



# **SENSORS AND AUTOMATION**

**Sarvesh Anand Mankar**  
**142203013**  
**SY Comp Div-2, S5 Batch**

# Practical-1: Characterization of RTD

## Aim:

1. Study static and dynamic characteristics of RTD
2. Study effect of various parameters on RTD performance

## Theory:

### RTD:

A resistance temperature detector (RTD) is a type of temperature sensor that measures temperature by the change in electrical resistance of a metal wire as it is heated or cooled. The most common metal used in RTDs is platinum, although other metals such as nickel and copper can also be used. RTDs have several advantages over other types of temperature sensors, including high accuracy, stability, and repeatability. They are also relatively easy to use and do not require any calibration or special circuitry.

### Temperature:

Temperature is a measure of the average heat or thermal energy of the particles in a substance. Since it is an average measurement, it does not depend on the number of particles in an object. In that sense it does not depend on the size of it. For example, the temperature of a small cup of boiling water is the same as the temperature of a large pot of boiling water. Even if the large pot is much bigger than the cup and has millions and millions more water molecules. The basic unit of temperature (T) in the International System of Units (SI) is the Kelvin (K). The commonly used other units of temperature are Degree Celsius ( $^{\circ}\text{C}$ ) and Degree Fahrenheit ( $^{\circ}\text{F}$ ).

### **Electrical Resistance:**

The electrical resistance of an object is a measure of its opposition to the flow of an electric current. For a wide range of materials and conditions, the electrical resistance does not depend on the amount of current through or the potential difference (voltage) across the object. That means the resistance  $R$  is constants for the given temperature and material. Therefore, the resistance of an object can be defined as the ratio of voltage to current, in accordance with

$$\text{Ohm's Law: } R = V/I \text{ ohm}$$

### **Temperature calculations:**

RTDs are manufactured from metals whose resistance increases with temperature. Within a limited temperature range, its resistance increases linearly with temperature:  $R_t = R_0[1 + \alpha (t - t_0)]$

Where:  $R_t$  = resistance at temperature 't'

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

$\alpha$  = temperature coefficient of resistance ( $^{\circ}\text{C}^{-1}$ )

Setting  $t_0$  to  $0^{\circ}\text{C}$  and rearranging to the standard linear  $y = m \cdot x + b$  form, it is clear that resistance vs. temperature is linear with a slope equal to  $R / R_0 = \alpha \cdot t + 1$

The relationship between resistance and temperature of RTD can be approximated by the Callendar-Van Dusen equation which is given by,

$$R_t / R_0 = 1 + \alpha [ t - \delta((t/100)-1)(t/100) - \beta((t/100)-1)(t/100)^3]$$

Where,

$t$  = temperature ( $^{\circ}\text{C}$ )


$R_t$  = Resistance at temperature,  $t^{\circ}\text{C}$

$R_0$  = Resistance at  $0^{\circ}\text{C}$

$\alpha$  = Constant (  $0.00385\Omega/\Omega/^{\circ}\text{C}$  )

$\delta$  &  $\beta$  are Linearization coefficients, where  $\beta = 0$  for  $t > 0^{\circ}\text{C}$

## Pretest:



Virtual Labs  
An MoE, Govt of India Initiative

HOMEPARTNERSCONTACT

Electrical Engineering > Sensors Modeling & Simulation Lab > Experiments

[Aim](#)  
[Theory](#)  
[Pretest](#)  
[Procedure](#)  
[Simulation](#)  
[Posttest](#)  
[References](#)  
[Feedback](#)

### Characterize the temperature sensor(RTD)

**Transducer is a device**

- ☐ a: that converts one form of energy into another form
- ☐ b: has mostly electrical output
- ☒ c: with both the above properties
- ☐ d: None of these

**Temperature is measure of degree of ----- of a substance**

- ☐ a: Coldness
- ☐ b: Hotness
- ☒ c: Hotness or Coldness

**The International System of Measurements (SI) use ----- scale for measuring temperature**

- ☐ a: Celcius
- ☒ b: Kelvin
- ☐ c: Farenheit
- ☐ d: Degree

**The freezing point of pure water is**

- ☒ a: 0 deg C
- ☐ b: 5 deg C
- ☐ c: 10 deg C
- ☐ d: -1 deg C

**Accuracy and range of measurement does not depend upon**

- ☐ a: The temperature being measured
- ☒ b: The size of system under measurement
- ☐ c: The construction of the sensor
- ☐ d: None of these

