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Ex/ET/T/112/2017(S)

B. ETCE. ENGG.SUPPLEMENTARY EXAMINATION 2017

1st Year, 1ST Semester

PHYSICAL ELECTRONICS

Full Marks : 100 Time : Three hours

*Answer **Question no. 1** and **any seven** from the rest.*

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

1. Define (***any ten***): 3x10=30

   a) Elemental semiconductor
   b) Lattice constant
   c) Basis of crystal
   d) Forbidden energy gap
   e) Fermi level
   f) Density-of-state effective mass
   g) Law of mass action
   h) Fully compensated semiconductor
   i) Saturation velocity of carriers
   j) Diffusion length of minority carriers
   k) Quantum size effect
   l) Quantum well.

2. Describe the *Free electron theory* and its limitations. What are the modifications introduced by Pauli and Sommerfeld? 8+2

3. What do you understand by E*ffective mass of carriers*? Derive two general expressions of it. 3+7

4. Explain how does the concept of *Hole* come? Why a hole is heavier than an electron? Name different kind of holes in the valence band. 5+3+2

5. Derive the expression of energy eigen values for an electron confined in an infinitely deep square potential well. 10

6. Establish the energy dependence of density-of-states function $D(E)$ for electrons in the conduction band of a semiconductor system, assuming the E-k relation to be parabolic. Also sketch variation of $D(E)$with E. 8+2

7. What is the Fermi-Dirac distribution function? Establish its variation with energy for both zero and non-zero temperatures. What is meant by Fermi-Dirac tail? 2+6+2

8. Prove that in a non-degenerate semiconductor $np = n_i^2$, with all terms bearing their usual significances. 10

9. What is *Compensation doping*? Describe how one can get a p-type semiconductor, starting with an n-type semiconductor doped with N_d donor concentration. Illustrate the mechanism schematically. 2+5+3

10. Formulate the continuity equation for excess holes in n-type semiconductor, and modify it if steady state carrier injection be maintained. 7+3

11. Describe the set-up for Haynes-Shockley experiment for an n-type sample and the scheme for determining the drift velocity of minority carriers in it. 10

12. Write notes on **(any one)**: 10

(a) Intrinsic semiconductor

(b) Hall effect

(c) Shockley-Reed-Hall recombination and Auger recombination.