EEE337/348: Tutorial 2

1) Consider a Si pn junction with the following parameters.

   Diode area, A = 1 mm^2
   p-side doping, $N_A = 1\times10^{16}$ cm^{-3}
   n-side doping, $N_D = 2\times10^{16}$ cm^{-3}
   Electron diffusion coefficients, $D_e = 20$ cm^2/s
   Hole diffusion coefficients, $D_h = 12$ cm^2/s
   Electron minority carrier lifetime, $\tau_e = 100$ ns
   Hole minority carrier lifetime, $\tau_h = 10$ ns
   Intrinsic carrier concentration, $n_i = 1.5\text{x}10^{10}$ cm^{-3}

   i) Calculate the minority carrier diffusion lengths.
   ii) When used as a solar cell, it is important to have a large depletion width. Calculate the depletion width of this diode at 0 V.
   iii) Assuming that when exposed to direct sunlight the electron-hole pair generation rate is constant and is given by 10^{22} $cm^{-3}s^{-1}$. Calculate the photocurrent produced.
   iv) Calculate the saturation current in this diode.

2) Using values obtained in part (1),
   i) calculate the open circuit voltage and the short circuit current of the Si diode in part (2).
   ii) Consider that the diode described in part (1) is a simple planar diode fabricated with a single implantation step and deposition of metal contacts. Discuss additional fabrication procedures that can be adopted to increase V_{OC}.

3) Consider a solar cell that produces short circuit current $I_{SC} = 25$ mA and an open circuit voltage, $V_{OC} = 0.53$ V.
   i) Calculate the maximum power produced by this solar cell if its fill factor is 0.81.
   ii) Assuming that $V_m = 0.9V_{OC}$ and $I_m = 0.9I_{SC}$ calculate the number of cells (specify how the cells should be connected) required to produce a total power of 10 W at an output voltage of 10 V.

4) Discuss the advantages of using a tandem solar cell over a single junction solar cell.

5) Describe the structure of a typical high efficiency 3 junction tandem solar cell. Explain how it works.