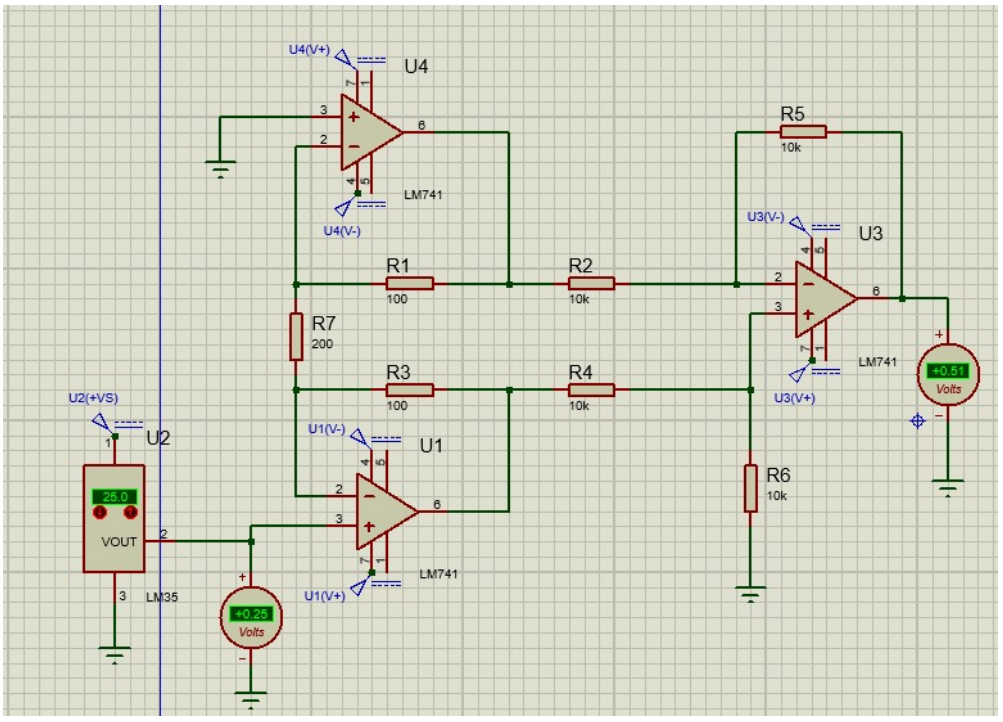
Av=1 25°



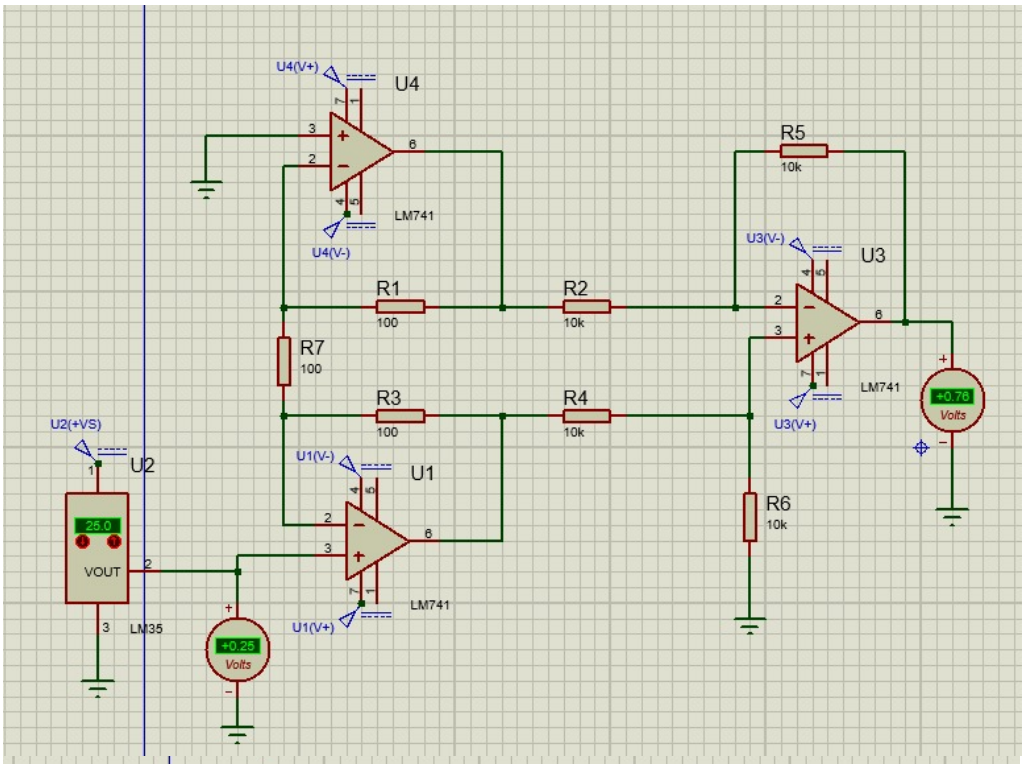
Av=1 50°


U4(V+)
U4
LM741
U4(V-)
R5
10k
U3(V-)
U3
R1
100
R2
10k
LM741
U3(V+)
+0.76
Volts
R3
100
R4
10k
U2(+VS)
U2
U1(V-)
U1
R6
10k
75.0
VOUT
LM35
