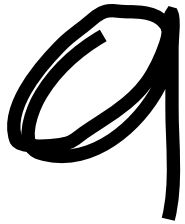


PRÁCTICA 9 – MEDICIÓN DE TEMPERATURA

LABORATORIO DE INSTRUMENTACIÓN

OBJETIVOS

Conocer la temperatura de una sustancia por medio de diferentes instrumentos.

Aprender a utilizar la tabla de termopares.

Aprender a usar un termistor, RTD y sensor basado en semiconductor

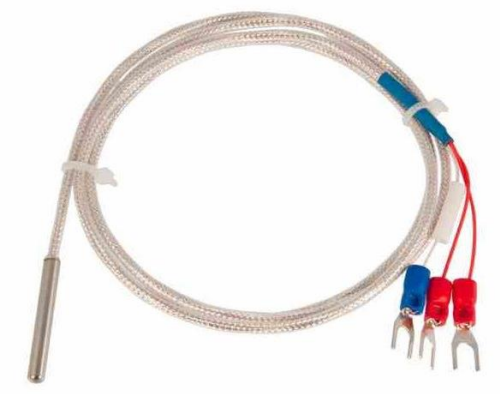
Hallar la curva de calibración de los diferentes instrumentos de medición de temperatura con respecto a una medida patrón.

INSTRUMENTOS A ESTUDIAR

Termopar

Termistor

RTD



TMP36

TERMOPAR (“TERMOCUPLA”)

Unión de dos conductores diferentes

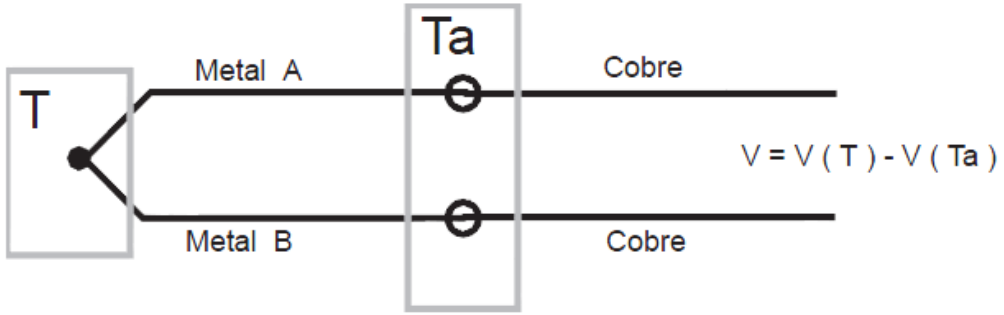
Salida de mili-voltaje

No necesita alimentación*

Necesita compensación de unión fría

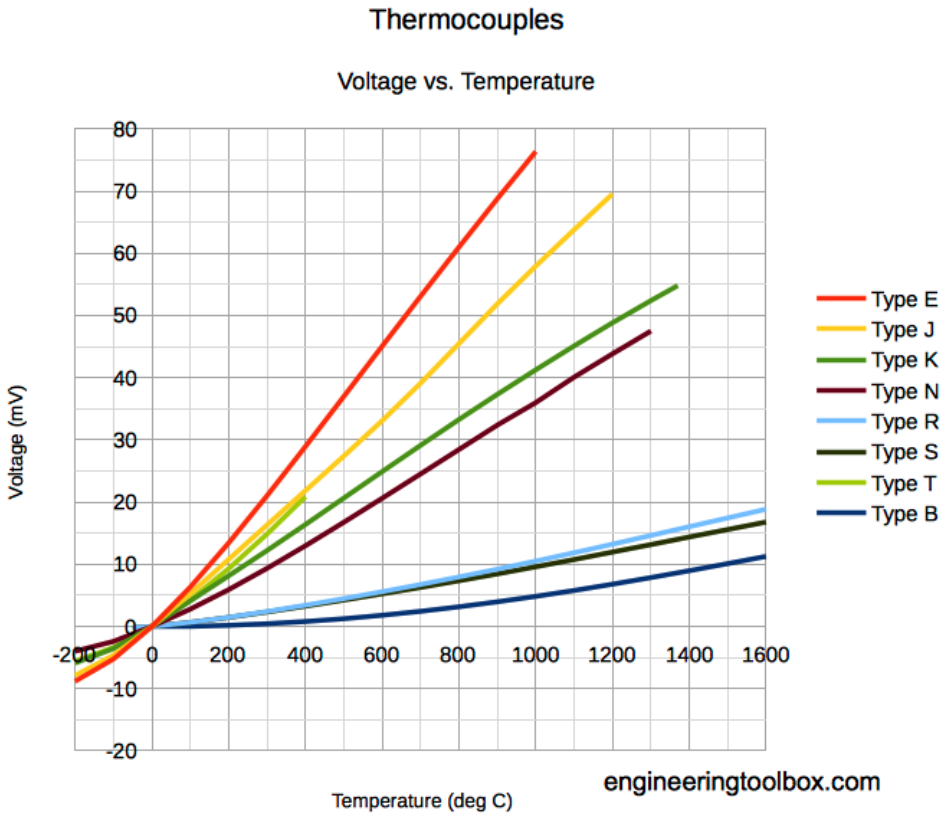
Mide **diferencia** de temperatura

*Necesita amplificación y acondicionamiento



TERMOPAR (“TERMOCUPLA”)

