142103005

Sensors and Automation
Assignment No : 1

Q1 Explain in detail construction, working principle and applications of resistance temperature detecters? what are the selection criteria of RTD one should take into consideration for specific applications? Explain with example.

Answer Resistance temperature detector i.e RTD is an electronic device used to determine the temperature by measuring the resistance of an electric wire. This wire is referred to as a temperature sensor. to measure the temperature with high accuracy. as RTD is the ideal solution as it has good linear characteristics over a wide range of temperatures.

The temperature is typically such that the wire is wound on a form (in coil) on notched mica cross frame to achieve small size imperring the thermal conductivity for decreased heat transfer is obtained. In the industrial RTD's the coil is protected by a stainless steel sheath or a protective tube. So that the physical strain in negligible as the wire expands and increases the length of wire with the temperature change. If the strain on the wire is increasing then the tension increases due to that the resistance of the wire will change with is undesirable. So, we don't want to change

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resistance of the wire by any other unwanted changes except the temperature changes.

This is also useful to maintain while the plant is in operation. mica is placed in between the steel sheath and resistance wire for better electrical insulation due to less strain in resistance wire, it should be carefully wond over mica.

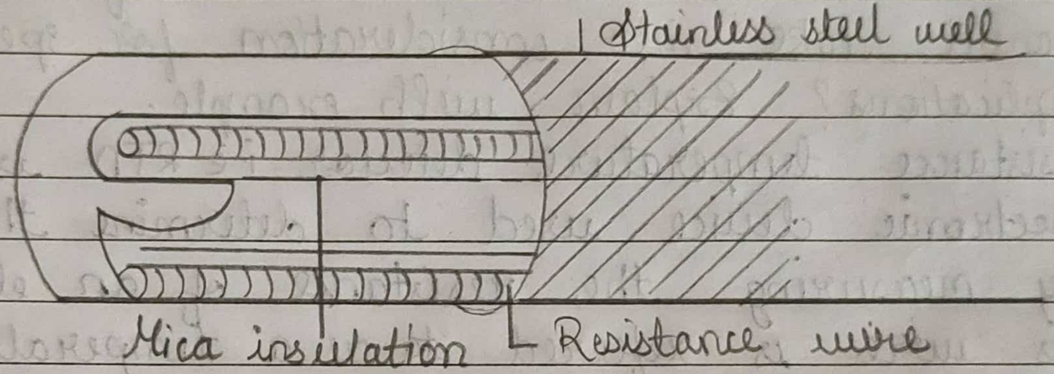

Figure: 3D view of RTD (cross-section)