LM741
U1(V+)
+0.76
Volts

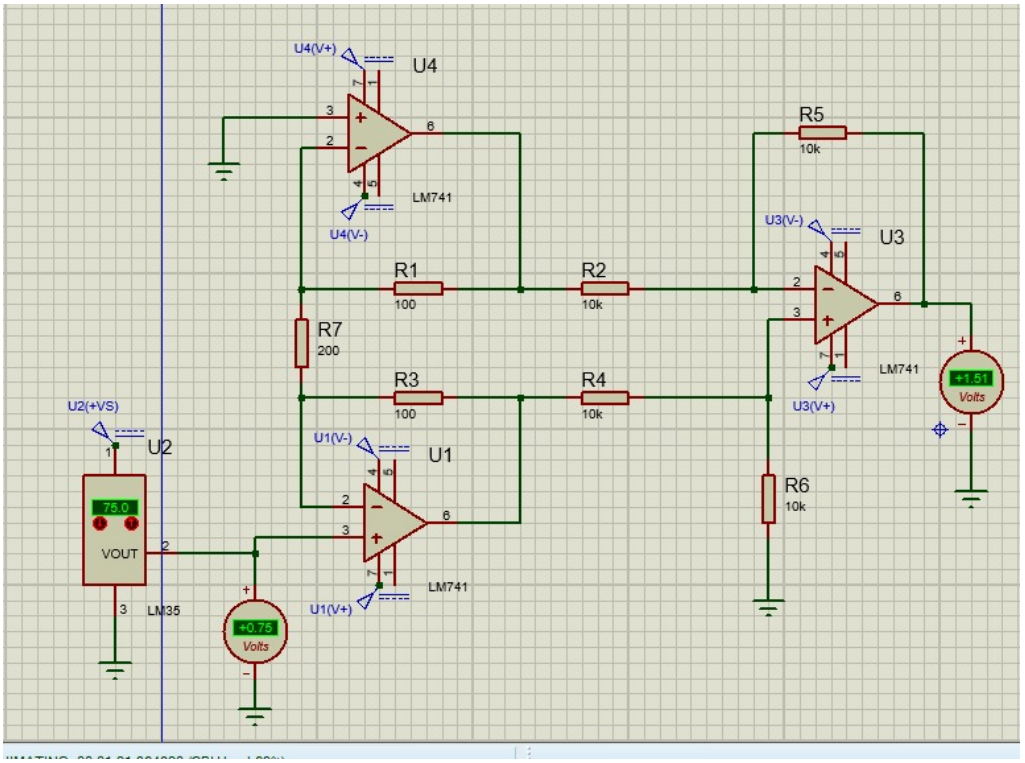
Av=1 75°


U4(V+)
U4
R5
10k
LM741
U4(V-)
U3(V-)
U3
R1
100
R2
10k
R7
200
LM741
+0.51
Volts
R3
100
R4
10k
U3(V+)
U2(+VS)
U2
U1(V-)
U1
R6
10k
25.0
VOUT
LM741
LM35
U1(V+)
+0.25
Volts