ANSI Code	ANSI MC 96.1 Color Coding		Alloy Combination		Maximum T/C Grande temp. range	EMF(mv)Over Max.temp.range	IEC 584-3 Color Coding	IEC Code
	Thermocouple	Extension	+ Lead	- Lead				
K			NICKEL-CHROMIUM Ni-Cr	NICKEL-ALUMINUM Ni-Al	-270 to 1372°C -454 to 2501°F	-6.458 to 54.886		K
J			IRON Fe (magnetic)	CONTANTAN COOPER-NICKEL Cu-Ni	-210 to 1200°C -346 to 2193°F	-8.095 to 69.553		J
T			COPPER Cu	CONTANTAN COOPER-NICKEL Cu-Ni	-270 to 400°C -454 to 752°F	-6.258 to 20.872		T
E			NICKEL-CHROMIUM Ni-Cr	CONTANTAN COOPER-NICKEL Cu-Ni	-270 to 1000°C -454 to 1832°F	-9.835 to 76.373		E
N			NICROSIL Ni-Cr-Si	NISIL Ni-Si-Mg	-270 to 1300°C -450 to 2372°F	-4.345 to 47.513		N
S	NONE ESTABLISHED		PLATINUM-10% RHODIUM Pt-10%Rh	PLATINUM Pt	-50 to 1768°C -58 to 3214°F	-0.236 to 18.693		S
R	NONE ESTABLISHED		PLATINUM-13% RHODIUM Pt-13%Rh	PLATINUM Pt	-50 to 1768°C -58 to 3214°F	-0.226 to 21.101		R
B	NONE ESTABLISHED		PLATINUM-30% RHODIUM Pt-30%Rh	PLATINUM-6% RHODIUM Pt-6%Rh	0 to 1820°C 32 to 3308°F	0 to 13.820		B



RTD

Resistive **T**emperature **D**etector
(Detector de Temperatura Resistivo)

Salida de resistencia

Necesita fuente de corriente o voltaje*

*Evitar auto-calentamiento (errores)

La siguiente ecuación se cumple para un rango limitado:

$$R_t = R_0[1 + \alpha\,(t - t_0)]$$

Where:

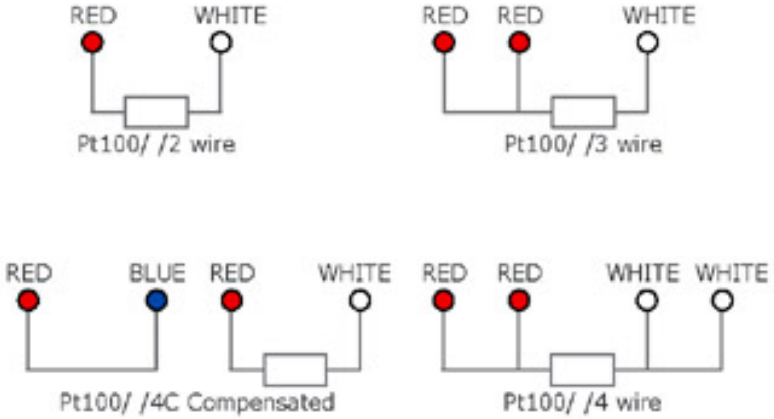
R_t = resistance at temperature 't'