Submit Quiz

5 out of 5





Community Links

[Sakshat Portal](#)  
[Outreach Portal](#)  
[FAQ: Virtual Labs](#)

Contact Us

Phone: General Information: 011-26582050  
Email: support@vlab.ac.in

Follow Us

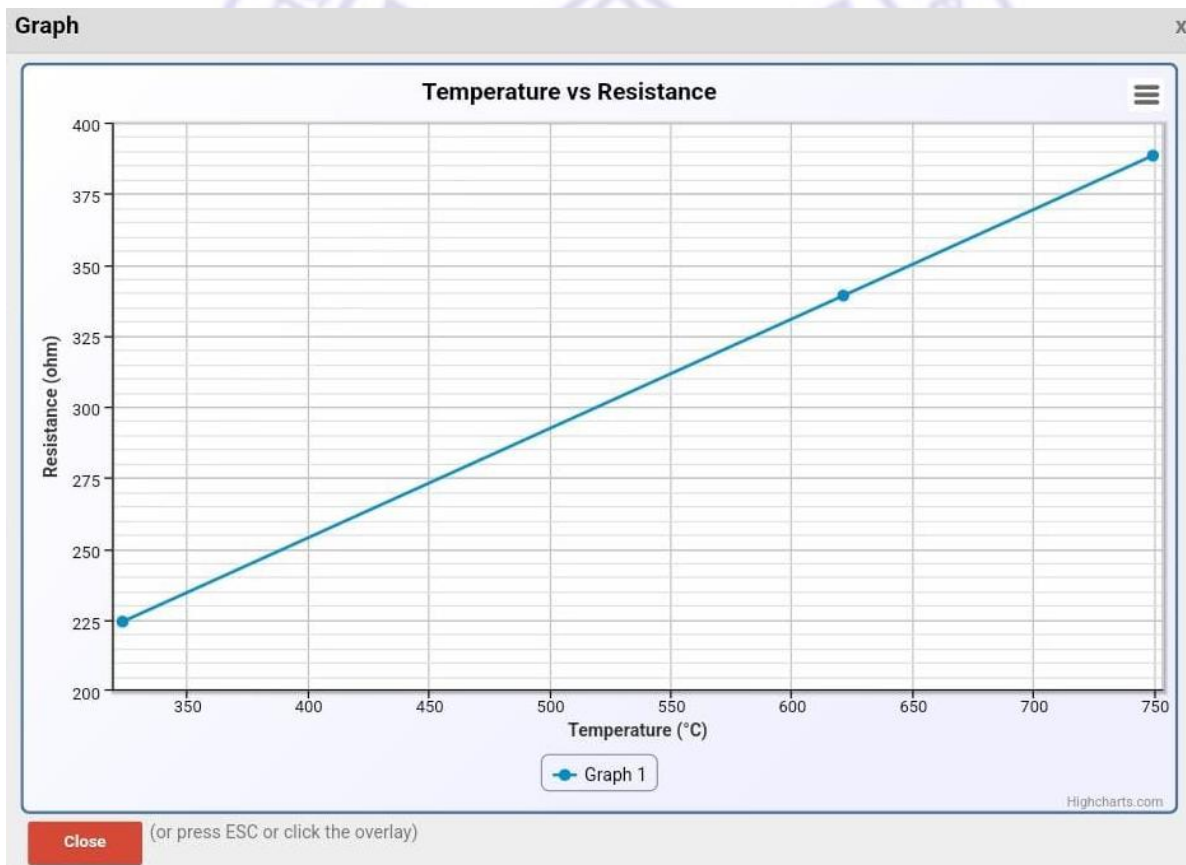


AGPL 3.0 & Creative Commons (CC BY-NC-SA 4.0)

### Selected Values:

1. Material: Platinum
2. Resistance (R0) :100
3. Measurement Temperature :621
4. Your Answer :339.085
5. Measurement Temperature :749
6. Your Answer :388.365
7. Measurement Temperature :323
8. Your Answer :224.35

