Chapter 06.03
Linear Regression-More Examples
Computer Engineering

Example 1

To simplify a model for a diode, it is approximated by a forward bias model consisting of DC voltage, V_d, and resistor R_d. Below are the current vs. voltage data that is collected for a small signal.

Table 1 Current versus voltage for a small signal.

V (volts)	I (amps)
0.6	0.01
0.7	0.05
0.8	0.20
0.9	0.70
1.0	2.00
1.1	4.00

The I vs. V data is regressed to $I = B_1 V + B_0$.

Once B_0 and B_1 are known, V_d and R_d can be computed as

$$V_d = -\frac{B_0}{B_1} \quad \text{and} \quad R_d = \frac{1}{B_1}$$

Find the value of V_d and R_d.

Solution

Table 2 shows the summations needed for the calculation of the constants of the regression model.

Table 1 Tabulation of data for calculation of needed summations.

i	V	I	V^2	$V \times I$
–	Volts	Amperes	Volts^2	Volt-Amps
1	0.6	0.01	0.36	0.006
2	0.7	0.05	0.49	0.035
3	0.8	0.20	0.64	0.160
4	0.9	0.70	0.81	0.630
5	1.0	2.00	1.00	2.000
6	1.1	4.00	1.21	4.400
$\sum_{i=1}^{6}$	5.1	6.96	4.51	7.231

$$n = 6$$

$$B_1 = \frac{n\sum_{i=1}^{6} V_i I_i - \sum_{i=1}^{6} V_i \sum_{i=1}^{6} I_i}{n\sum_{i=1}^{6} V_i^2 - \left(\sum_{i=1}^{6} V_i\right)^2}$$

$$= \frac{6(7.231) - (5.1)(6.96)}{6(4.51) - (5.1)^2}$$

$$= 7.5143 \text{ A/V}$$

$$\bar{I} = \frac{\sum_{i=1}^{6} I_i}{n}$$

$$= \frac{6.96}{6}$$

$$= 1.16 \text{ A}$$

$$\bar{V} = \frac{\sum_{i=1}^{6} V_i}{n}$$

$$= \frac{5.1}{6}$$

$$= 0.85 \text{ V}$$

$$B_0 = \bar{I} - B_1 \bar{V}$$
$$= 1.16 - (7.514)(0.85)$$
$$= -5.2269 \text{ A}$$

$$I = 7.514 \times V - 5.2269$$

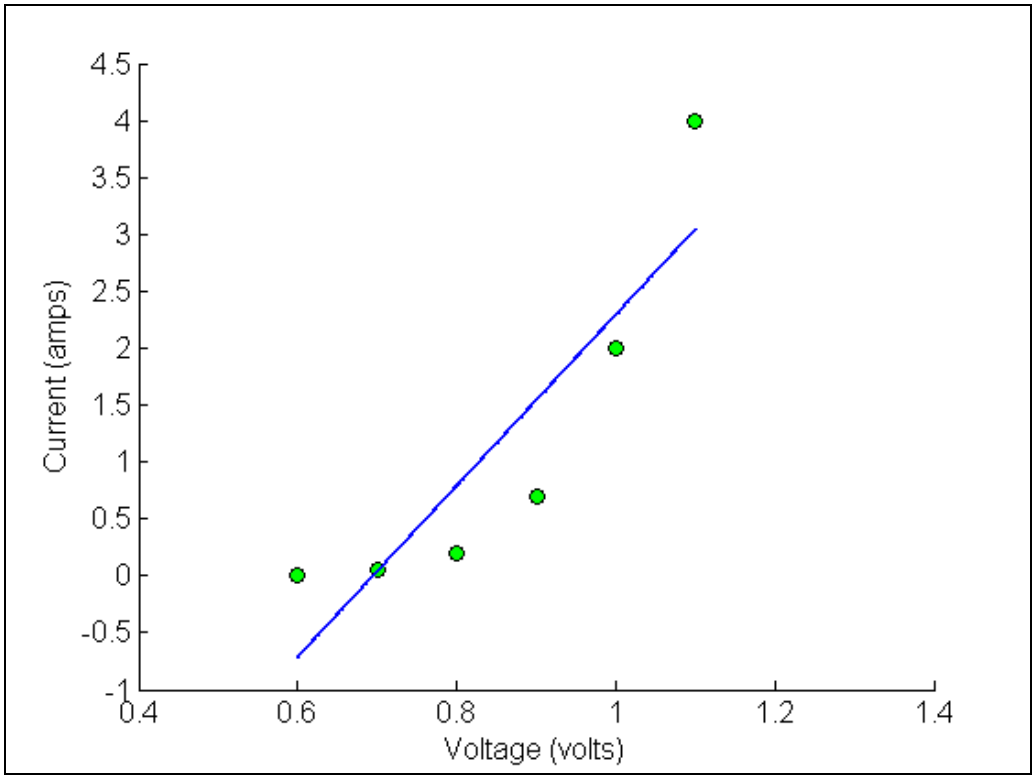

Figure 1 Linear regression of current vs. voltage

Solving for V_d and R_d:

$$V_d = -\frac{B_0}{B_1}$$
$$= -\left(\frac{-5.2269}{7.5143}\right)$$
$$= 0.69560 \text{ Volts}$$

$$R_d = \frac{1}{B_1}$$
$$= \frac{1}{7.5143}$$
$$= 0.13308 \text{ Ohms}$$