Faculty of Engineering – Shoubra Department: **Electrical Eng.** Semester: **Fall 2014**		**Course: ECE 111:** **Electronic Engineering Fundamentals** **Instructor**: **Dr.** Abdallah Hammad
Total Grade: **25**	**Mid Term Exam**	Number of questions: **4** - Time allowed: **90 Min**

Answer all questions: write each question number and part number ahead of your answer

$K=1.38\times10^{-23}$ J/K $h=6.64\times10^{-34}$ J.s $q=1.6\times10^{-19}$ C $m_o=9.1\times10^{-31}$ Kg

Question 1 (7 marks)

a) For Silicon at T = 300 K is doped with acceptor atoms at a concentration of $N_A = 7 \times 10^{15}$ cm^{-3}. If the effective mass of holes is 0.81 m_o . ($n_i = 1.5 \times 10^{10}$ cm^{-3})
   i- Determine the position of Fermi energy level relative to the valance band.
   ii- Calculate the concentration of additional acceptor atoms that must be (added/removed) to move the Fermi level a distance KT closer to the valence-band edge.

b) Prove that the probability of occupying an energy level below the Fermi energy equal the probability that energy level above the Fermi energy and equally far away from the Fermi energy is not occupied.

Question 2 (5 marks)

In a **particular semiconductor material**, $\mu_n = 1000$ $cm^2/V.s$, $\mu_p = 600$ $cm^2/V.s$, and $N_C = N_V = 10^{19}$ cm^{-3}. Assume that these parameters are independent of temperature. The measured conductivity of the intrinsic material is $\sigma = 10^{-6}$ $(\Omega.cm)^{-1}$ at T = 300 K. Find the conductivity at T = 500 K.

Question 3 (6 marks)

a) Derive an expression for the Hall voltage $V_{H.}$

b) Consider silicon at T = 300 K. A Hall effect device is fabricated with the following geometry: $t = 5 \times 10^{-3}$ cm, $d = 5 \times 10^{-2}$ cm, and w = 0.5 cm. The electrical parameters measured are: $I_x = 0.50$ mA, $V_x = 1.25$ V, and $B_z = 650$ gauss $= 6.5 \times 10^{-2}$ Tesla. The Hall field is $E_H = 16.5$ mV/cm. Determine:
   i- The Hall voltage.
   ii- The conductivity type.
   iii- The majority carrier concentration.
   iv- The majority carrier mobility.

Question 4 (7 marks)

a) What is meant by the barrier potential in the pn junction? Derive its expression as a function of the donors and acceptor concentrations in the n-side and p-side respectively.

b) Consider a uniformly doped silicon pn junction with doping concentrations $N_A = 5 \times 10^{17}$ cm^{-3} and $N_D = 10^{17}$ cm^{-3}. The junction has a cross-sectional area of 10^{-4} cm^2. Calculate:
   i- The barrier potential at T = 300 K.
   ii- The depletion region width W and xno.
   iii- The maximum electric field for this junction.
   iv- The total charge in the in the region $(0 \leq x < x_{no})$.

Good Luck