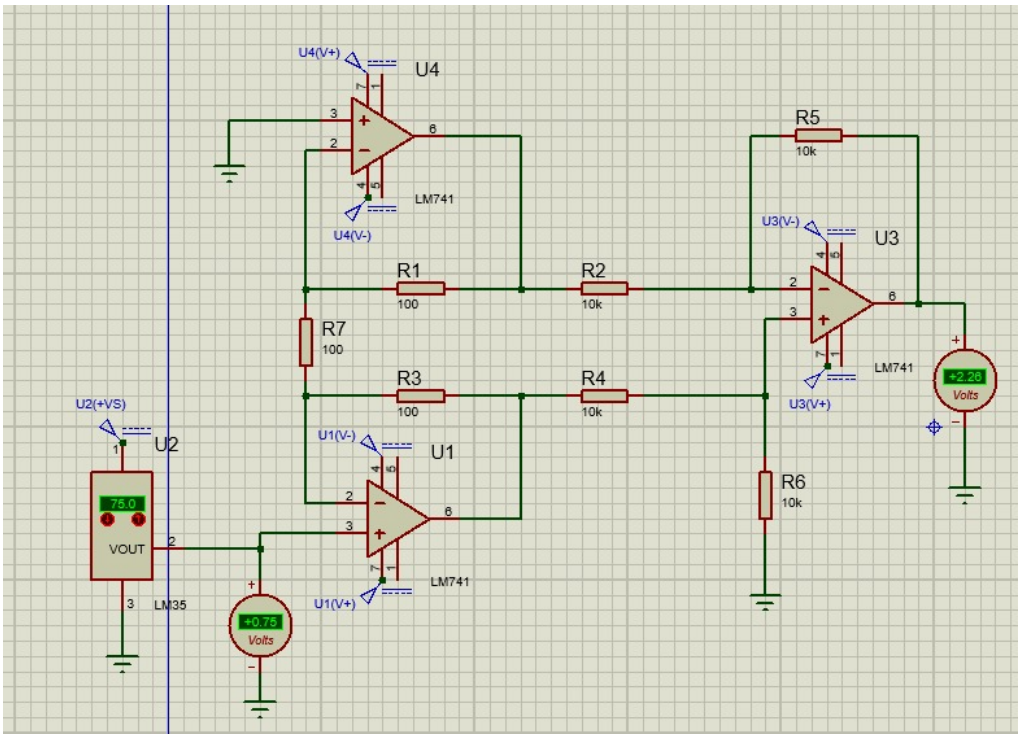
Av=2 25°


U4(V+)
U4
LM741
U4(V-)
R1
100
R2
10k
R5
10k
U3(V-)
U3
R7
100
R3
100
R4
10k
LM741
U3(V+)
+0.76
Volts
U2(+VS)
U2
U1(V-)
U1
R6
10k
25.0
VOUT
LM35
U1(V+)
LM741
+0.25
Volts

