PG/IVS/ELC-403/12

M.Sc. 4th Semester Examination, 2012

ELECTRONICS

(*Quantum Electronics*)

PAPER—ELC-403

(Theory)

Full Marks : 50

Time : 2 hours

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

The figures in the right-hand margin indicate marks

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

Illustrate the answers wherever necessary

1. (*a*) What is stimulated emission ? In what ways it is different from spontaneous emission ?

   (*b*) Write down the conditions for using time independent Schrödinger equation for a system.

(*Turn Over*)

(*c*) Explain why quantum electronic devices operated at optical frequency is more noisy than those operated at microwave frequency.

(*d*) Explain why absolute monochromacity of an electromagnetic radiation is an unattainable goal.

(*e*) Discuss why the dimension of a QW should be less than the mean free path of the electrons/holes in the material. 2 × 5

2. (*a*) Derive the expression for second order perturbation in energy when time independent perturbation is in action.

(*b*) Show that the constant in a series solution of wave function depends upon time when perturbation is acting. 5 + 5

3. (*a*) Mention the steps for producing MASER.

(*b*) Discuss, in details, the variation of $f(E)$ with (E).

(*c*) Give a comparative estimate of semiconductor laser and gas laser. 2 + 5 + 3

4. (*a*) Deduce expression for photon density at steady state in a semiconductor laser cavity.

(*b*) With clear diagram explain the action of Double heterojunction semiconductor.

(*c*) Compare MQW and SL structures. 4 + 4 + 2

5. (*a*) Discuss how carrier confinement and optical confinement are achieved in a QW.

(*b*) Give an estimate of the thickness of active region of a QW.

(*c*) GaAs layer is having $10^{17}/cm^3$ charge carriers. Find λ_F 4 + 4 + 2

6. (*a*) An atom is irradiated by light. Write down the total Hamiltonian. Give interpretation of each term.

(*b*) At $t = 0$, the atom is known to be in an eigenstate '*i*' of the time independent part of the Hamiltonian. Calculate the probability of finding the atom in another state '*f*', also an eigenstate of the some part, at a later time *t*. 2 + 8

[*Internal Assessment* : 10 Marks]