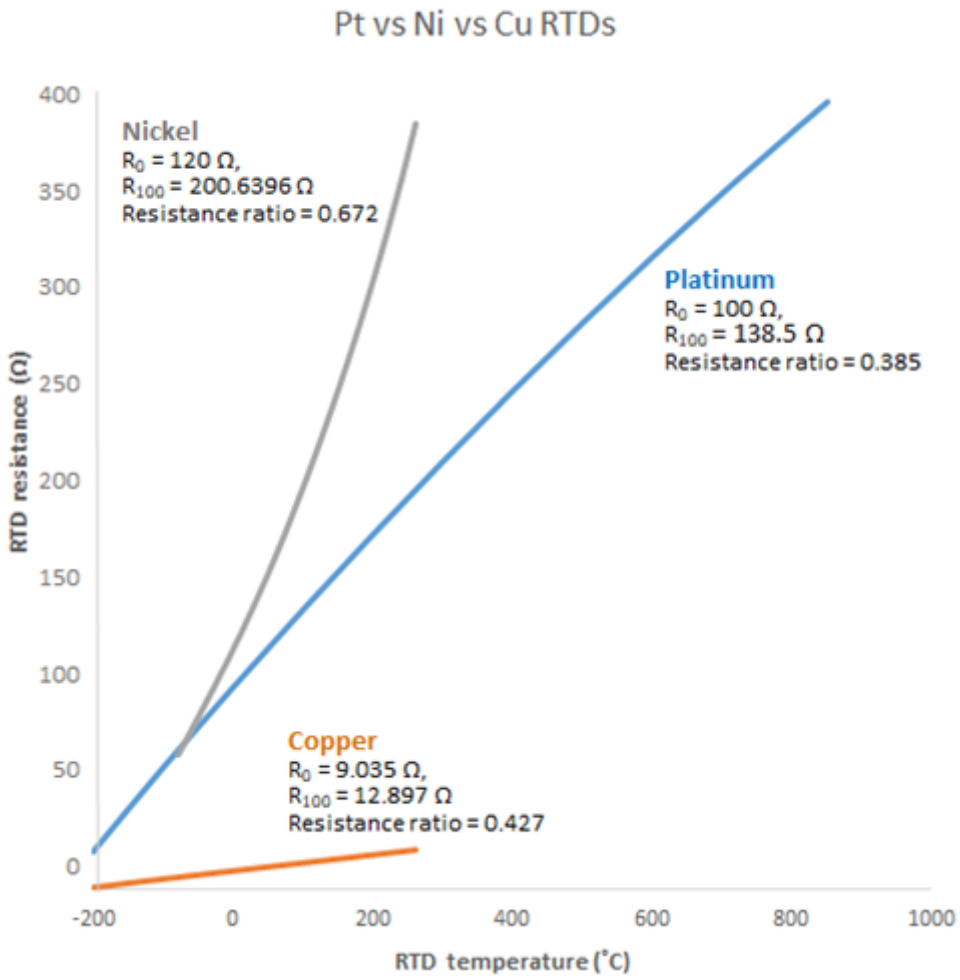
R_0 = resistance at a reference temperature (Generally 0 degree C)

α = temperature coefficient of resistance ($°C^{-1}$)

RTD

RTD type	Maximum measurement range	Long term stability	Corrosion resistance	Temperature vs. resistance linearity	Typical resistance at 0°C	Typical resistance at 100°C	Change in resistance 0...100°C	Resistance ratio (R_{100}-R_0)/ R_0	Alpha (α) (R_{100}-R_0)/(100 x R_0)
Platinum	-200...850°C	Excellent	Excellent	Good	100 Ω	138.5 Ω	38.5 Ω	0.385	0.00385
Nickel	-80...260°C	Fair	Good	Fair	120 Ω	200.64 Ω	80.64 Ω	0.672	0.00672
Copper	-200...260°C	Good	Fair	Excellent	9.035 Ω	12.897 Ω	3.86 Ω	0.427	0.00427





TERMISTOR

Thermistor = **Ther**mo Res**istor**

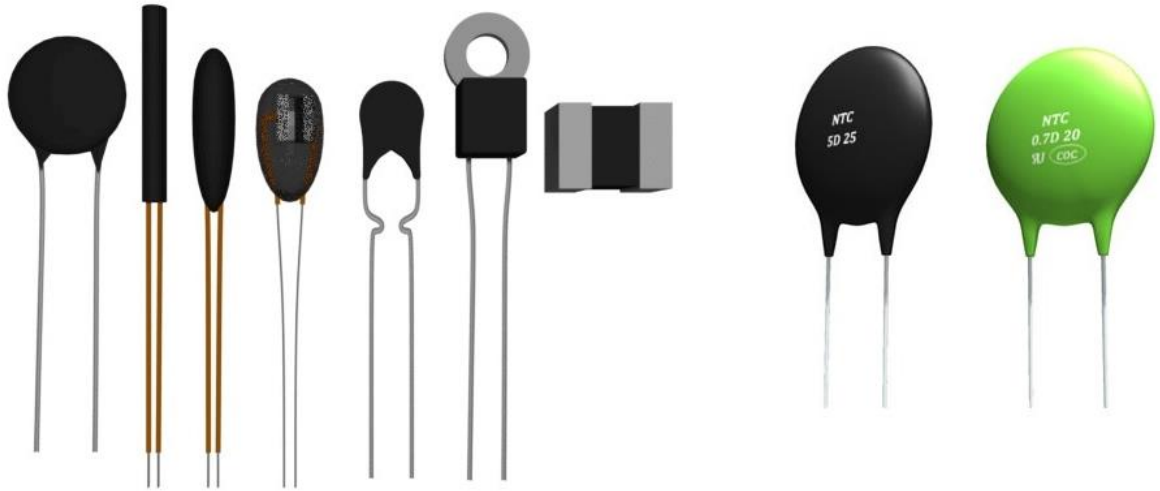
Salida de resistencia

Necesita fuente de corriente o voltaje*

*Evitar auto-calentamiento (errores)

NTC (Negative Temperature Coefficient)

