

1. A PN junction LED has cross-sectional areas of $A=10^{-3} \text{ cm}^2$. The reverse-saturation current densities at $T=300 \text{ K}$ is 10^{-12} A/cm^2 . A forward-bias current of 5 mA is required in this diode. The bandgap energy is 3 eV.
 - (a) Calculate the emission wavelength of this LED. (10 %)
 - (b) Determine the forward-bias voltage required across the PN junction diode. (10%)
 - (c) What is the external quantum efficiency and internal quantum efficiency of LED? (10%)

2. Please sketch the ideal energy-band diagrams for an ideal metal-to-n-type semiconductor junction (a) before and after “ohmic” contact, (b) before and after “Schottky” contact. Please label the following terms: E_c , E_v , E_F , ϕ_m (work function of metal), ϕ_s (work function of semiconductor), ϕ_{Bn} (barrier height), χ (electron affinity of semiconductor), V_{Bi} (built-in potential)..... (20%)

3. For measuring the following parameters of semiconductor including:
 - (a) resistivity, (b) carrier type, (c) majority carrier concentration, (d) majority carrier mobility, and (e) photoconductivity, what kinds of experiments you will establish and detailedly explain how they work. (35%)

4. Please explain the following items:
 - (1) Effective mass. (5%)
 - (2) Gunn diode. (5%)
 - (3) The Ebers-Moll model for p-n-p transistor. (5%)