2014

M.Sc.

4th Semester Examination

ELECTRONICS

PAPER—ELC-403

Full Marks : 50

Time : 2 hours

The figures in the right-hand margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Illustrate the answers wherever necessary.

(Quantum Electronics)

Answer *Q. No. 1* and any *three* from the rest.

1. (a) Why should the direct bandgap semiconducting materials be used for developing opto-electronic devices generally ?

(b) Using time independent perturbation theory derive the first order perturbation in energy.

(c) Show graphically how density of states for electrons in a quantum well differs form that of bulk devices.

(d) What is stimulated emission? In what ways it is different from spontaneous emission?

(e) Discuss the merits of MQW laser compared to QW laser. 2×5

2. (a) Explain photo-conduction & photo-emission.

(b) Discuss the principle of operation of quantum well laser.

(c) Explain 'quasi-equilibrium' for a semi-conductor laser. 3+4+3

3. (a) What are the advantages of SAM-APD over an ordinary APD? What is GRIN-SCH?

(b) Describe the principle of operation of a super lattice APD? (3+2)+5

4. (a) Show using time dependent perturbation theory, that the transition probability from an initial step $|m>$ to a final state $|k>$ may be expressed as :

$$|a(t)|^2 = 4\left|\langle k|H'|m\rangle\right|^2 \frac{\sin^2\left(\frac{1}{2}\omega_m t\right)}{\hbar^2\omega^2_{km}}$$

The symbols have their usual meanings.

(b) Write the expression for Fermi-Golden Rule explaining the meaning of each term. Briefly indicate how you would derive the expression for Einstein B coefficient using Fermi-Golden Rule. 5+(2+3)

5. (a) What do you mean by perturbation? What are degenerate and non-degenerate systems?

(b) Derive the expression for density of states as a function of energy for a bulk device.

(c) Draw the density of states function for electrons in bulk, Quantum well, Quantum wire and Quantum dot in the same diagram. (1+3)+4+2

6. (a) How is threshold current reduced in quantum well?

(b) Why the dimension of a quantum well should be less than the mean-free path of the electron/hole in the material?

(c) Describe the working principle of a quantum well infra-red photo-detector. 3+2+5

Internal Assessment — 10