PTC (Positive Temperature Coefficient)



$$R = R_0 e^{\beta\left(\frac{1}{T} - \frac{1}{T_0}\right)}$$

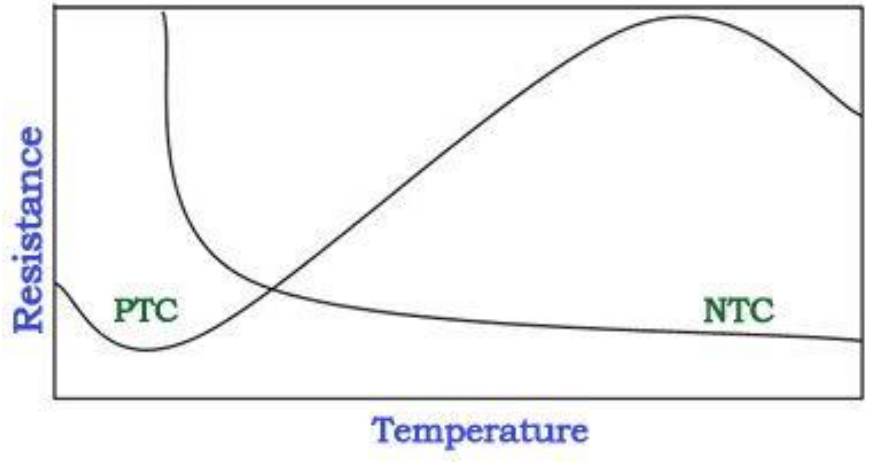
R is the resistance of thermistor at the temperature T (in K)

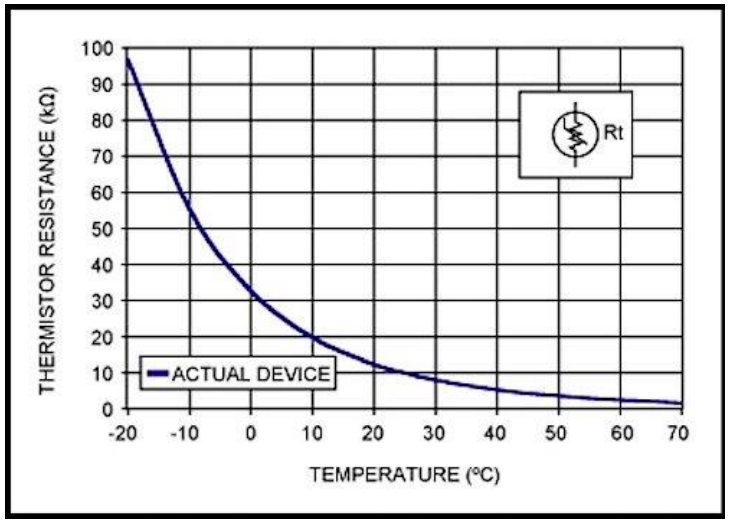
R_0 is the resistance at given temperature T_0 (in K)

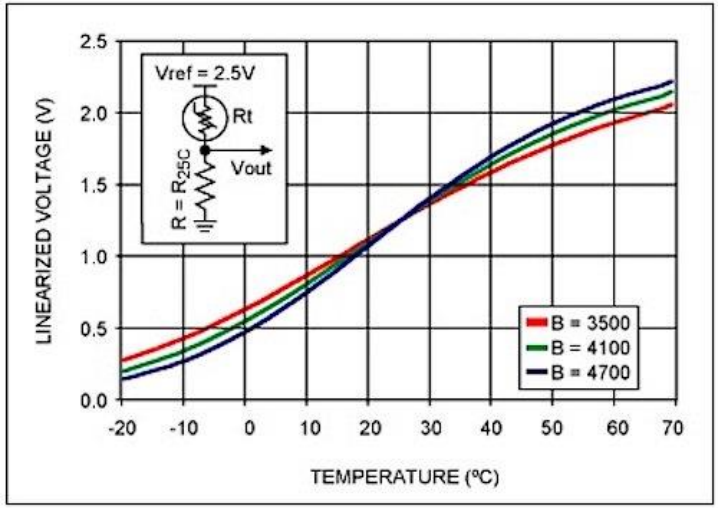
β is the material specific-constant

TERMISTOR

Thermistors	Measured R_{T0} (kΩ)	Measured β –Values (K)	Linearizing Resistance r (Ω)	Excitation Voltage (V_i) (V)	Feedback Resistance R_f (kΩ)
Thermistor I (100 Ω)	0.11	2847.4	30.0	1.0	0.19
Thermistor II (1 kΩ)	1.34	3056.4	519.0	1.0	2.99
Thermistor III (5 kΩ)	4.86	3963.3	642.0	1.0	4.12