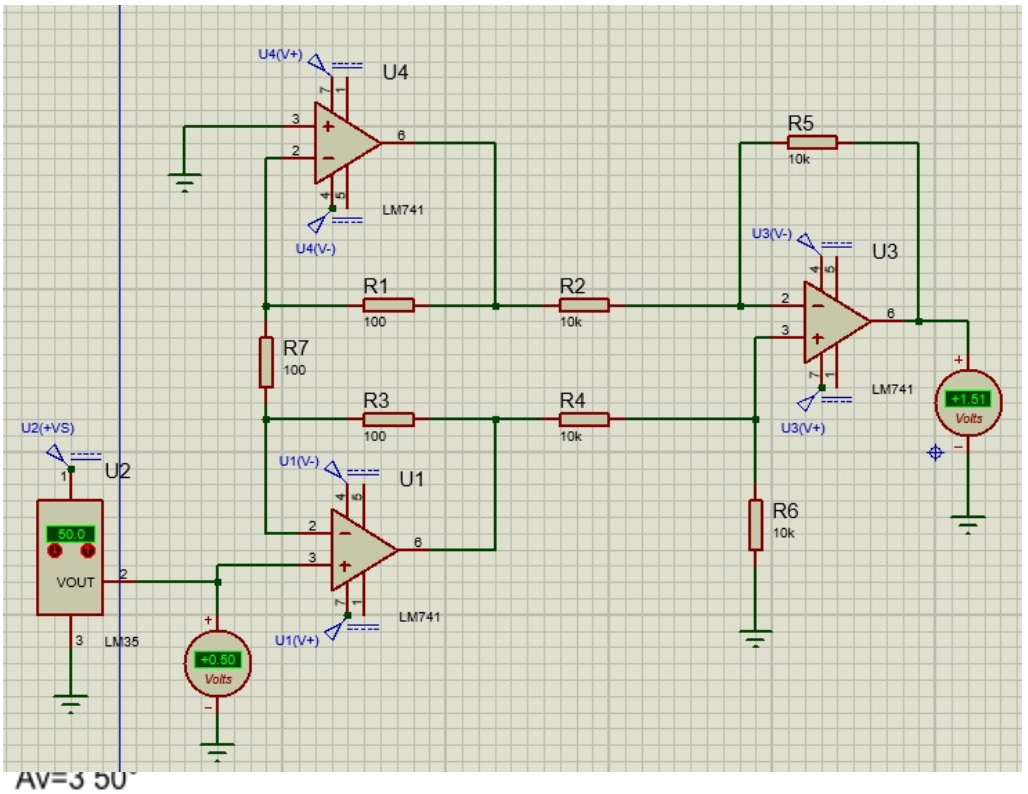
Av=2 50°


U4(V+)
U4
LM741
U4(V-)
R1
100
R2
10k
R5
10k
U3(V-)
U3
R7
200
R3
100
R4
10k
LM741
U3(V+)
+1.51
Volts
U2(+VS)
U2
U1(V-)
U1
R6
10k
75.0
VOUT
LM35
U1(V+)
LM741
+0.75
Volts

Av=2 75°


U4(V+)
U4
LM741
U4(V-)
R5
10k
U3(V-)
U3
R1
100
R2
10k
R7
100
LM741
+2.26
Volts
U3(V+)
R3
100
R4
10k
U2(+VS)
U2
U1(V-)
U1
R6
10k
75.0
VOUT
LM35
U1(V+)
LM741
+0.75
Volts

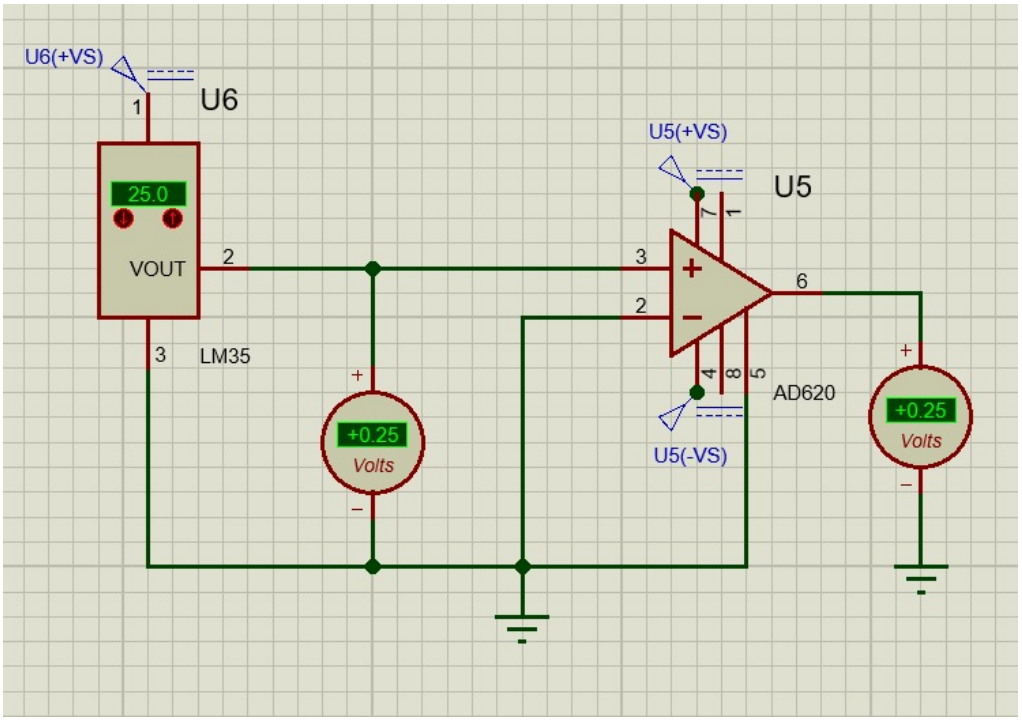
Av=3 25°


U4(V+)
U4
LM741
U4(V-)
R5
10k
U3(V-)
U3
R1
100
R2
10k
R7
100
LM741
+1.51
Volts
U3(V+)
R3
100
R4
10k
U2(+VS)
U2
U1(V-)
U1
R6
10k
50.0
VOUT
LM35
U1(V+)
LM741
+0.50
Volts

