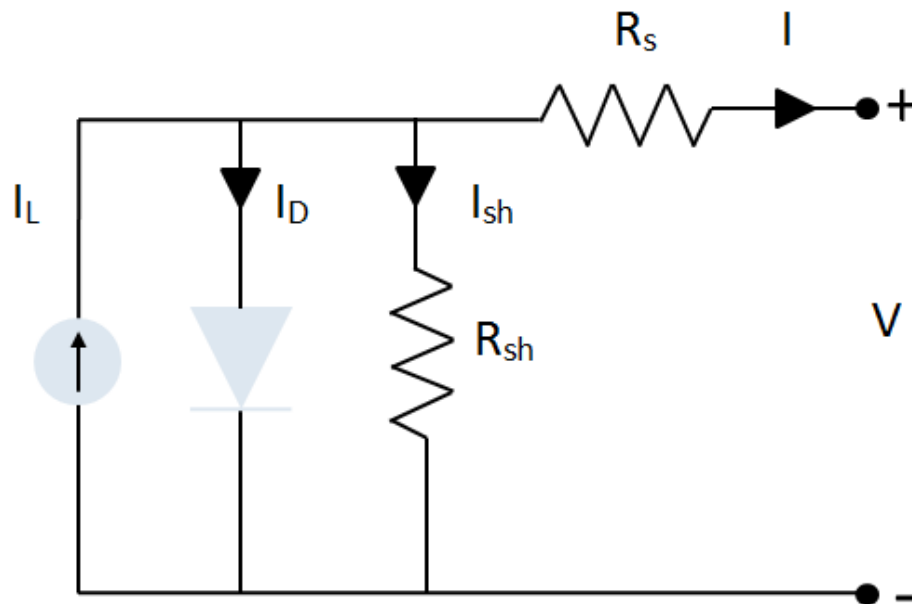


Parameter Estimation for Photovoltaic Diodes

▼ Introduction



The behavior of a photovoltaic diode is described by this equation

$$I_f = I_{pv} - I_0 \left(e^{\frac{fR_s + V_f}{n v t}} - 1 \right) - \frac{I_f R_s + V_f}{R_p}$$

This application

- will rearrange this equation to give I in terms of the LambertW function
- find the best-fit parameters against experimental data

▼ Rearrange Diode Equation

> restart :

$$I_r := \text{solve} \left(I_f = I_{pv} - I_0 \cdot \left(e^{\frac{(V_f + I_f \cdot R_s)}{n \cdot V_t}} - 1 \right) - \frac{V_f + I_f \cdot R_s}{R_p}, I_f \right)$$

$$I_r := - \frac{-W \left(-\frac{I_0 R_p R_s e^{\frac{R_p (I_0 R_s + I_{pv} R_s + V_f)}{n V_t (R_p + R_s)}}}{-R_p V_t n - R_s V_t n} \right) + \frac{R_p (I_0 R_s + I_{pv} R_s + V_f)}{n V_t (R_p + R_s)} }{R_s} n V_t + V_f \quad (2.1)$$

> I_pred := unapply(I_r, V_f, I_pv, I_0, n, R_s, R_p) :

▼ Import Experimental I-V Data for Photo Voltaic Diode

> data := ImportMatrix("this:///diode experimental data.xlsx");

$$data := \begin{bmatrix} 26 \times 2 \text{ Matrix} \\ \text{Data Type: float}_8 \\ \text{Storage: rectangular} \\ \text{Order: Fortran_order} \end{bmatrix} \quad (3.1)$$

> V_data := convert(data[.., 1], Vector) :

> I_data := convert(data[.., 2], Vector) :

> p1 := plot(V_data, I_data, style = point, legend = "Experimental Data") :

> T := 273.15 + 33 :

k := 1.380650 · 10⁻²³ :

q := 1.602176 · 10⁻¹⁹ :

V_t := $\frac{k \cdot T}{q}$:

▼ Find Best-Fit Parameters

> res := Statistics:-NonlinearFit(I_pred, V_data, I_data, parameterranges = [0.1 ..1, 0 ..0.0001, 1 ..2, 0.01 ..0.1, 1 ..100], output = solutionmodule, iterationlimit = 50, optimalitytolerance = 0.01) :

> pars := res:-Results(parametervector);

$$pars := \begin{bmatrix} 0.7663937375048753 \\ 0.00000936308114823049 \\ 1.923856439323053 \\ 0.016002604408174137 \\ 51.387460064408074 \end{bmatrix} \quad (4.1)$$