TMP36

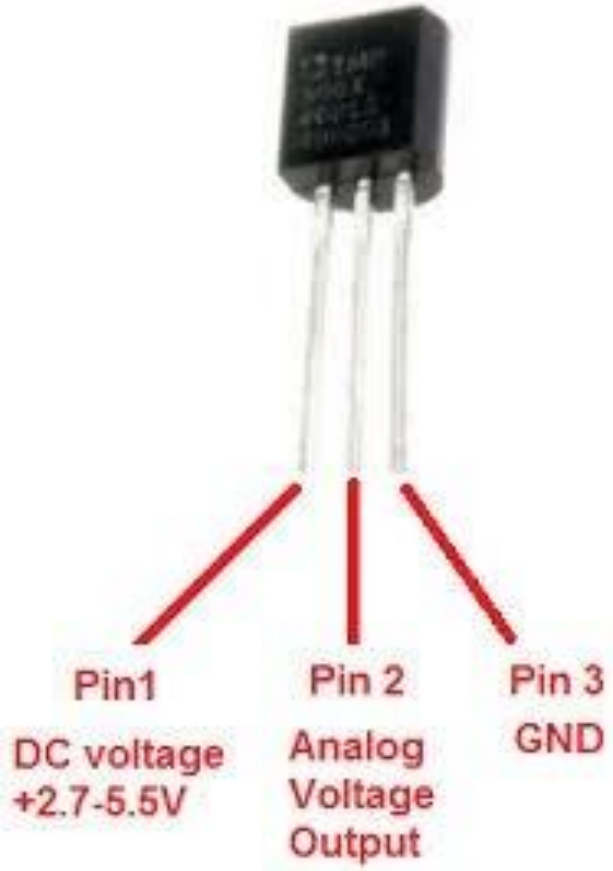
Basado en comportamiento térmico de semiconductores.