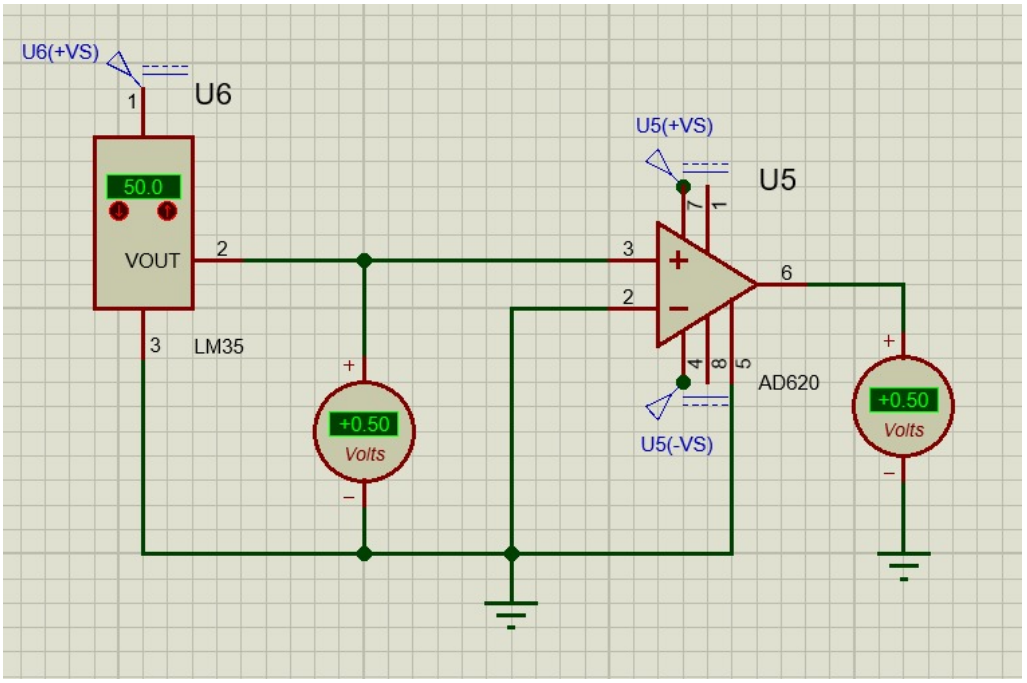
AV=3 50°

Av=3 75°

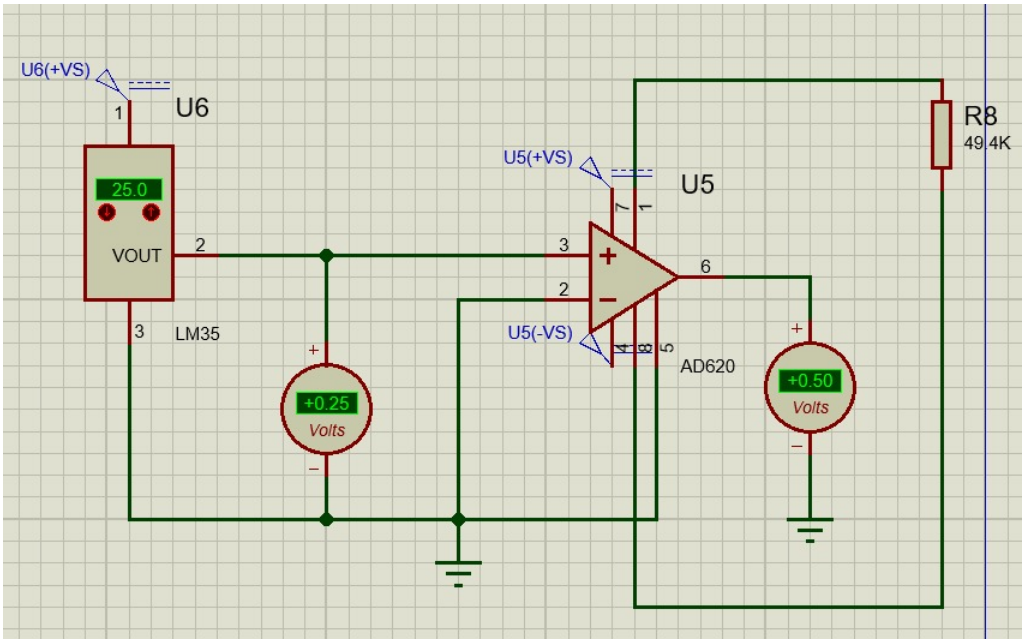
Evidence circuit 2



Av=1 25°