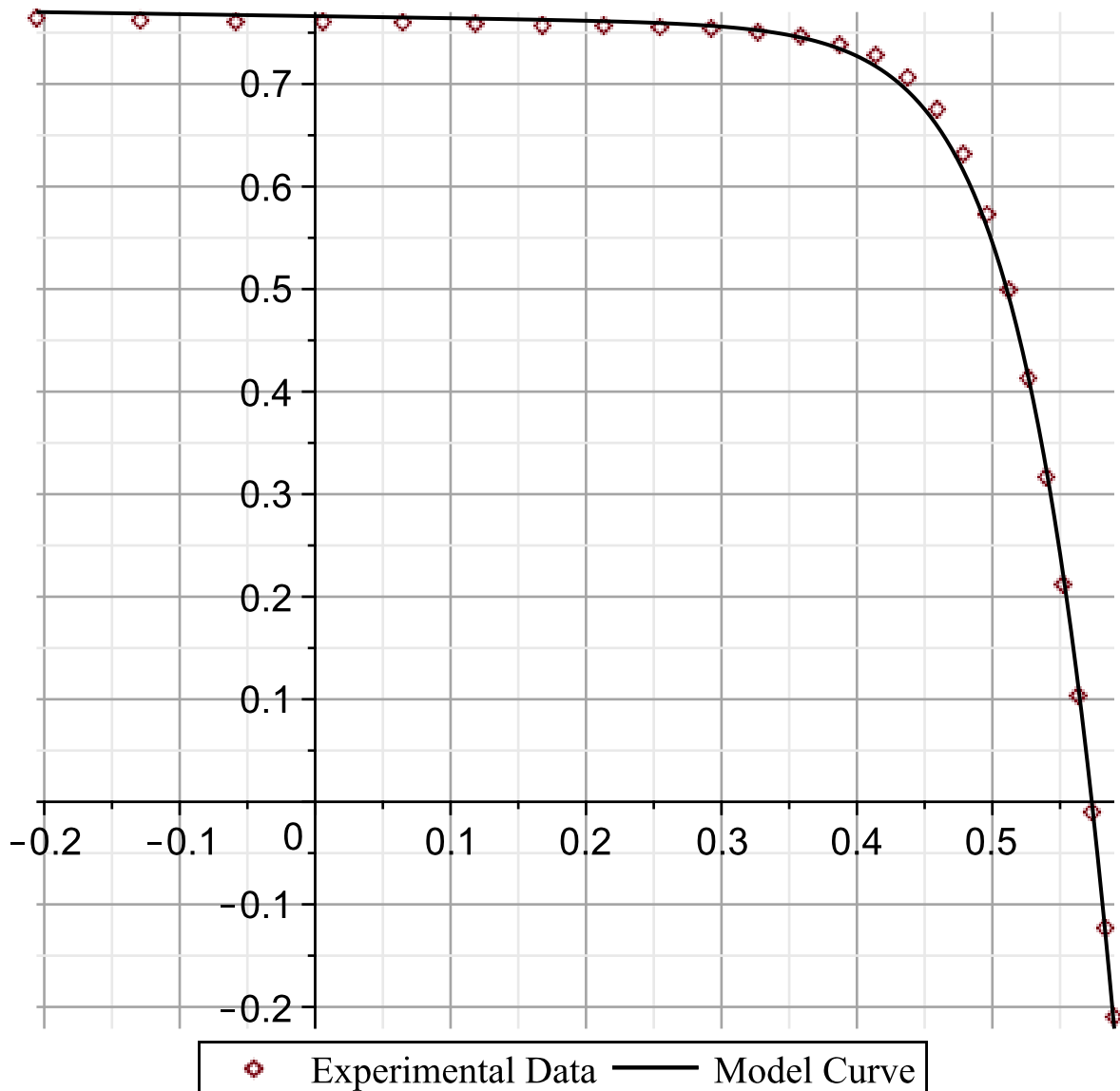
> res:-Results(residualsumofsquares)

$$0.001785240007 \quad (4.2)$$

▼ Plot Model Curve Against Experimental Data

- > $p2 := \text{plot}('I_pred'(Vf, pars[1], pars[2], pars[3], pars[4], pars[5]), Vf = \min(V_data) \dots \max(V_data), color = black, legend = ["Model Curve"], axesfont = [Arial], legendstyle = [font = [Arial]], size = [800, 500], gridlines) :$
- > $\text{plots:display}(p1, p2, title = "Parameter Estimation for Photovoltaic Diode", titlefont = [Arial, 18])$

Parameter Estimation for Photovoltaic Diode



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