Paper Code: MTMC-102/MEC-905 **Roll No.**

M.Tech.
FIRST SEMESTER EXAMINATION, 2016-17
PHYSICAL ELECTRONICS

[Time: 3 Hours] [Max. Marks:70]

Note:- Attempt all questions. Assume suitable data if not given. Notations have usual meanings.
Useful Constant: Planck constant , h = 6.626 x 10^{-34} J-sec,
Effective mass: For Si, $m_e = 1.1m_o$ and $m_h = 0.56m_o$
ε_r for silicon =11.8 ,Permittivity of free space , ε_0 =8.85 X10^{-14} F/cm,

1. Attempt any **TWO** parts of the following:- **(7x2=14)**

(a) What is the physical meaning of wave function? Develop and explain the one dimensional Schrodinger wave equation.

(b) What is the Heisenberg Uncertainty Principle? The uncertainty in position of an electron is 1.2 Angstrom. Determine the minimum uncertainty in momentum and also the corresponding uncertainty in kinetic energy.

(c) Find the wave functions for a particle trapped in a potential well with potential V(x) zero except at the boundaries x = 0 and L, where it is infinitely large. Sketch the first two wave functions.

2. Attempt any **TWO** parts of the following:- **(7x2=14)**

(a) Draw and explain the relation between the energy and momentum for the free particle. State the definition of effective mass from the Energy versus wave vector diagram and discuss its meaning in terms of movement of a particle in a crystal.

(b) (i) The conductivity of a certain extrinsic n-type semiconductor was measured and found to be 0.183 $(\Omega\text{-Cm})^{-1}$ and 0.1 $(\Omega\text{-Cm})^{-1}$ at 300 K and 435 K respectively. Intrinsic carriers can be assumed negligible in this temperature range.

(I) What scattering mechanism dominates the mobility in this temperature range?
(II) What is the exponent of T in the mobility expression here?
(III) What conductivity do you expect to have at 400 K?

(ii) Find the number of equivalent (110) plane in a cubic crystal. If the lattice constant of a diamond crystal is 3.56 angstroms. Calculate the number of atoms per cm square in the diamond crystal in the (100) plane.

(c) (i) A Si sample with doping concentration of 10^{17} Phosphorus atoms/ Cm^3 is optically excited at 300 K such that $g_{op} = 10^{20}$ EHP/ Cm^3-sec and $\tau_n = \tau_p = 10$ μ sec. What is the separation of the quasi-Fermi levels? Draw the energy band diagram of the sample.

(ii) State and derive the continuity equation for electron.

3. Attempt any **TWO** parts of the following:- **(7x2=14)**

(a) In a p^+-n junction, the n-doping is doubled. How do the following change if everything else remains unchanged?

(i) Junction capacitance,
(ii) Built-in-potential,
(iii) Breakdown voltage,
(iv) Ohmic losses and
(v) Reverse saturation current.

Indicate the changes with proper justification.

(b) An abrupt Silicon p-n junction has 5 x 10^{17} Boron atoms/ Cm^3 on one side and 3 x 10^{15} Phosphorus atoms/ Cm^3 on the other. Calculate the diffusion potential, depletion width and draw an equilibrium energy band diagram for the junction . Show the Fermi level position and also calculate the contact potential from the diagram. Verify your result.

(c) What is Schottky effect? Explain with suitable necessary energy-band diagrams the formation of rectifying and non rectifying contacts of metal and n-type semiconductor.

4. Attempt any **TWO** parts of the following: - **(7x2=14)**

(a) Define the threshold voltage and derive the expression for it requited for the ideal MOS capacitor. Sketch the capacitance voltage relation for the ideal n channel MOS capacitor.

(b) Explain the effects of applied voltage on the ideal MOS capacitor. Derive an expression for the surface potential required to make the surface exactly intrinsic and hence to bring strong inversion in term of impurity concentration.

(c) Explain with neat sketch the effects of work function difference and charges in the oxide and at the interface on the threshold voltage and other properties of the ideal MOS structure.

5. Write Short Notes on any **TWO** of the following: - **(7x2=14)**

(a) Gettering

(b) Hall Measurement Technique

(c) Deep Level Transient Spectroscopy (DLTS),

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