1. A Schottky diode and a PN junction diode have cross-sectional areas of $A=5\times10^{-3}$ cm^2. The reverse-saturation current densities at T=300 K of the Schottky diode and the PN junction diode are 2×10^{-8} A/cm^2, and 4×10^{-12} A/cm^2, respectively. A forward-bias current of 1 mA is required in each diode. (Assume Eg = 2 eV for the pn junction diode and φ_{B0}= 1V for the Schottky diode.)
   (a) Determine the forward-bias voltage required across the Schottky diode. (15%)
   (b) Determine the forward-bias voltage required across the PN junction diode. (10%)

2. For a semiconductor, Eg = 3 eV, $m_p^* = 5\, m_n^*$, T = 300 K, and $n_i = 5\times10^6$ cm^{-3}.
   (a) Determine the position of the intrinsic Fermi energy level with respect to the center of the bandgap. (10%)
   (b) Impurity atoms are added so that the Fermi energy level is 1 eV below the center of the bandgap. What is the concentration of impurity atoms added? (15%)

3. (30%) Explain the following items:
   (a) Einstein relation
   (b) Exciton
   (c) Effective mass
   (d) Tunnel diode
   (e) Fill factor for solar cell
   (f) Annealing

4. (20%) For semiconductor, if it is possible that the Fermi level is above the bottom of the conduction band (E_c) or below the top of the valance band (E_v). If "Yes", please explain why and present an example. If "No", please explain why and present an example.