Exercise 7

Exercise 1: Given the I(V) characteristics of the best a-Si:H cell (Voc = 890 mV, Isc = 16.8 mA/cm^2, FF = 68%, Eff = 10%) and c-Si cell (Voc = 740 mV, Isc = 41.8 mA/cm^2, FF = 82.7%, Eff = 25%), discuss the benefit (or loss) of stacking these cells to form a tandem device:

a) For a 2 terminal device?

b) For a 4 terminal device?

c) Discuss the differences with the a-Si/μc-Si tandem cell case.

Exercise 2: Consider two solar cells a and b that are not interconnected monolithically but as a 4-terminal tandem device, such that the I-V curves of each cell could be measured independently of the other one:

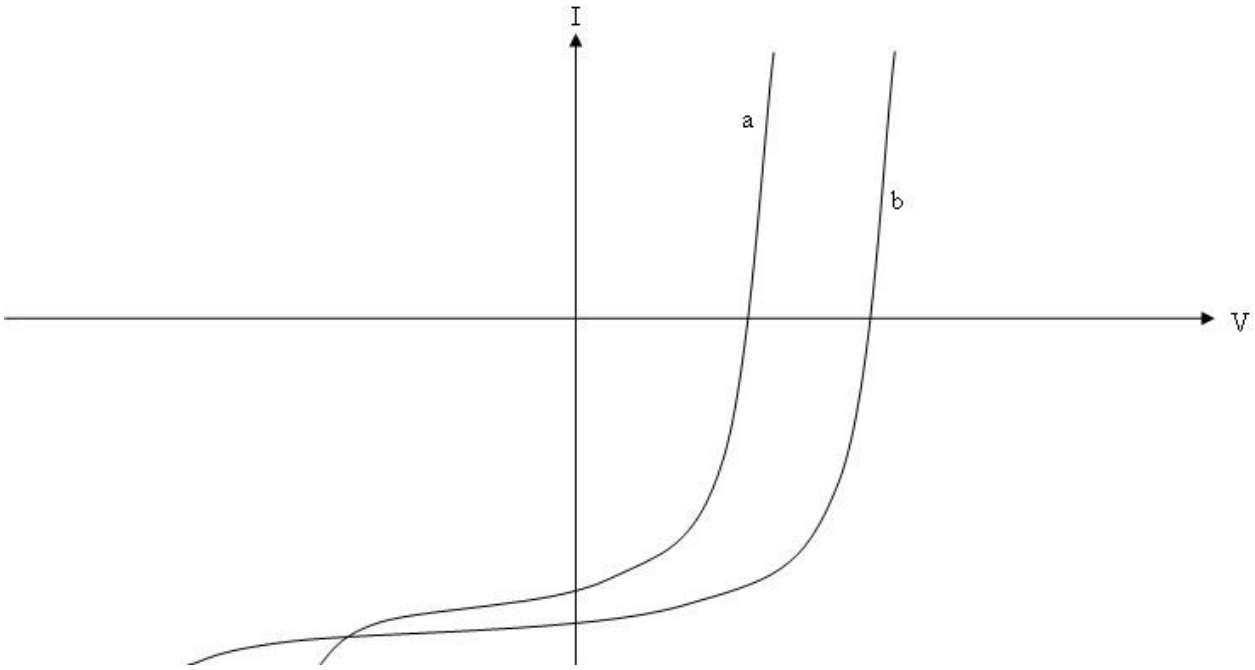

Figure 1: I-V curves of two solar cells a and b that are used together in a tandem device.

Imagine now that you interconnect the two cells monolithically.

a) Which cell is the top/bottom cell and why?

b) Draw the I-V curves of the cell [ab] (or [ba] according to your answer a)).

c) Which cell is the limiting one and why?

Exercise 3: Consider a pin-junction in dark with abrupt separation between the layers. Furthermore, assume the following constant density of charged dangling bonds N_{db} through the i layer of thickness d:

$$\rho(x) = \begin{cases} +qN_{\mathrm{db}} & \text{for x} \in [-d/2; 0] \\ -qN_{\mathrm{db}} & \text{for x} \in]0; d/2] \,. \end{cases}$$

The built-in voltage in the junction is given by V_{bi}.

a) Calculate the electric field distribution $E(x)$ within the i-layer by solving Poisson's equation for this configuration by choosing appropriate boundary conditions. Poisson's equation is given by:

$$\frac{\partial^2 \phi(x)}{\partial x^2} = \frac{\rho(x)}{\epsilon_0 \epsilon_r}$$

where

$$\frac{\partial \phi(x)}{\partial x} = -E(x).$$

b) Which value is required for N_{db} to have a vanishing field in the middle of the layer if d is 200 nm and 600 nm ? Take $\epsilon_r = 11.68$ and $V_{bi} = 1.2\,\mathrm{V}$.

c) Compare the value obtained in b) with N_{db} of a degraded material.

d) Discuss what could happen under illumination.