ELEC-E8422 An Introduction to Electric Energy

Exercise Session 2: Solar Energy

EX1 Solar Panels

Under some solar conditions, an ideal PV cell produces 3 W and its output voltage is 0,5 V. What is the output power, current and voltage of the system if there are 10 cells connected in series and three of these 10-cell units are connected in parallel.

EX2 Solar Panel Model

The current of a solar cell Is = 1,1 A and its reverse saturation current is Io = 1 nA. Calculate the voltage and current of the solar cell at the maximum power point. The model of the solar cell is shown below and the diode current can be calculated from $I_d = I_o\left(e^{V_d/V_T} - 1\right)$, where the thermal voltage VT = kT/q, the Boltzman's constant k = 1,380*10 -23 J/K, T is the temperature in Kelvins, and the electrons electric charge is e = 1,602*10-19 C.
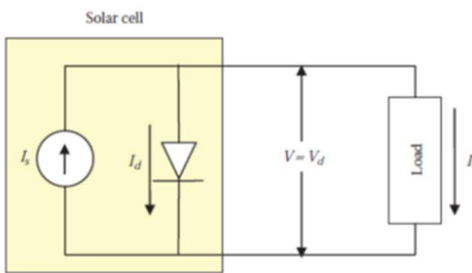

Figure: Model of the solar cell

EX3 Solar Panel Temperature

The cell of the previous question operates at the temperature of 35 °C (308,15 K). Calculate the value of the output voltage and load resistance at the maximum power point.

EX4 Solar Panel Efficiency

The surface area of the previous solar cell is 80 cm^2, the series resistance is 10 mΩ, the parallel resistance 500 Ω, and the load voltage is 0,5 V. At the given point, the solar power density is 300 W/m^2. Calculate the irradiance efficiency η$_{irradiance}$, i.e. the ratio of the power of the cell and power in radiation. What is η, the efficiency of the whole panel, i.e. the ratio of the output power and power in radiation?