Experiment: 5

Describe the Construction and Characteristics of Platinum R.T.D Resistance Transducer.

.EQUIPMENTS

- Temperature Transducer Trainer IT-5929
- Digital Multimeter.
- Stopwatch (not supplied).
- 2mm Connecting Leads.

THEORY

RTD:

Resistance thermometers, also called resistance temperature detectors (RTDs), are sensors used to measure temperature by correlating the resistance of the RTD element with temperature. Most RTD elements consist of a length of fine coiled wire wrapped around a ceramic or glass core. The element is usually quite fragile, so it is often placed inside a sheathed probe to protect it. The RTD element is made from a pure material, typically platinum, nickel or copper. The material has a predictable change in resistance as the temperature changes and it is this predictable change that is used to determine temperature.

Common RTD sensing elements constructed of platinum, copper or nickel have a repeatable resistance versus temperature relationship (R vs. T) and operating temperature range. The R vs. T relationship is defined as the amount of resistance change of the sensor per degree of temperature change. The relative change in resistance (temperature coefficient of resistance) varies only slightly over the useful range of the sensor.

Platinum R.T.D (Resistance Temperature Dependent) Transducer:

Platinum is the best metal for RTDs because it follows a very linear resistance-temperature relationship and it follows the R vs. T relationship in a highly repeatable manner over a wide temperature range. The unique properties of platinum make it the material of choice for temperature standards over the range of -272.5 °C to 961.78 °C and is used in the sensors that define the International Temperature Standard, ITS-90. Platinum is chosen also because of its chemical inertness.

The construction of the platinum R.T.D. transducer is shown in Figure below, consisting basically of a thin film of platinum deposited on a ceramic substrate and having gold contact plates at each end that contact the film. The platinum film is trimmed with a laser beam so that the resistance is 100 Ω at 0˚C.The resistance of the film increases as the temperature increases i.e. it has a positive temperature coefficient. The increase in resistance is linear, the relationship between resistance change and temperature rise being 0.385 Ω/˚C.

$$R_t = R_o + 0.385t \qquad (5.1)$$

Here

R_t = resistance at temperature t˚C.

R_o= resistance at 0˚C (= 100 Ω).

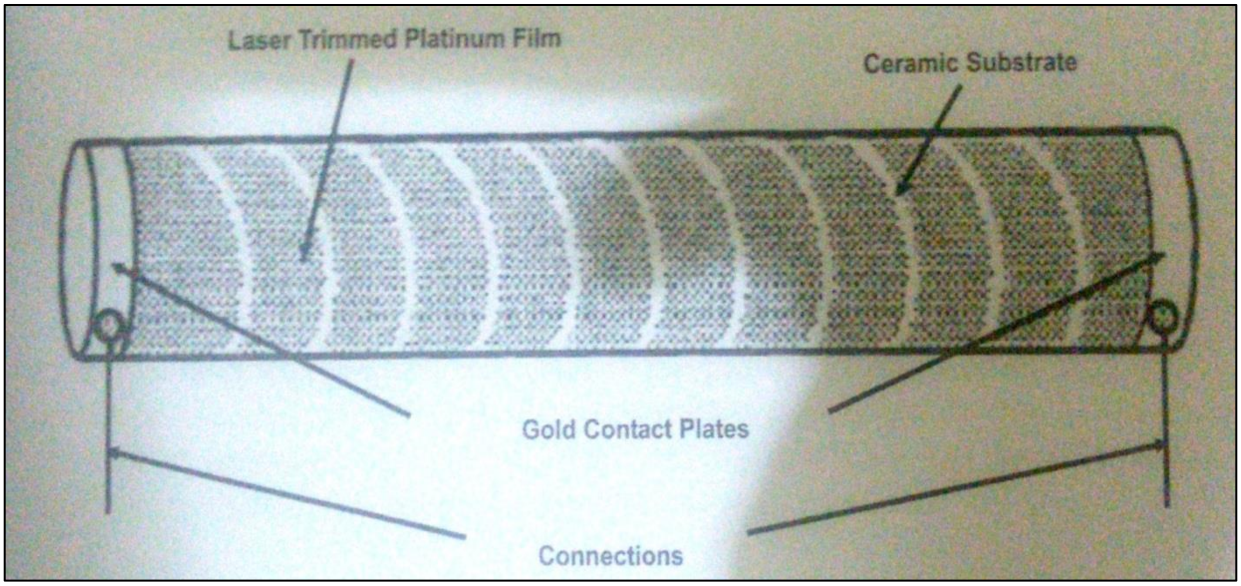


Figure 5.1 (Internal Structure of R.T.D)