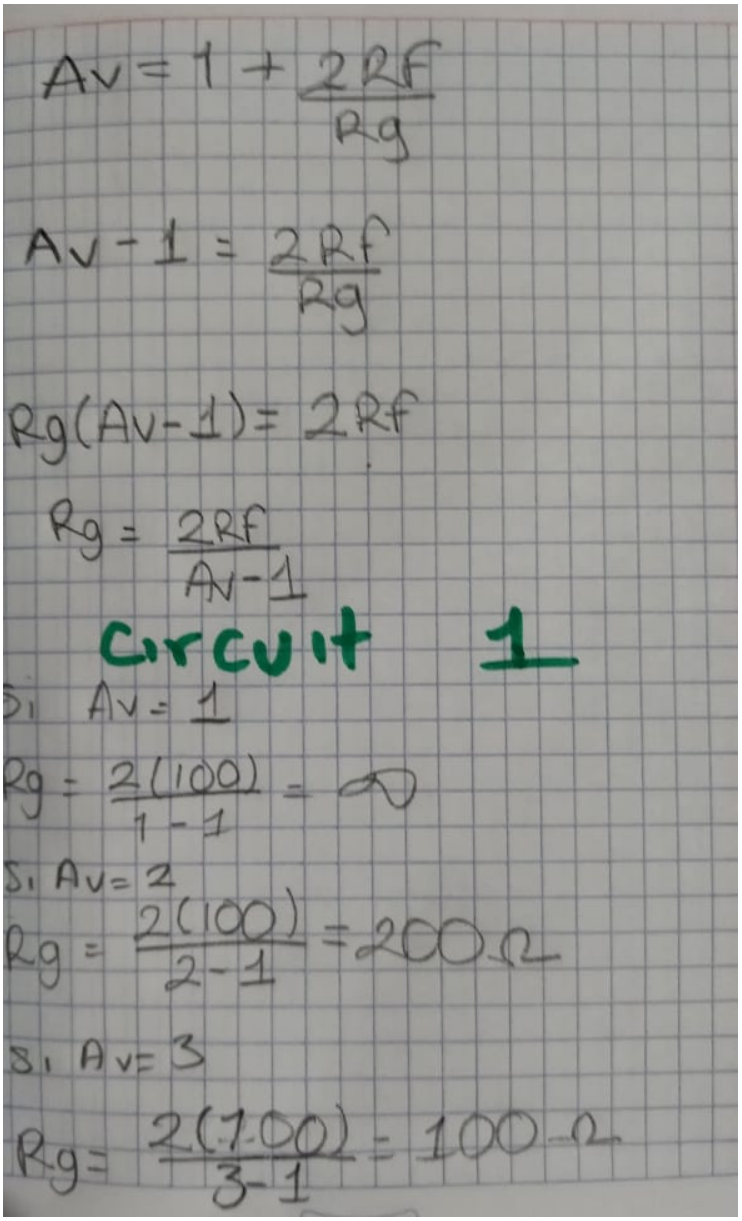

U6(+VS)
U6
1
50.0
VOUT
2
3
LM35
+0.50
Volts
U5(+VS)
U5
7
1
3
2
6
4
8
5
AD620
U5(-VS)
+0.50
Volts

