Ref. No.: Ex/ET/T/112/2018

B.E. ELECTRONICS AND TELE-COMMUNICATION ENGINEERING EXAM 2018

FIRST YEAR FIRST SEMESTER

PHYSICAL ELECTRONICS

Marks: 100 Time: Three hours

The figures in the margin indicate full marks.

Answer ***any five*** questions.

(*All parts of the same question must be answered together*)

1.a)	Define unit cell and mention its importance.	3+3
b)	Describe crystal structures of (a) *GaAs* and (b) *Si*. Also name the structures.	4+2+2
c)	Determine the variation of potential energy of an electron with distance along a one-dimensional monoatomic crystal, and construct the Kronig-Penney model, supported by a neat sketch, for the crystal.	3+3
2.a)	Determine the wave function and energy for an electron confined in an infinitely deep square potential well.	12
b)	i) What is the ground state electron energy in the above case? ii) Determine the ground state electron energy, if width of the above well be doubled. Justify results (i) and (ii) with the help of Heisenberg Uncertainty principle.	2+2+4
3.a)	What do you mean by Crystal momentum?	4
b)	Derive expressions for carrier effective mass.	2+2
c)	Mention the general features of conduction band of the semiconductor for which the band curvature effective masses in transverse and longitudinal directions are: (i) unequal, (ii) equal.	4+3
d)	Explain how the heavy hole and light hole bands originate.	5
4.a)	Derive the thermal equilibrium concentration of electrons in the conduction band in terms of Fermi energy, if the number of electrons is quite large.	10
b)	Only mention the approximation to be made in the above derivation, if the number of electrons present is very few.	2
c)	Determine the position of Fermi level in an intrinsic semiconductor. Explain under what condition the intrinsic Fermi level would be (i) at, (ii) above and (iii) below the mid-gap energy.	4+4

[Turn over

5.a)	Describe various statistical distributions related to distribution of particles among available energy states. Which one is appropriate for distribution of conduction band electrons in a degenerate semiconductor?	7+1
b)	In a solid, the uppermost band is partially filled at $T = 0K$. Is the material a metal, an insulator or a semiconductor, if the gap between that band and the next lower band is (i) 0.7 eV, (ii) 7.0 eV ?	2+2
c)	Determine the energy range over which variation of the Fermi-Dirac distribution function with temperature is significant.	8
6.a)	What do you mean by a compensated semiconductor?	4
b)	Determine the electron and hole concentration in *Si* at 300 K with $N_D = 10^{16}$ cm^{-3} and $N_A = 2 \times 10^{18}$ cm^{-3}. Find out whether it is a degenerate *Si* or not. Take at 300 K, $n_i = 1.5 \times 10^{10}$ cm^{-3} for *Si* and $k_BT = 26$ meV.	4+4
c)	What is Phonon? Compare *Acoustic* and *Optic* phonons.	2+6
7.a)	From the general form of DOS function in bulk semiconductor, derive the energy dependence of density of states in two- dimensional (QW) and one-dimensional (QWW) systems of semiconductor.	4+6
b)	Explain carrier diffusion in non-homogeneous semiconductor and derive an expression for the resulting current density.	10
8.	Write notes on ***any two***:	10+10
a)	Technique for single crystal growth of *Si*,	
b)	Extrinsic semiconductor,	
c)	Shockley-Read-Hall recombination and Auger recombination,	
d)	Experimental determination of carrier effective mass.	