### Level 1:





## Level-2:



Bare → Time constant is 1.17 seconds  
Material: Platinum

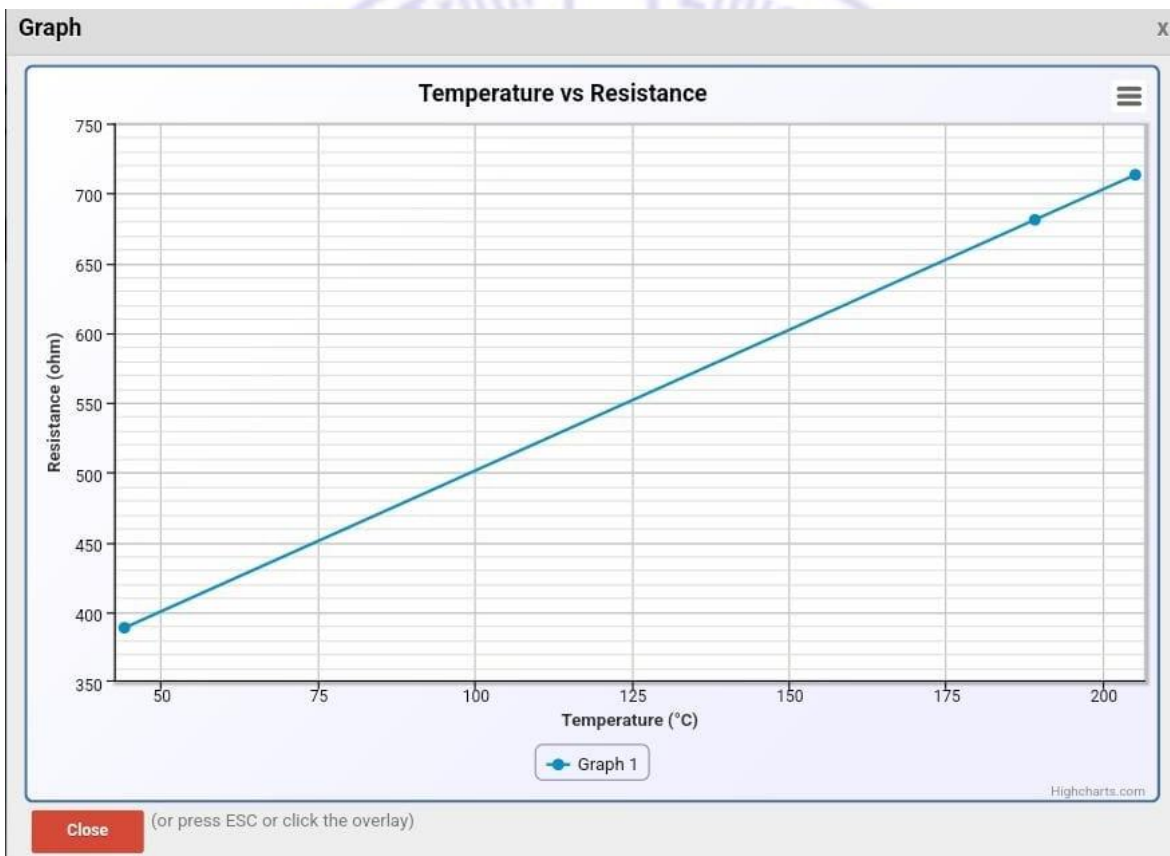
Withsheath:  
Material = SS410  
Thickness = 1mm  
Time constant = 3.46 seconds

Thermowell:  
Material = SS316  
Thickness = 2.0mm  
Filling = Silicon compound  
Time constant = 41.16 seconds