Normally, the unit would be connected to a D.C. supply via a series resistor and the voltage developed across the transducer is measured. The current flow through the transducer will then cause some self-heating, the temperature rise due to this is being of the order of 0.005˚C /mW dissipated in the transducer.

The electrical circuit arrangement of R.T.D. the IT-5929 unit is shown in Figure 5.2.

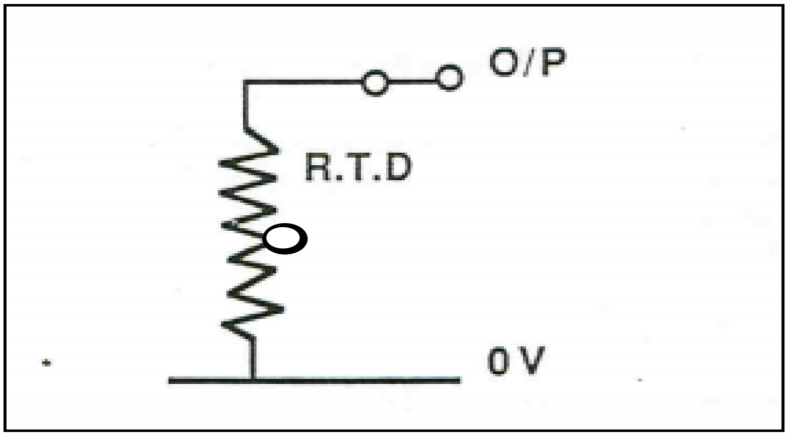


Figure 5.2 (Circuit Diagram R.T.D)

The white dot indicates that this is p.t.c not n.t.c (negative temperature coefficient) type of resistor which should have a black dot.

In the practical exercised you will connect the platinum RTD in series with a high resistance to a DC supply and measure the voltage drop across it. Due to the small variation in resistance, the current change will be negligible ad the voltage drop across the transducer will be directly proportional to its resistance.

