2015

M.Sc. Part-II Examination

PHYSICS

PAPER—X

Full Marks : 75

Time : 3 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.

Use separate answer-scripts for Group-A and Group-B

Group-A

[ Marks : 40 ]

1. Answer any five questions : 5×2

(a) How can you develop an opto electronic XOR logic gate with SLM?

(b) What is the advantage of trinary logic system over binary logic system?

(Turn Over)
(c) Write down the name of four non-linear materials.

(d) Why a material shows non-linear behavior, when it is exposed under laser radiation?

(e) What do you mean by graded index optical fibre?

(f) What is the difference between spontaneous emission and stimulated emission of a laser radiation?

(g) What do you mean by Q-switching?

2. Answer any two questions: 2×3

(a) Describe the method of Q-switching by mechanical shuttering.

(b) Find the ratio of the stimulated to the spontaneous emission rate at a temperature of 250°C for the sodium D1 lines (λ = 590 nm) h = 6.6 × 10^{-34} Js; k = 1.38 × 10^{-23} Jk^{-1}.

(c) A step index fibre has a core of index 1.500 and a cladding of index 1.489. Find the temporal broadening of a pulse in nano second per km. Also find the spread in space for 1 km of the fibre.

3. Answer any one question: 1×4

(a) What do you mean by Q-factor of a laser resonator? And derive its relation with the exponential time constant of a resonator.

(b) Using Burger's law show that the amplification of light is not possible in a two level laser system.

4. Answer any two questions: 2×10

(a) What is a four level laser system? Why this type of system is advantageous over other laser systems? Obtain the equation of population inversion in a four level laser system.

In a He - Ne laser transition from 3S → 2P level gives a laser emission of λ = 632.8 nm. If the 2P level has energy 15.2 × 10^{-19} J, calculate the pumping energy required, assuming no loss whatsoever.

(h = 6.6 × 10^{-34} Js; 1eV = 1.6 × 10^{-19} J) 1+1+5+3

(b) Deduce the relation n = n_0 + n_1I for a non-linear material. Symbols have their usual meaning.

Discuss the process of self focussing by exploitation of non-linear phenomenon of a dielectric medium. What is
intermodal dispersion in a step index optical fibre. Derive its expression for a step-index optical fibre.

(c) Show how can you obtain all optical XOR, AND, OR, NOR gates in practice. What is 'Basic Module'? How tristate input signal can be generated by using Basic Module?
Write down the truth table of tristate (I, O, T) AND, OR & XOR gates.

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**Group-B**

[ Marks : 35 ]

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

1. Answer any **two** bits:

   (a) Calculate the energy difference between conduction bond and Fermi energy in an intrinsic Si sample at 300K.
   \[ (m_e^* = 1.1m, m_h^* = 0.59m) \]

   (b) Find the electrical neutrality condition when a semiconductor is doped with donor impurity.

   3+2+1+4

(c) The minority carrier lifetime in p type material is \(10^{-7}\) second. The mobility of electron in Si is \(0.15 \text{ m}^2\text{V}^{-1}\text{s}^{-1}\) at 300K. If \(10^{20}\) electrons/m\(^3\) are injected at \(x = 0\), what is the diffusion current density just at the junction?

2. (a) Find the density of electron in the conduction bond for a non-degenerate semiconductor at Temperature \(T\).

   (b) What is law of mass action?

3. (a) Clearly draw the band diagram of a p-n junction under equilibrium condition.

   (b) Derive Diode equation assuming band picture of a p-n junction.

4. (a) What is meant by Linearly Graded Junction?

   (b) Find the expression of Junction Capacitance for linearly graded junction.

5. (a) What is meant by equilibrium and non-equilibrium carriers?

   3+7

C/16/DDE/M.Sc./Part-II/Physics/10 (Continued)
(b) Find an expression of Growth of carriers when light falls on a semiconductor?

(c) What is meant by relaxation time.

6. (a) Assuming Boltzmann Transport equation find the expression of electrical conductivity of a nondegenerate semiconductor.

(b) Prove that mobility of a nondegenerate semiconductor is proportional to $7^{\frac{3}{2}}$ at low temperature region.