ISE 2211 • Exam VI • 22 July 2021 15 pts. NAME SOLUTION

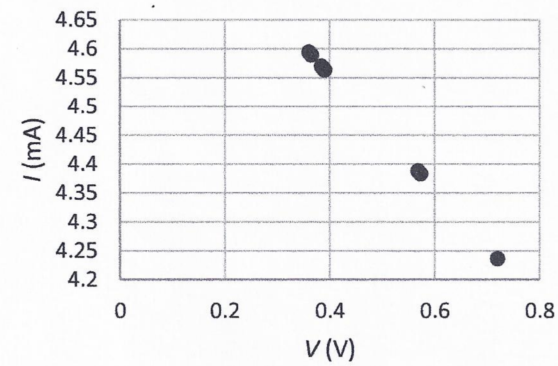
Ten 1N34A germanium diodes were tested by Joe Tritschler using a Peak Atlas DCA55 Semiconductor Component Analyser. The following data gives forward voltage drop in volts vs. test current in milliamperes. Determine least-squares estimates for slope (β_1) and intercept (β_0) of the simple linear regression model of test current vs. forward voltage and use it to write an equation for the estimated regression line. <u>Include units with all answers.</u>

Formulae:

$$\hat{\beta}_1 = \frac{\sum y_i x_i - \frac{(\sum y_i)(\sum x_i)}{n}}{\sum x_i^2 - \frac{(\sum x_i)^2}{n}} = \frac{S_{XY}}{S_{XX}},$$

$$\hat{\beta}_0 = \bar{y} - \hat{\beta}_1 \bar{x}$$

Forward Voltage Drop, V (x)	Test Current, mA (y)
0.404	4.552
0.365	4.590
0.573	4.384
0.568	4.389
0.360	4.595
0.384	4.571
0.386	4.569
0.387	4.567
0.720	4.237
0.390	4.564



Note: Joe computed the following sums for you. He is a super-swell guy.

$\sum x_i = 4.537$ $\quad \bar{x} = 0.4537$ $\quad \sum x_i^2 = 2.193715$ $\quad \sum x_i y_i = 20.290469$

$\sum y_i = 45.018$ $\quad \bar{y} = 4.5018$ $\quad \sum y_i^2 = 202.795162$

$$S_{XY} = 20.29 - \frac{45.018 \cdot 4.537}{10} = -0.1347 \quad +1$$

$$S_{XX} = 2.194 - \frac{4.537^2}{10} = 0.1356 \quad +1$$

$$\hat{\beta}_1 = \frac{-0.1347}{0.1356} = -0.9934 \quad \text{mA/V}$$

+1 +1

$$\hat{\beta}_0 = 4.5018 - -0.9934 \cdot 0.4537 = 4.953 \quad \text{mA}$$

+1 +1

$$\hat{y} = 4.953 - 0.9934\,x \quad (\text{mA})$$

+1 +1

Determine the coefficient of determination for the relationship between forward voltage drop and test current. Use it to write a 95% C.I. on their correlation coefficient. (Don't worry about the low sample size; compute it anyway.) What does the confidence interval imply about the relationship between forward voltage drop and test current?

really should not have rounded here; affects outcome significantly!

$$SS_T = 202.8 - 10 \cdot 4.5018^2 = \underline{0.1380}$$

$$SS_E = 0.1380 - 0.9934 \cdot 0.1347$$

$$= \underline{0.004189}$$

$$R^2 = 1 - \frac{0.004189}{0.1380} = \underline{0.9696} \quad +3$$

$$\rho: \quad \tanh\left(\tanh^{-1} R \pm \frac{z_{\alpha/2}}{\sqrt{n-3}}\right)$$

$$z_{\alpha/2} = z_{.025} = 1.960$$

$$\tanh^{-1}\sqrt{.9696} = 2.432 \quad +1$$

$$\left.\begin{array}{l} \tanh\left(2.432 + \frac{1.960}{\sqrt{7}}\right) = 0.9965 \\ \tanh\left(2.432 - \frac{1.960}{\sqrt{7}}\right) = 0.9343 \end{array}\right\} +1$$

$$0.9343 < \rho < 0.9965 \quad +1$$

very strong relationship! +1