2013

M.Sc. Part-II Examination

PHYSICS

PAPER—X

Full Marks : 75

Time : 3 Hours

The figures in the 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 Gr. A & Gr. B.

Group—A

[Marks—40]

Answer *all* questions.

1. Answer any *five* questions : 5×2

(a) What is the fundamental difference between the generation of radiation from a 3-level laser and a Na-Vapour lamp ?

(b) What are virtual and real images in relation to the reconstruction of the images from a hologram ?

(c) Discuss the principle of optical NOR logic operation with non-linear material.

(d) What is volume hologram ?

(e) Compare focusing by a convex lens with the self-focusing by a non-linear material.

(f) Give four examples of non linear optical Crystals synthesized in laboratory (not available in nature).

(g) Explain the superiority of optical logic gates over electronic logic gates and optoelectronic logic gates.

2. Answer any *two* questions : 2×3

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

(b) In a He-Ne laser transition from 35→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.

(c) Calculate the ratio of stimulated to spontaneous emission rates for the wavelength $\lambda = 5893\,\mathring{A}$ at 200°C.

3. Answer any *one* question : 1×4

(a) Construct an optoelectronic half-adder circuit.

(b) What is V-parameter of an optical fibre and what is the physical significance ?

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. Derive an expression for Q factor of a laser resonator. 1+1+5+3

(b) What is intermodal dispersion in a step-index optical fibre ? Derive its expression for a step-index optical fibre. A step-index fibre has a core of index 1.5 and cladding of index 1.489. Find the temporal broadening of a pulse in nano-second per kilometre. Also, find the spread in space for 1 km of the fibre. What are the advantages and disadvantages of optical fibre communication over the conventional communication system using wires ?

1+3+3+(2+1)

(c) How phase matching condition is achieved for second harmonic generation by using a non-linear material ? What are the advantages of tri-state logic

system over binary system? Write down four applicans of non linear optical materials. Prove that the refractive index of a centro. Symmetric non-linear crystal becomes intensity dependent.

3+1+2+4

Group—B

[Marks—35]

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

1. Answer any *two* bits : $2\times2\frac{1}{2}$

(a) In an n type semiconductor the Fermi level lies 0.3 ev below the conduction band at 300K. If the temperature is increased to 330K, find the new position of the Fermi level.

(b) A Sillicon is doped with 10^{14} atom/cm^3. Find the barrier potential for a symmetric junction at room temperature.

$m_e^* = 1.1m$

$m_h^* = 0.56m$, $E_g = 1.1ev$

(c) Assume p^+n junction with a graded n region where the doping is describe by $N_d(x) = Gx^m$. The depletion layer width W extends from the junction at x = 0 to the n region. Find an expression for maximum electric field.

2. (a) Describe in details the growth of current in a semiconductor when light is on & hence find an expression of Generation rate of carriers.

(b) Explain how will you determine lifetime of carrier experimentally. 8+2

3. (a) Derive diode equation.

(b) What is the significance of diode ideality factor?

(c) Find an expression of Diffusion Capacitance of a p-n junction per unit area. 5+1+4

4. (a) Describe with band diagrams the formation of Schotky barrier in a metal/n type semiconductor junction.

(b) Describe in details the Schotky diffusion theory. 4+6

5. (a) Find an expression of carrier concentration in an n type semiconductor in the extremely low temperature region.

   (b) Find an expression of depletion temperature in an n type semiconductor. 7+3

6. (a) Assuming Boltzman transport equation find an expression of electrical conductivity in a non degenerate semiconductor.

   (b) Show how mobility varies with temperature in a non-degenerate semiconductor. 8+2
