Paper Code: EC-301/EEC-301	**Roll No.**									

B.Tech.
THIRD SEMESTER EXAMINATION, 2016-17
FUNDAMENTALS OF ELECTRONICS DEVICES

[Time: 3 Hours] [Total Marks: 100]

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 GaAs, $m_e^* = 0.067\ m_o$ & $m_h^* = 0.48\ m_o$ and For Si, $m_e = 1.1 m_o$ and $m_h = 0.56 m_o$ 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:- **(10x2=20)**

(a) *(i)* With a suitable sketch describe briefly the lattice structure of InP. *(ii)* Show the (211) plane and the [211] direction in a cubic crystal lattice.

(b) *(i)* What do you mean by effective mass of a carrier? What is the kinetic energy of a hole at the top of the valence band? *(ii)* Derive an expression for equilibrium electron concentration in the conduction band of a semiconductor.

(c) *(i)* Calculate the Fermi level position in Si containing 10^{16} Phosphorus atoms/ Cm^3 at 100 K assuming 50% of the impurities are ionized at this temperature. Also calculate the resistivity and conductivity of the material at room temperature.
(ii) What properties of a semiconductor are determined from Hall effect experiment. Justify your answer.

2. Attempt any ***TWO*** parts of the following:- **(10x2=20)**

(a) (i) What is luminescence? Explain various types of luminescence. How is it differ from incandescence process?

(ii) A photon of monochromatic light of wavelength 5000 A^0 is absorbed in GaAs and excites an electron from the valence band into conduction band. Calculate the velocity of electron.

(b) (i) A Si sample with doping concentration of 10^{17} Arsenic 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. How is quasi Fermi levels differ from the Fermi level? Explain.

(ii) Derive the simple diffusion equation for electron. How is diffusion length related with mobility of carrier? Also explain the physical significance of diffusion length of carriers.

(c) (i) Calculate difference in relaxation times for electrons and holes in Silicon crystal at room temperature.
(ii) Assume that excess electrons are somehow injected into a semi-infinite semiconductor bar at x=0, and the steady state electrons injection maintains a constant excess electrons concentration at the injection point. Derive the equation which gives the distribution of excess electrons as a function of x.

3. Attempt any ***TWO*** parts of the following:- **(10x2=20)**

(a) What is diffusion potential? Explain. Derive an expression for it assuming abrupt junction. How is it modified by the application of bias voltage? Explain with the help of energy band diagram.

(b) A Si abrupt p-n junction has $N_a = 3 \times 10^{18}$ / Cm^3 on the p-side and an area of 1.6×10^{-3} Cm^2. The junction capacitance is 18 pF at a reverse bias of 3.2 V and 12 pF at 8.2 V. Calculate the built-in voltage and the donor concentration on the n-side.

(c) What do you mean by minority carrier injection and minority carrier extraction? Derive an expression for the current voltage relation in an ideal p-n junction diode.

4. Attempt any ***TWO*** parts of the following:- **(10x2=20)**

(a) Explain the construction, basic principle, operation and characteristics of a majority carrier diode with suitable diagram.

(b) What do you mean by normally -ON and normally -OFF MESFET? Explain the operation of GaAs MESFET with the help of its construction and characteristics of the device. What are the advantages of it over Si MESFET?

(c) What are the advantages and disadvantages of FET over BJT? Describe the construction, operation and characteristics of an enhancement type p-channel MOSFET with the help of energy band diagram of MOS Structure.

5. Attempt any ***TWO*** parts of the following:- **(10x2=20)**

(a) Describe the construction, working principle and voltage-current characteristics of an Esaki diode. Also discuss the materials used in the diode with suitable energy band diagram.

(b) What is R-W-H mechanism? Explain with energy band structure. Describe a device based on this effect with suitable diagram in detail. Also draw its V-I characteristics and explain.

(c) (i) What is photoconductivity? Explain how the photocurrent is proportional to the lifetime and inversely proportional to the transit time of carrier.

(ii) What is photoconductor? Explain its working, applications, and limitations. Also discuss the time response and optical sensitivity of the device.