Necesita alimentación

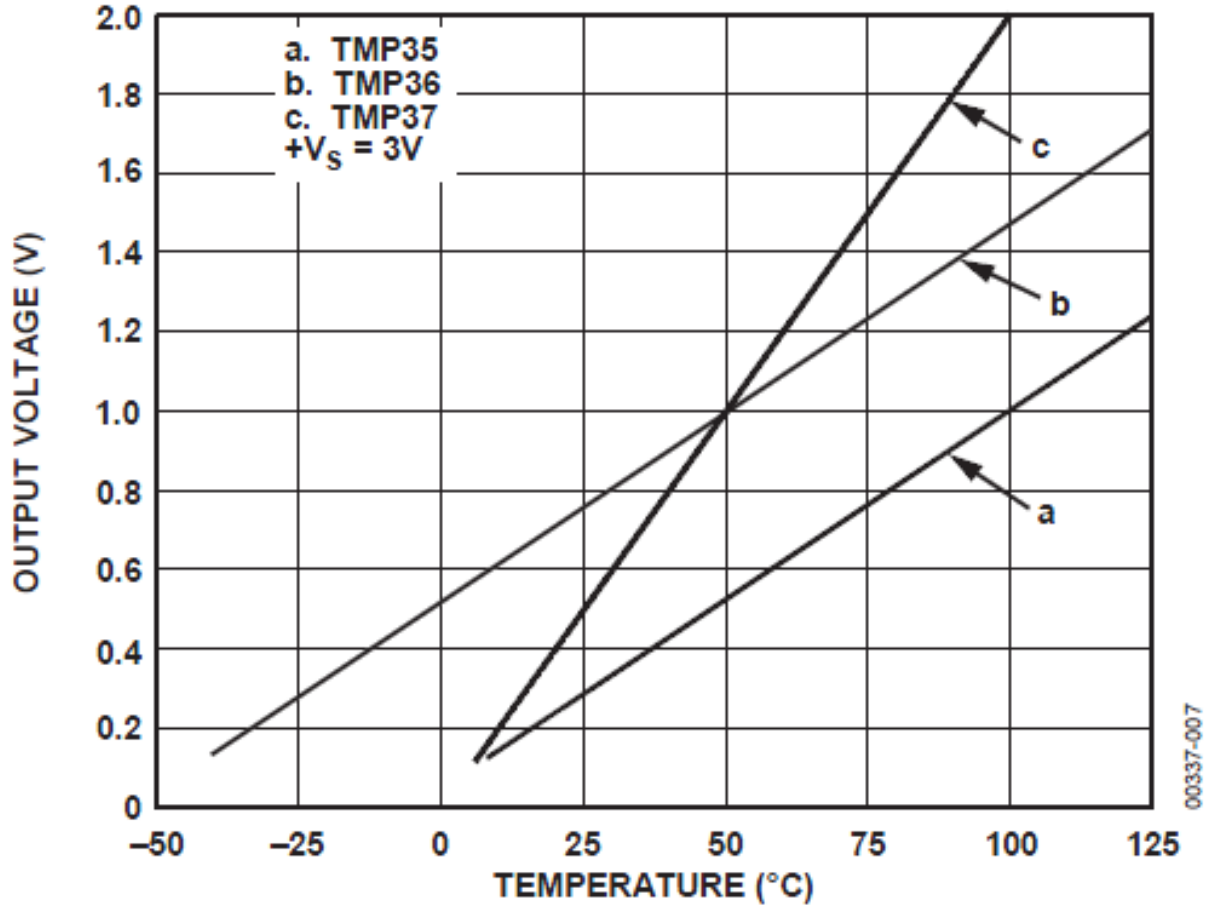
Salida de voltaje calibrada

Respuesta más lineal

Rango limitado



TMP36

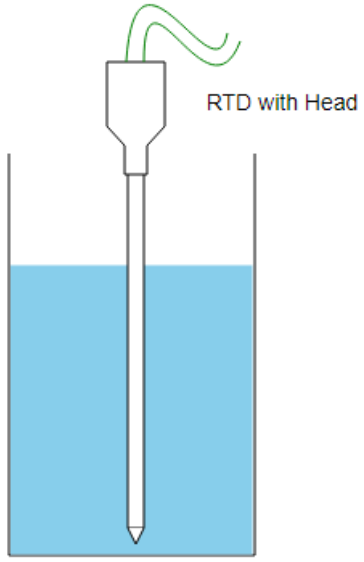

a. TMP35
b. TMP36
c. TMP37
+V_S = 3V
OUTPUT VOLTAGE (V)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
–50
–25
0
25
50
75
100
125
TEMPERATURE (°C)
c
b
a
00337-007

COMPARACIÓN

Typical Temperature Sensor Characteristics				
Typical Charac-teristics	Thermistors General Purpose	Resistance Temperature Devices (RTDs)	Thermocouples (TCs)	Semiconductor Temperature Sensors
Temperature Range	- 55°C to + 125°C	- 200°C to + 850°C	-600°C to +2000°C	-50°C to +150°C
Linearity	Exponential	Fairly linear	Fairly Linear	Best
Sensitivity	High	Low	Medium	Highest
Response Time	Fast	Slow	Fast to Slow (depends on construction)	Slow
Excitation or power	Needed	Needed	Not Needed	Needed
Long-Term Stability	Low	High	High	Medium
Self-heating	Yes	Yes	No	Yes
Cost	Low	Low (film) High (wire wound)	Moderate to High: (depends on construction)	Low to Moderate

SIMULADOR DE TERMOPAR

Level-1 Static Characteristics



Static Characteristics

Control Panel

Material : Select

R_0: Select

Get temperature ==>

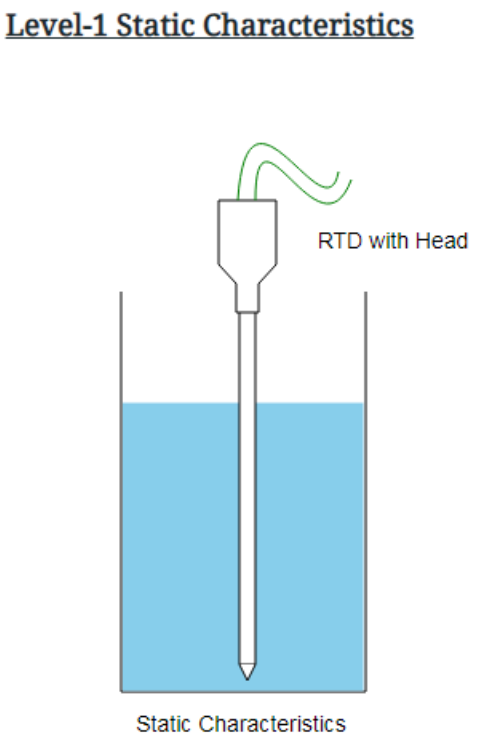
Enter Output R_t Value :