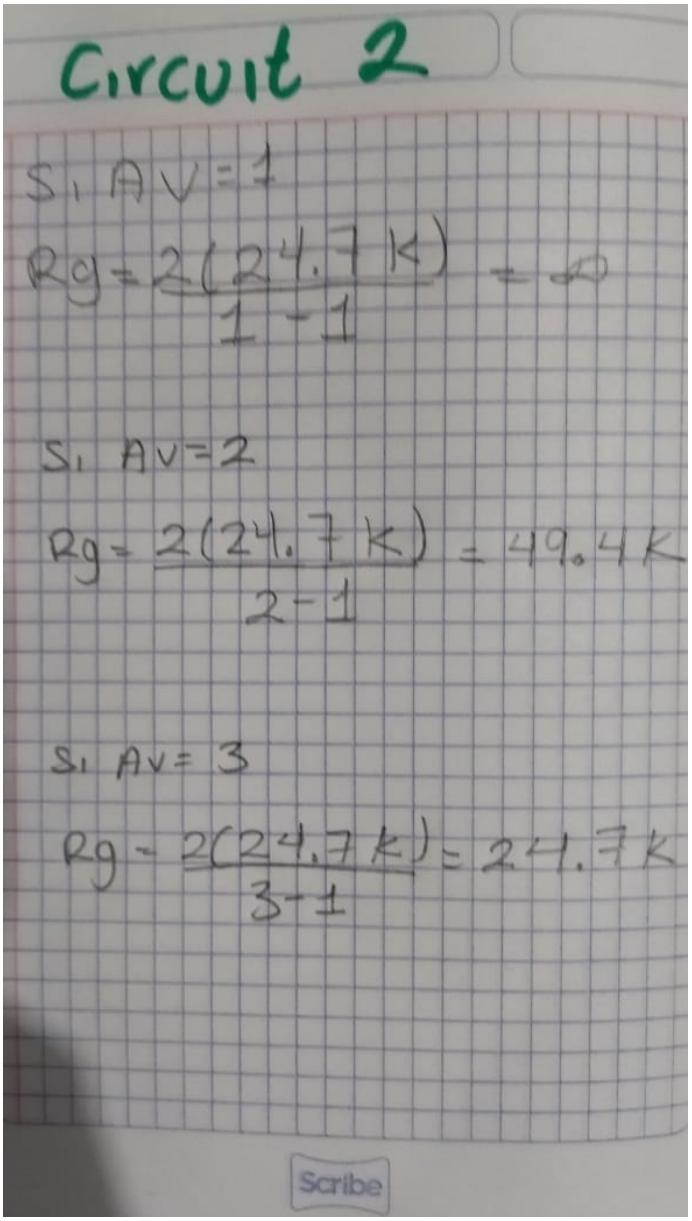
Av=1 50°


U6(+VS)
U6
1
25.0
VOUT
2
3
LM35
+0.25
Volts
U5(+VS)
U5
7
1
3
2
6
U5(-VS)
4
8
5
AD620
+0.50
Volts
R8
49.4K

Av=2 25°

Calculations




Circuit 2
Si Av=1
Rg= 2(24.7 k) / 1-1 = ∞
Si Av=2
Rg= 2(24.7 k) / 2-1 = 49.4 K
Si Av= 3
Rg= 2(24.7 k) / 3-1 = 24.7 K
Scribe

Questionnaire

1. Which is the main feature of a generator sensor?
   Generator sensors are those that generate an electrical signal from the magnitude they measure, without the need for an electrical supply

2. What is the Instrumentation Amplifier used for?
   To amplify an input signal.
3. Which are the features of an Instrumentation Amplifier?
   The instrumentation amplifier has all the characteristics of the operational amplifier: 1) differential amplification, 2) high input impedance, and 3) low output impedance; but it has other important characteristics: 4) the gain can be modified, and 5) the gain is constant over a wide frequency band.
4. What is the mathematical expression for calculating the voltage gain in the instrumentation amplifiers used?
   $AV = 1 + \frac{2R_f}{Rg}$
5. To measure temperature with a thermocouple, how should the thermocouple sensor be used with the Instrumentation Amplifier?

Conclusions

This practice seemed too interesting to us, because we could see how the AD620 amplifier saved us from doing everything that was done with the LM741, although at first it caused us problems with the measurement, after reviewing the circuit we were able to fill the table

References

Texas Instruments. (n.d.). LM53 Precision Centigrade Temperature Sensor. Obtained from: https://www.electronics-tutorials.ws/opamp/opamp_5.html

Electronics Tutorials. (n.d.). The Differential Amplifier. Obtained from: https://www.ti.com/lit/ds/symlink/lm35.pdf?ts=1632250913917&ref_url=https%253A%252F%252Fwww.ti.com%252Fproduct%252FLM35

Electronic Circuits and Diagrams-Electronic Projects and Design. (n.d.). Instrumentation amplifier.Obtained from: https://www.circuitstoday.com/instrumentation-amplifier