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

B. ETCE. ENGG. SUPPLEMENTARY EXAMINATION 2017

1st Year, 1st Semester

ELECTRON DEVICE – I (OLD)

Full Marks : 100 Time : Three hours

Answer any five questions.

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

1.(a) Describe (a) Simple cubic, (b) Face centred cubic and (c) Body centred cubic lattices. Determine the number of atoms/unit cell and packing factor in each case. 3x5

(b) Sketch the variation of potential energy of an electron moving thro' a one-dimensional mono-atomic crystal. 5

2.(a) Describe the wavefunction and energy eigen values for an electron confined in an infinitely deep square potential well. 14

(b) Describe behavior of the electron if the above well be of finite depth. 6

3. Define 'Intrinsic' and 'Extrinsic' semiconductors. Explain how intrinsic silicon can be converted to (i) n-type Si and (ii) p-type Si. 5+15

4.(a) Derive the expression for electron concentration in a non-degenerate n-type semiconductor. 10

(b) Obtain an expression of the intrinsic carrier concentration for a semiconductor. 5

(c) Determine the position of Fermi level in an n-type semiconductor in terms of doping levels in it. 5

5.(a) What is the Fermi-Dirac distribution function? Sketch and explain its variation with energy at both $T = 0$ K and $T > 0$ K. 2+8

(b) Deduce the continuity equation for holes in an *n*-type semiconductor, in which excess holes are injected to modify the equilibrium hole concentration along the *x*-direction. 10

6.(a) Derive temperature dependence of the mobility of carriers in an extrinsic semiconductor. 12

(b) Discuss how the majority carrier concentration varies with temperature in an extrinsic semiconductor. 8

7.(a) A Si sample has donor concentration of $3x10^{18}$ cm^{-3}. Determine the concentration of hole, and the ratio of electron and hole concentrations. Given that the intrinsic carrier concentration is $1.5x10^{10}$ cm^{-3} at 300 K. 5

(b) Find the conductivity and resistivity of an intrinsic semiconductor at 300 K. Given that $n_i = 2.5x10^{13}$ cm^{-3}, $\mu_n = 3800$ cm^2/Vs and $\mu_p = 1800$ cm^2/Vs. 5

(c) A p-Si sample has majority carrier concentration of 10^{16} cm^{-3}. Donor atoms with concentration $5x10^{18}$ cm^{-3} are added to it. What are the concentrations of majority and minority carriers in the resulting sample? Also determine the corresponding shift in Fermi level. 10

8. Write notes on **(any two)**: 2x10

(a) Reduced Brillouin zone

(b) Carrier effective mass

(c) Recombination of carriers

(d) Phonon.