King Saud University
College of Science, Department of Physics - Girls Section.
M.Sc Program

Final Examination, IST Semester 1427-28H
Date: 18-1-1428H (Tuesday, 06-02-2007G)
Time: 8.00 am to 11 am (3 hours).

PHYS 572

Answer any ***five*** questions. Max. Marks: 60

Question 1:

(a) Compare between Diamond lattice and Zincblende lattice structures with neat figures.

(b) Deduce an expression for the density of allowed energy states per unit volume.

(c) A silicon sample is doped with 10^{17} arsenic atoms/cm^3. Find the carrier concentration and Fermi level at 300K. Show these results graphically in a band diagram.

Question 2:

(a) Derive a relation for the electron mobility of an n-type semiconductor with uniform donor concentration in thermal equilibrium and discuss the various scattering mechanisms.

(b) A four point probe (with probe spacing of 0.4mm) is used to measure the resistivity of a p-type silicon sample. Find the resistivity of the sample if its diameter is 100 mm and thickness is 50µm. The constant current source is 1 mA and the measured voltage between the inner two probes is 8 mV [Take the correction factor ~ 4.5]. If the sample is cut into small square chips 4mm on each side [C.F ~ 2.5], what will be the measured voltage for a constant current source of 1mA.

Question 3:

(a) Discuss briefly carrier generation and recombination processes and obtain an expression for the lifetime of the excess minority carriers.

(b) What are compensated semiconductors? Consider an n-type silicon semiconductor at T=300K in which $N_D = 10^{18}$ cm^{-3} and $N_A = 0$. Determine the thermal equilibrium electron and hole concentrations for a given doping concentration.

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Question 4:

(a) Distinguish between a Schottky barrier diode and the p-n Junction diode? Derive an expression for the barrier height from the current-voltage characteristics of a metal - semiconductor contact.

(b) Calculate the theoretical barrier height, built- in potential and maximum electric field in a metal-semiconductor diode for zero applied bias. Consider a contact between tungsten and n-type silicon doped to $N_D = 10^{17}$ cm^{-3} at T= 300K.
Given that $\varphi_m = 4.55$ V and $\chi = 4.01$V.

Question 5:

(a) Show with specific examples that the contribution to the thermal conductivity of semiconductors of the conduction electrons and holes in general is quite small.

(b) Derive an expression for the optical absorption coefficient. How do you obtain the energy bandgap of semiconductors using optical absorption or transmission spectrum?

(c) Calculate the thickness of a semiconductor that will absorb 85 percent of the incident photon energy, given that the incident wavelength is $\lambda = 0.6\mu$m with and an absorption coefficient $\alpha \sim 10^4$ cm^{-1}.

Question 6:

Write ***short notes*** on any three of the following:

(a) Degenerate and Nondegenerate Semiconductors
(b) Haynes- Shockley Experiment.
(c) Depletion capacitance
(d) Tunneling process
(e) Thermoelectric Power

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Constants: $h=6.626\times10^{-34}$ J.S, $c=3.0\times10^{8}$ m/s, $q=1.602\times10^{-19}$ C,
$k_B = 1.380\times10^{-23}$ J °K^{-1}, $n_i=1.45\times10^{10}$ cm^{-3} for Si at 300K,
$N_C = 2.8\times10^{19}$ cm^{-3} for Si at 300K,
$N_V = 1.04\times10^{19}$ cm^{-3} for Si at 300K,
$\varepsilon_s = 11.7\ (8.85\times10^{-14})$ for Si