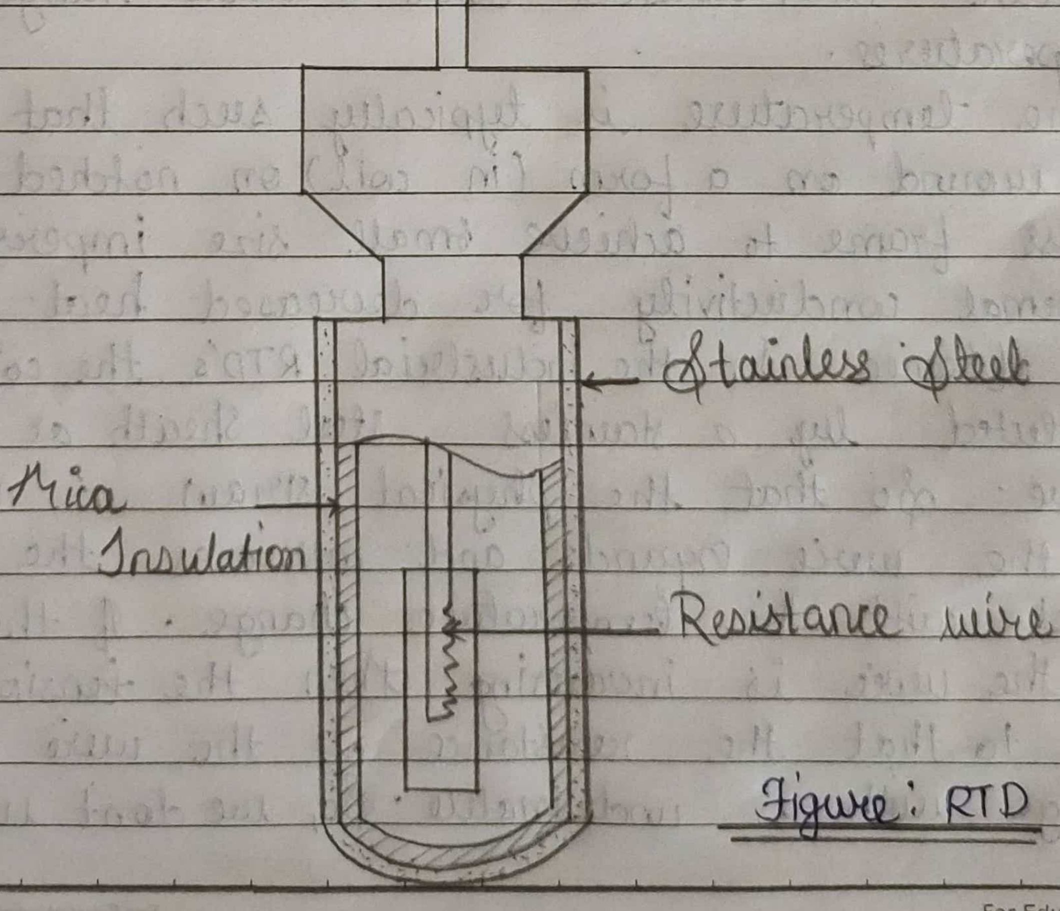

Figure: RTD

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- Applications of RTD :

1. RTD is used in power electronics, computer, consumer electronics, food handeling and processing industrial electronics, medical electronics, military and aerospace.
2. RTD sensor is used in automofire to measure the engine temperature an oil level sensors in communication and instrumentation for sensing over the temperature of amplifiers, transistor gain stabalizers.

Some of the examples of RTD sensor are coolant sensor, transmission oil temperature sensors, fire detectors, etc due to their accuracy and stability RTD sensores are rapidly replacing thermocouples in industrial applications.

RTD can give higher accuracy values. RTD can be stable for many years comparatively to the thermocouple. which stable only for a few hours of use. There are RTD present in our day of day appliances like coffee machines, cell phons etc.

