國立臺南大學 104 學年度 **電機工程學系碩士班** 招生考試　半導體物理　試題卷

本試卷計 10 大題，每題 10 分，合計 100 分

1. What is effective mass? How is effective mass defined in terms of the E versus k diagram?

2. (a) Sketch a graph of n_0 versus temperature for an n-type material.
   (b) Describe the Hall effect.

3. Why, in general, is the concentration of excess carriers less at the surface of a semiconductor than in the bulk?

4. Why does a capacitance exist in a reverse-biased pn junction? Why does the capacitance decrease with increasing reverse-biased voltage?

5. Sketch the energy bands in a zero-biased, reverse-biased, and forward-biased pn junction.

6. A particle is in an infinite square well of size L. Calculate the ground-state and the first-excited-state energy if the particle is an electron and L = 1 nm.

7. The forbidden energy band of Ge is 0.66 eV.
   (a) Determine the minimum frequency of an incident photon that can interact with a valence electron and elevate the electron to the conduction band.
   (b) What is the corresponding wavelength?

8. The Fermi energy level for a particular material at T = 300 K is 6 eV. The electrons in this material follow the Fermi-Dirac distribution function.
   (a) Find the probability of an energy level at 6 + 2kT eV being occupied by an electron.
   (b) Find the probability of an energy level at 6 eV being occupied by an electron.

9. Consider an n-type silicon semiconductor is which $N_d = 10^{16}$ cm^{-3} and N_a = 0. The intrinsic carrier concentration is assumed to be $n_i = 1.5\times10^{10}$ cm^{-3}. Find the majority and minority carrier concentration.

10. Consider a silicon pn junction with doping densities $N_a = 10^{18}$ cm^{-3} and $N_d = 10^{15}$ cm^{-3}. Assume that $n_i = 1.0\times10^{10}$ cm^{-3}, thermal voltage V_t = 25 mV, and the relative permittivity ε_r = 11.7. Find the built-in potential barrier and the space charge width. [ln(10)=2.3]