M.Sc. 4th Semester Examination, 2015

PHYSICS

PAPER — PHS-403 (A + B)

Full Marks : 40

Time : 2 hours

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

PHS-403(A)

[*Marks* : 20]

Answer Q.Nos. 1& 2 and any **one** from the rest

1. Answer any *two* bits :   2 × 2

   (a) When the reverse gate voltage of JFET change from 4·0 to 3·9 V, drain current change from 1·3 to 1·6 mA. Find the value of Transconductance.

(b) Explain what is SCR ?

(c) Prove that when lattice scattering is involved, mobility of a nondegenerate semiconductor can be shown as

$$\mu_e \, \alpha T^{-\frac{3}{2}}.$$

2. Answer any *two* questions :   3 × 2

(a) The resistivity of a semiconductor was known to be ·00893 Ω m at room temperature. The flux density B_z is 0·5 Weber/m². Calculate the Hall angle for a Hall coefficient of 3·66 × 10⁻⁴ m³/c.

(b) What is a Gunn Diode and explain its mechanism.

(c) Explain how drift mobility can be experimentally determined through Hayne's Shockley experiment.

3. (a) Assuming Boltzman transport equation derive thermoelectric power of the couple 1 & 2 of nondegenerate semiconductors

$$\alpha_{12} = \frac{k}{e}\left[A - \frac{E_F}{kT} \right]$$

where A basis between 2 and 4. **8**

(b) What is meant by volume component of thermoelectric power ? **2**

4. (a) Explain how a bipolar transistor can be converted to a phototransistor. **4**

(b) Explain quantum Hall effect and find an expression of Hall Voltage assuming a 2d electron gas. **6**

PHS-403(B)

[*Marks* : 20]

Answer Q.Nos. 1& 2 and any **one** from the rest

1. Answer any *two* questions : 2 × 2

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

(4)

(b) What is a graded-index fibre ? Discuss its advantages over a step index one.

(c) Explain the superiority of optical logic gates over electronic logic gates and opto-electronic logic gates.

(d) Write the general equation of dielectric polarization of a nonlinear material. Hence modify the equation when the material is isotropic.

2. Answer any *two* bits : 3 × 2

(a) Obtain the expression of time broadening in a multimode optical fiber. 3

(b) With supporting diagram draw the method of reconstruction of a wavefront from a recorded hologram. 3

(c) (i) Calculate the V parameter of a planar waveguide when its core diameter is 5 μm, the free-space wavelength used is 600 nm, refractive indices of core and cladding regions as 1·5 and 1·4 respectively.

(ii) An optical planar waveguide has the V-parameter value-II. How many modes will be found there? $1\frac{1}{2} \times 2$

(d) What is "BASIC MODULE" and give its working principle. 3

3. Prove that the 'ray path' in a graded index optical fibre is sinusoidal, whose refractive index is given by

$$n^2(r) = n_1^2 \left[1 - \left(\frac{r}{a} \right)^2 \right] \text{ for } |r| < r_0$$

$$= n_1^2 \left[1 - \left(\frac{r_0}{a} \right)^2 \right] \text{ for } |r| > r_0$$

An optical fibre is of diameter 100 μm. If the core is of refractive index 1·5, find the axial distance travelled by a ray incident 30^0 between two successive internal reflections. Make a comparison between ordinary photography and a holography. 4 + 4 + 2

4. What do you mean by second harmonic generation of light in a non-linear material ? Discuss the method of second harmonic generation. What is phase matching condition ? Why this condition is essential in 2nd harmonic generation ? Discuss the method of establishing phase matching condition in 2nd harmonic generation.

$$1 + 3 + 1\frac{1}{2} + 1\frac{1}{2} + 3$$

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