GP108 :: MINI PROJECT

CALIBRATION OF A THERMISTOR

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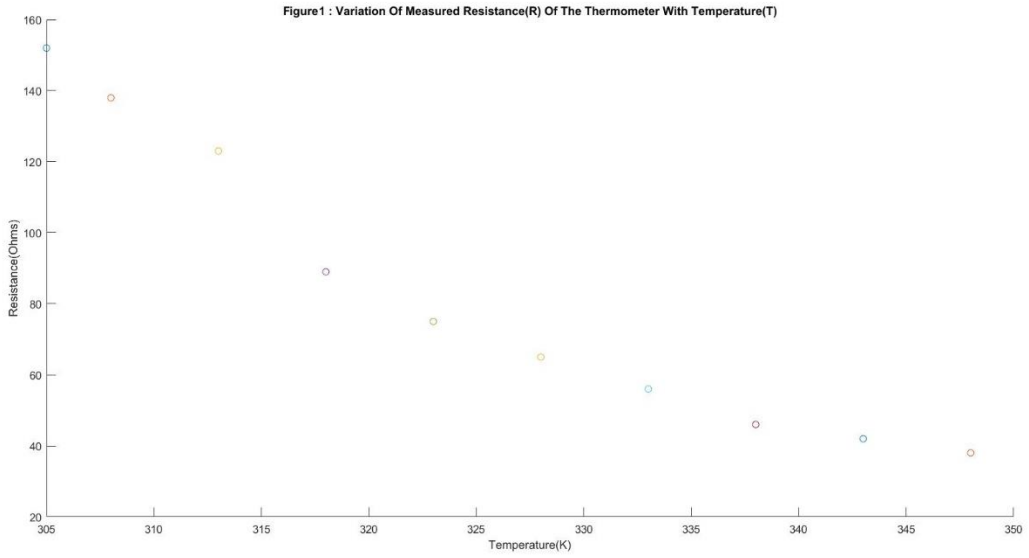
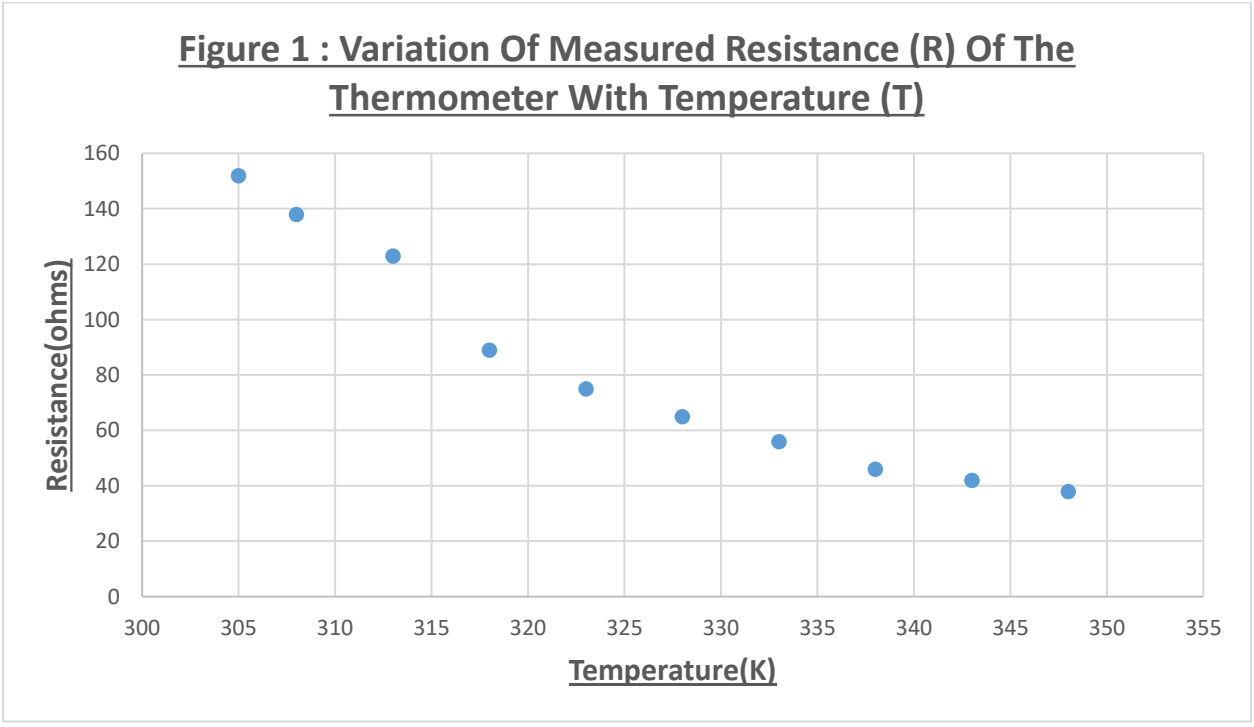
Temperature(K)	305	308	313	318	323	328	333	338	343	348
R(Ω)	152	138	123	89	75	65	56	46	42	38

Table 1





The resistance (R) vs. temperature (T) characteristic of a thermistor can be approximated by the equation $R = R_0 e^{\lambda}$, where $\lambda = (1/T - 1/T_0)$ and R_0 is the resistance at temperature $T_0 = 300\ K$. β is the material constant of the thermistor. Estimate R_0 and β using Least Mean Square (LMS) error.

$$R = R_0 e^{(1/T - 1/T_0)}$$

Therefore,

$$\ln(R) = \ln(R_0) + \beta(1/T - 1/T_0)$$
$$\ln(R) = \ln(R_0) + \beta(1/T - 1/T_0)$$
$$\ln(R) = \beta/T + \ln(R_0) - \beta/T_0$$

Now, the measurements given in Figure 1 can be expressed in the matrix form as following,

$$\begin{bmatrix} \ln(R1) \\ \vdots \\ \ln(R6) \end{bmatrix} = \begin{bmatrix} 1/T_1 & 1 \\ \vdots & \vdots \\ 1/T_6 & 1 \end{bmatrix} \begin{bmatrix} \beta \\ \ln(R_0) - \beta/T_0 \end{bmatrix} + \begin{bmatrix} e_1 \\ \vdots \\ e_6 \end{bmatrix}$$

Where e is error. This can be written as,

$$Y = XC + E$$

It can be proved that, for Least Mean Square (LMS) error,

$$C = (X^T X)^{-1} X^T Y$$

By substituting from Table1,

$$Y = \begin{bmatrix} 5.02 \\ 4.93 \\ 4.81 \\ 4.49 \\ 4.32 \\ 4.17 \\ 4.03 \\ 3.83 \\ 3.74 \\ 3.64 \end{bmatrix} \qquad X = \begin{bmatrix} 0.00328 & 1 \\ 0.00325 & 1 \\ 0.00319 & 1 \\ 0.00314 & 1 \\ 0.00310 & 1 \\ 0.00305 & 1 \\ 0.00300 & 1 \\ 0.00296 & 1 \\ 0.00292 & 1 \\ 0.00287 & 1 \end{bmatrix}$$

$$C=\begin{bmatrix} \beta \\ \ln(R_0)-\beta/T_0 \end{bmatrix} = \begin{bmatrix} 3569.1 \\ -6.7 \end{bmatrix}$$

Therefore,

$\beta=3569.1$ K

$R_0=180.73\ \Omega$

Therefore, **the equation for the above thermistor** can be given by equation,

$$\mathbf{R=180.73e^{3569.1(1/T-1/300)}}$$

The corresponding curve to equation is shown in Figure2,