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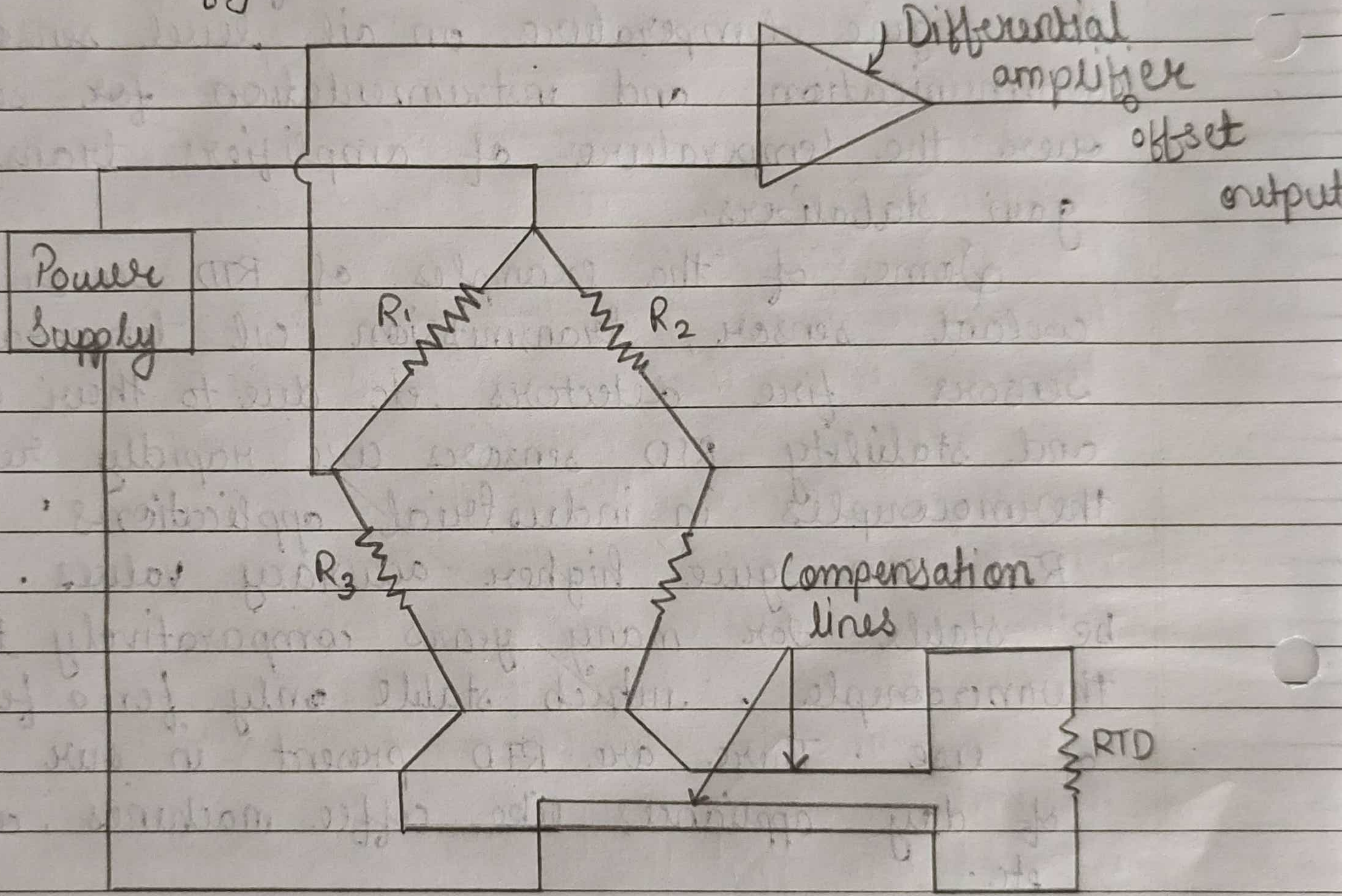
Q2 RTD is regarded as a high precision wire wound resistor varies with temperature by measuring the resistance of the metal its temperature can be determined. To detect the small variations of resistance of the RTD, a temperature transmitter in the form of a wheatstone bridge is generally used as shown in the figure.



a) Let the RTD has $\alpha_0 = 0.005/^\circ C$ and $R = 500\,\Omega$ at $20^\circ C$. The RTD is used in bridge ckt as shown in figure with $R_1 = R_2 = 500\,\Omega$ and R_3 a variable resistor used to null a bridge. If the supply voltage is 12V and RTD is placed in both at $0^\circ C$.
Find the value of R_3 to null the bridge.

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b. In part (a) assume that now RTD has dissipation constant $P_D = 25 mW/°C$ at 20°C. Repeat part (a) to find the value of R_3 to null the bridge. Comment on variation in the answer.

→ The value of RTD resistance at 0°C without including the effects of dissipation.

$$R = 500 \, [1 + 0.005 \, (0 - 20)]$$
$$= 450 \, \Omega$$

Here, if we exclude the effects of self-heating we would expect the bridge to null R_3 equal to 450 Ω. Now, as we see the effects of self-heating. For this problem first we find the power dissipated in the RTD from the circuit. b) $P_D = 25 mV/°C$ at 20°C

$$\therefore \; P = I^2 R$$

$$i = \frac{12}{500 + 450} = 12.63 \, mA \text{ or } 0.01263 \, A$$

$$\therefore \; P = (0.01263)^2 \times 450$$
$$= 71.78 \, mW \text{ or } 0.07178 \, W$$

$$\therefore \text{Temperature rise } (\Delta T) = \frac{P}{P_0} = \frac{71.78 \, (mW)}{25 \, mW/°C}$$
$$= 2.87 \, °C$$

∴ The RTD is not actually at bath temperature of 0°C but a temperature of 1.66°C.

$$\therefore \; R = 500 \, [1 + 0.005 \, (2.87 - 20)] = 457.175 \, \Omega$$