EXPERIMENT

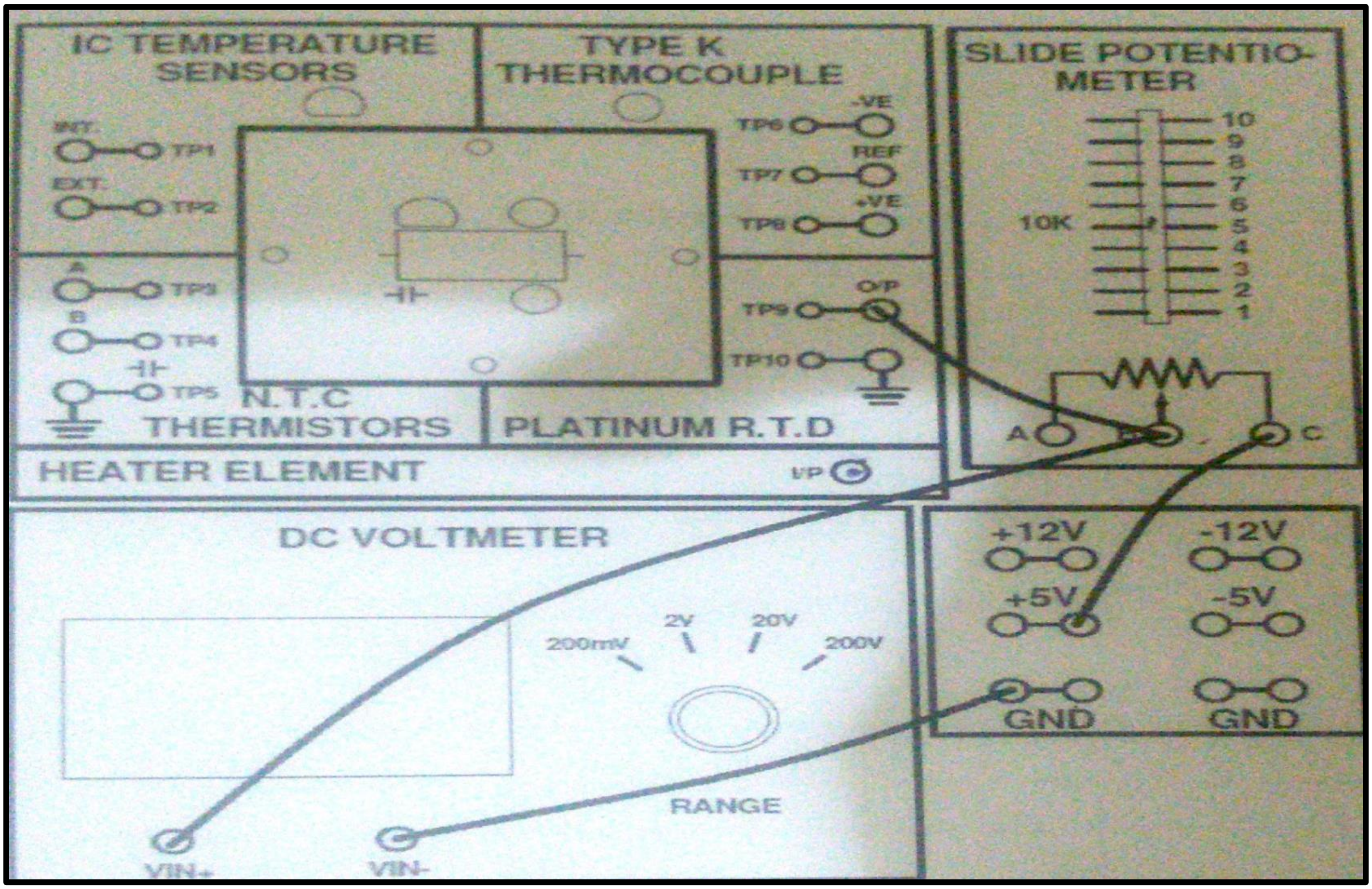


Figure 5.3 (Experimental Setup)

- Connect the circuit as shown in Figure 5.3, with the voltmeter set to its 2 V or 200mV DC range. Also, set the slider of the 10K Ω carbon resistor to mid-way.
- With the power supply switched ON, adjust the control of the 10 kΩ resistor so that the voltage drops across the platinum R.T.D. is 0.108 V (108mV) as indicated by the digital voltmeter.
- This calibrates the platinum R.T.D. for an ambient temperature of 20 ˚C, since the resistance of the R.T.D. at 20 ˚C will be 108 Ω.

Note: If the ambient temperature differs from 20 ˚C, the voltage can be set to the correct value for this ambient temperature if desired.

1. Set the voltmeter to its 20 V range and measure the output from the I.C. temperature transducer to obtain the ambient temperature in˚C.
2. Calculate the resistance at that temperature using the formula:
   R.T.D. resistance = 100 + 0.385× ˚C.
   And set the voltage drop across the R.T.D. for this value.

- Now connect the +12 V supply to the heater input and note the values of the voltage across the R.T.D. with the voltmeter set to its 2V range (this representing the R.T.D. resistance), and the output voltage from the temperature transducer with the voltmeter set to its 20 V range (this representing the temperature of the R.T.D.). Enter the values in Table 5.1.
- Repeat the readings at 1-minute intervals and enter the values in Table 5.1.

