ECE 2260

PSEUDO-LABORATORY REPORT

DESIGN OF AN LED DISPLAY DRIVER

THE UNIVERSITY OF UTAH

A. Introduction

This report describes the results of experiments on the current-versus-voltage characteristics of an LED. This report also describes the design of a simple circuit to drive the LED.

The handout reproduced in Appendix A gives the detailed procedure and motivation for the project. In brief, this report contains results for the following tasks:

1) Use of linear regression to find parameters for a Shockley law model of an LED,
2) Use of nonlinear optimization algorithm to find parameters for a Shockley law model of an LED, and
3) Calculation of a suitable resistor value to be used in series with an LED.

B. Linear Regression Model for LED

As described in Section C of Appendix A, an LED's voltage and current were measured with a simple experimental setup consisting of a 12 Volt power supply across a potentiometer in series with an LED. By adjusting the potentiometer, the voltage across and current through the LED were varied. Table I lists results measured with a digital current/voltage meter in the laboratory.

TABLE I

LED MEASUREMENTS

voltage (V)	current (mA)
1.30	0.6
1.35	2.2
1.40	13.6
1.41	21.1

We can use the data in Table I to fit a Shockley's law model describing the relationship between current and voltage for diodes:

$$i = I_s\left(e^{v/V_T} - 1\right) \qquad (1)$$

where

i ≡ current through diode in Amps

v ≡ voltage across diode in Volts

I_s ≡ reverse saturation current in Amps

V_T ≡ thermal voltage = kT/q in Volts ≈ 26 mV at room temperature

k ≡ Boltzmann constant = $1.38 \cdot 10^{-23}$ J/°K

T ≡ temperature °K (293 °K = 68°F, 300°K = 80.6°F)

q ≡ electronic charge = $1.602 \cdot 10^{-19}$ C

Because we wish to use linear regression as our first method of modeling the diode, we reduce Equation (1) to a linear approximation. Our first step is to ignore the –1 term in (1).

$$i = I_s e^{v/V_T} \quad (2)$$

Our second step is to take the natural log of both sides of (2):

$$\ln(i) = \ln(I_s) + \frac{v}{V_T} \quad (3)$$

We observe that (3) has a linear form

$$\ln(i) = a_0 + a_1 v \quad (4)$$

where

$a_0 \equiv \ln(I_s)$

$a_1 \equiv 1/V_T$

The Matlab™ script "lin_reg_diode.m" in Appendix B finds the values of a_0 and a_1 that give the best fit, (in the least-squares sense), of the data in Table I to the line described by (4). Note that lin_reg_diode.m employs the Matlab™ backslash, \, operator to compute the optimal linear regression (or least-squares) fit. Fig. 1 shows the fit obtained. Table II lists the values of a_0 and a_1, as well as the values of I_s and V_T obtained from a_0 and a_1 by the following equations:

$$I_s = e^{a_0} \quad (5)$$

$$V_T = 1/a_1 \quad (6)$$

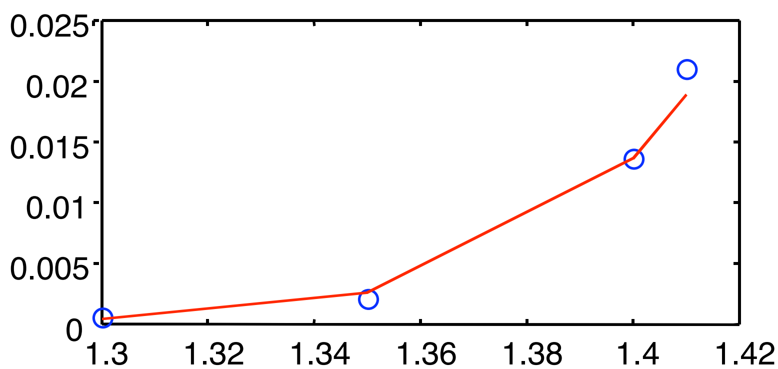

Fig. 1. Linear regression fit (solid line) to LED data (circles) in *i*-*v* format. Horizontal axis =voltage (V); vertical axis = current (A).

TABLE II

LED LINEAR REGRESSION PARAMETERS

parameter	value
a_0	0.6
a_1	2.2
I_s	2.52e-22 (A)
V_T	357 (˚K)

C. "fmins" Nonlinear Optimization Model for LED

... Continue the report in the above fashion. Include figures where appropriate...

D. LED Driver Circuit Design

... Derive the driver resistor value here. Include a circuit diagram. The last section is the Conclusion. It is a brief factual summary of your results. Appendices follow Conclusion. (I have left out Appendices since they were previously handed out in class. You must include appendices in your report.) You can put, for example, the lab handout, Matlab™ listings, and other reference items there...

...Here is a sample Conclusion. Your Conclusion must also answer any questions posed by the laboratory handout...

E. Conclusion

The parameters for the LED Shockley law model, (found by linear regression and the Matlab™ "fmins" function), differ slightly, (see Tables II and III). For both sets of parameters, however, we obtain nearly the same resistor value of 2 kΩ for the driver circuit shown in Fig. 1.