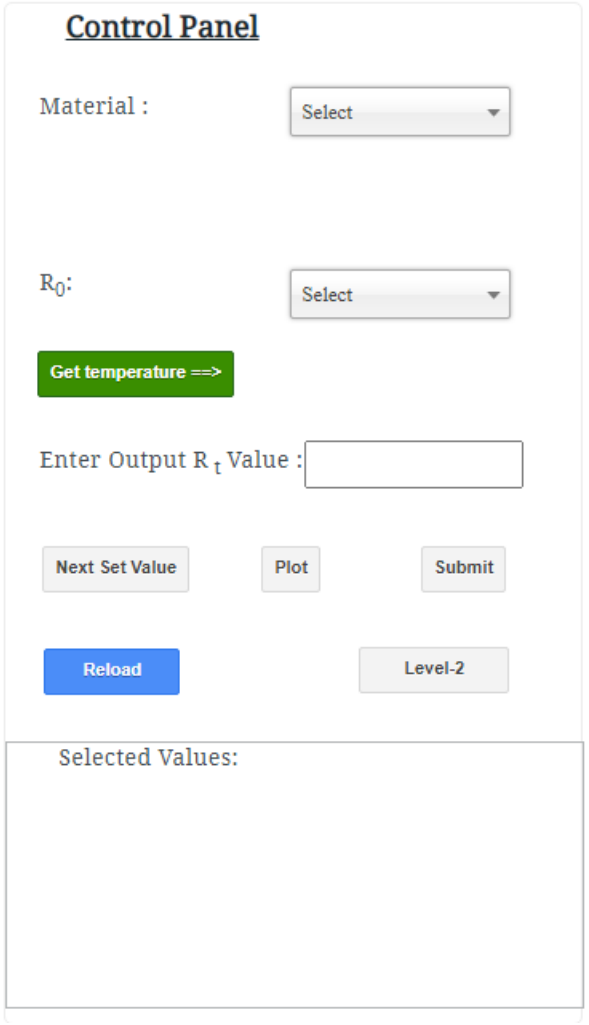
Next Set Value | Plot | Submit

Reload | Level-2

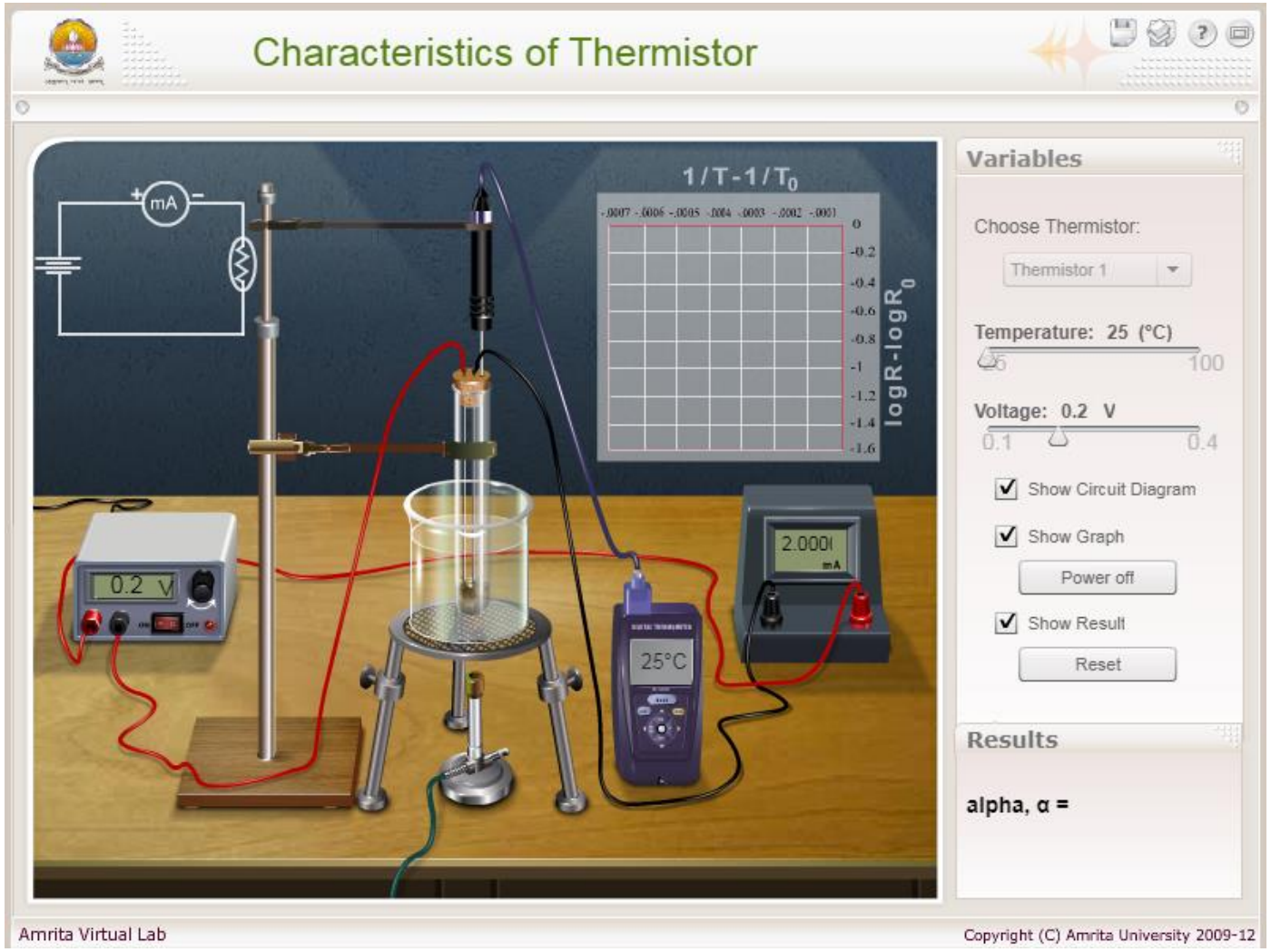
Selected Values:

SIMULADOR DE RTD

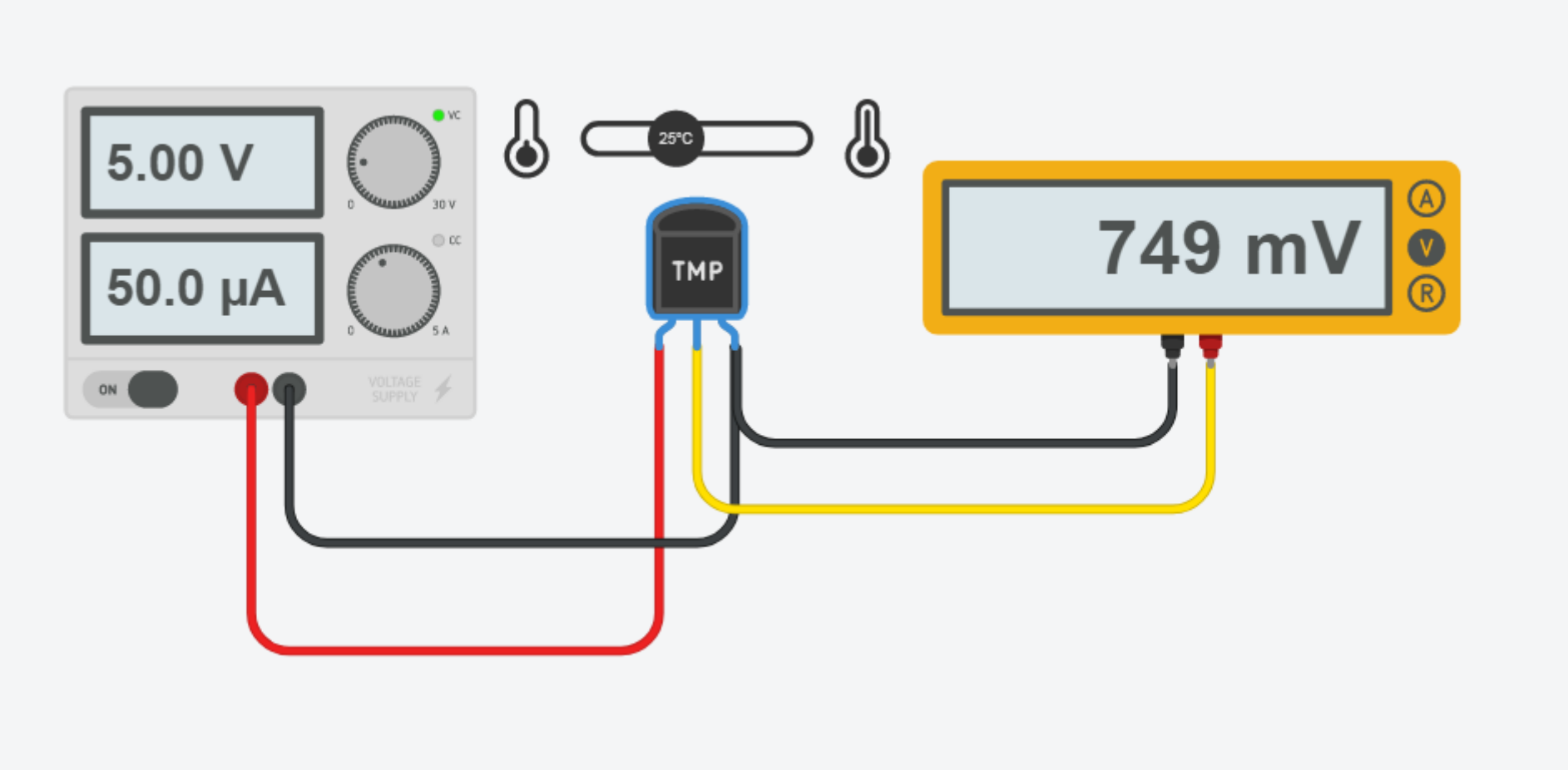




SIMULADOR DE TERMISTOR



SIMULADOR DE TMP36



SIMULADORES

Termopar:

http://sl-coep.vlabs.ac.in/Thermocouple/thermocouple.html

RTD:

http://sl-coep.vlabs.ac.in/Rtd/rtd.html

Termistor:

https://vlab.amrita.edu/?sub=1&brch=282&sim=1511&cnt=4

TMP36

https://www.tinkercad.com/

MATERIAL AUDIOVISUAL

Sensores de temperatura:
https://www.youtube.com/watch?v=4mQ3o1t4Ssg&t=35s
https://www.youtube.com/watch?v=w3Hfj2kMrGo
Termopar
https://www.youtube.com/watch?v=1wwAQNECC9A
RTD
https://www.youtube.com/watch?v=dQJpTusWJHA
Termistor
https://www.youtube.com/watch?v=cnvzYTF48Tg
Sensores basados en semiconductores (TMP36)
https://www.youtube.com/watch?v=lrNZ8YSvfS4