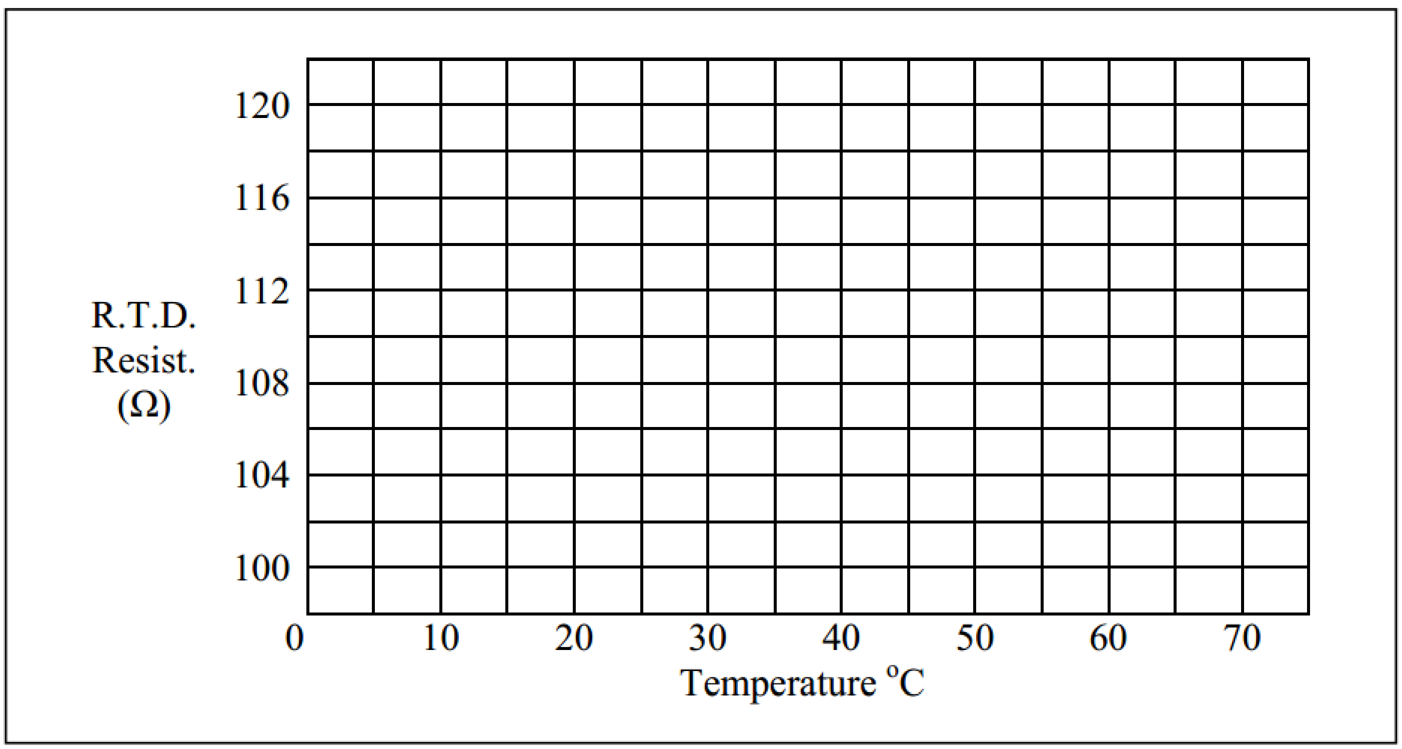
RESULTS

Enter value after 1-minute interval.

Time (Minutes)	RTD Temperature (℃)	RTD Resistance (Ω)
0		
1		
2		
3		
4		
5		
6		
7		

Table 5.1 (Observation R.T.D)

Plot the graph 5.1 of R.T.D. resistance against temperature on the axes provided.



Graph 5.1 (Resistance Vs Temperature)

DISCUSSION

A platinum R.T.D. transducer has resistance of 100 Ω at 0 ˚C and 138 Ω at 100 ˚C.

1. What would be its resistance 50 ˚C?
2. What temperature would be represented by a resistance of 115.2 Ω?

CONCLUSION

Instructor Signature: ________________________________ **Date:** ________________