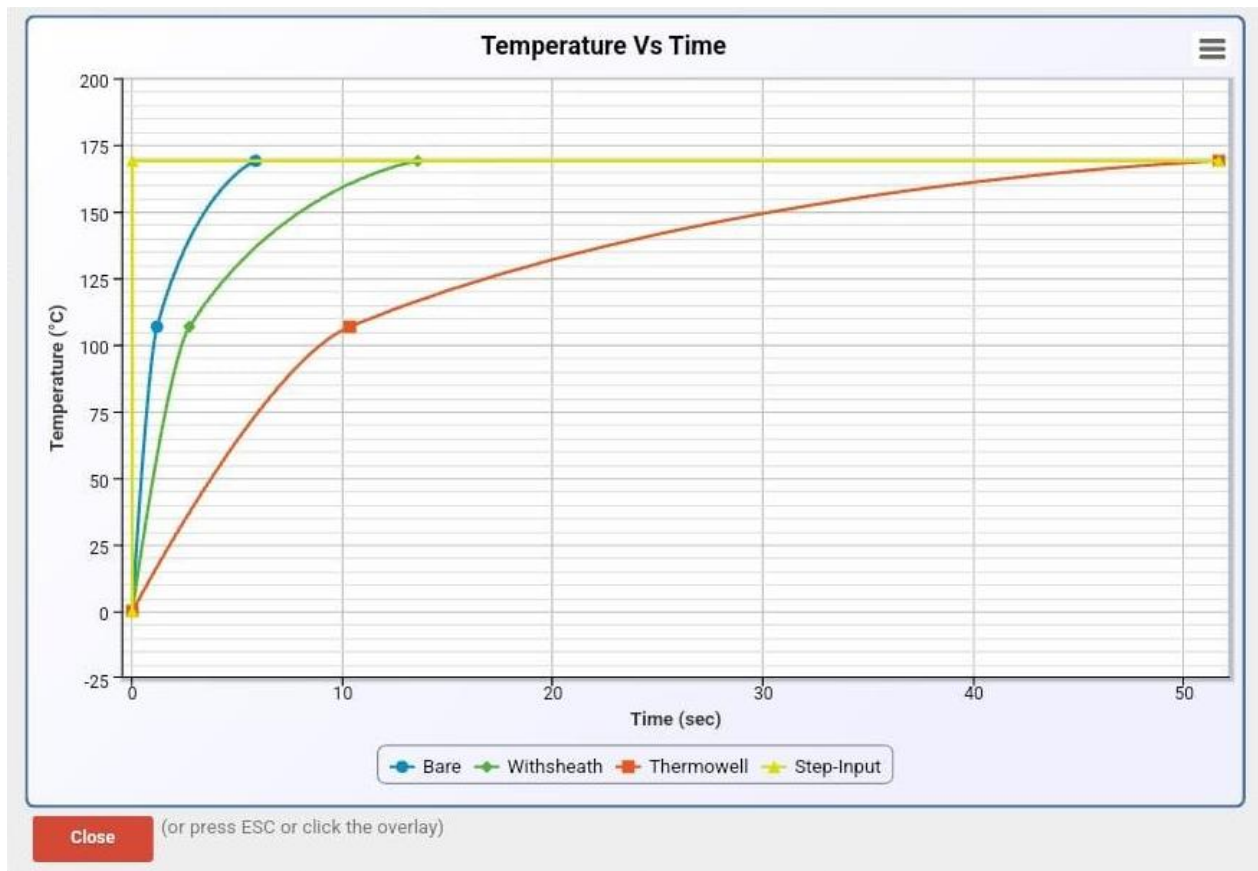
### Selected Values:

1. Material: Nickel
2. Resistance ( $R_0$ ): 300
3. Measurement Temperature: 44
4. Your Answer: 681.024
5. Measurement Temperature: 205
6. Your Answer: 713.28

### Level 1:




## Level 2:





## Posttest:

Virtual Labs  
An MoE, Govt of India Initiative

HOMEPARTNERSCONTACT

Electrical Engineering > Sensors Modeling & Simulation Lab > Experiments

Aim

Theory

Pretest

Procedure

Simulation

Posttest

References

Feedback

### Characterize the temperature sensor(RTD)

RTD is very popular for temperature measurement because of

- ☐ a: Cost
- ☐ b: Self heating
- ☐ c: None of these
- ☒ d: Linearity

In the Pt100, the suffix 100 refers to

- ☐ a: Resistance at Room Temperature
- ☒ b: Resistance at 0 degree C
- ☐ c: 100% pure platinum
- ☐ d: 80% pure platinum

Commonly used RTD Material is

- ☒ a: Platinum
- ☐ b: Aluminium
- ☐ c: Both of these
- ☐ d: None of these

RTDs are preferred over thermistors because

- ☒ a: RTDs have larger temperature range than thermistors
- ☐ b: RTDs are more sensitive than thermistors
- ☐ c: RTD's are less sensitive to lead resistance than thermistors
- ☐ d: None of these

PTC stands for

- ☐ a: Platinum Temperature Coefficient
- ☐ b: Partial Temperature Coefficient
- ☒ c: Positive Temperature Coefficient
- ☐ d: None of these

Submit Quiz

5 out of 5





Community Links

Sakshat Portal  
Outreach Portal  
FAQ: Virtual Labs

Contact Us

Phone: General Information: 011-26582050  
Email: support@vlabs.ac.in

Follow Us



AGPL 3.0 & Creative Commons (CC BY-NC-SA 4.0)

## Conclusion:

We studied characteristics of RTD and effects of various parameters on RTD performance are verified.