2019

M.Sc.

4th Semester Examination

PHYSICS

PAPER – PHS-403 (Gr. – A + B)

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.
Use separate answer scripts for Group A and Group B

(Gr. A – *Semiconductor Devices*)
Answer Q1 and any one from Q2 and Q3.

1. Answer any five bits: 5 X 2 = 10

(a) Describe the working principle of Unijunction Transistor (UJT).

(b) Describe the advantages of phototransistor over photodiodes.

(c) Why low temperature is an important criterion for operation of Single Electron Transistor (SET)?

(d) A copper strip is placed inside of an uniform magnetic field of 2.5 T. The Hall electric field is measured to be 1.5×10^{-3} V/m. (a) What is the drift speed of the electron? Assuming that $n = 8.0 \times 10^{28}$ / m^3 and cross-sectional area of 5.0×10^{-6} m^2, (b) Calculate the current flowing through the strip.

(e) Make a comparison between thyristor and transistor.

(f) Explain the working principle of DIAC.

(g) 'Degenerate semiconductors are essential for the fabrication of semiconductor laser'- Explain.

(Turn Over)

(h) Consider a silicon tunnel diode at T = 300K with doping concentration of $N_d = N_a = 5\times10^{19}$ cm^{-3}. Assuming the abrupt junction approximation is valid, determine the space charge width at a forward-bias voltage of $V_a = 0.4$ V.

2. (a) Describe the I-V characteristics of Tunnel Diode using the band diagrams. (7)

(b) Explain the origin of negative differential mobility in Gunn diode. (3)

3.a) Assuming Boltzmann transport equation derive the expression of electron mobility μ_n in terms of relaxation time (τ) for non-degenerate semiconductor. Show that in case of ionized impurity scattering μ_n vary with temperature as $T^{3/2}$. (8)

(b) What is meant by nondegenerate semiconductor? Which statistics is valid for carrier distribution in non-degenerate semiconductor? (2)

(Gr. B – *Applied Optics*)

Answer Q1 and any one from Q2 and Q3.

1. Answer any five bits: 5 X 2 = 10

(a) How does crystal symmetry affect second- and third- order nonlinear polarizations?

(b) What is dispersion compensated fiber?

(c) What is self-focusing?

(d) Consider a fiber consisting of a core of refractive index 1.48 and having air (n_2=1) as cladding. What is its numerical aperture? What is the maximum incidence angle upto which light can be guided by the fiber?

(e) Write the advantages of an all optical logic gate over electronic and opto-electronic logic gates.

(f) What is holography? Make a comparison between ordinary photography and a holography.

(g) Construct an optoelectronic XOR and AND gate.

(h) What is phase matching condition in second harmonic generation?

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2. (a) Consider the case of sum- frequency generation in a lossless optical medium. Write down the coupled amplitude equations. Deduce the expressions of amplitudes in perfect phase matching conditions. Show their variations graphically and explain. (2+3+2)

(b) When the waveguide is called weakly guiding? Explain with reasoning. (1+2)

3. (a) What is electro-optic Kerr effect? (2)

(b) Distinguish between Bragg's diffraction and Raman-Nath diffraction. (2)

(c) What is graded index fiber? Prove that the ray path of a graded index fiber is sinusoidal, whose refractive index is given by $n^2(r) = \begin{cases} n_0^2\left[1-\left(\frac{r}{a}\right)^2\right], & |x| > a \\ n_2^2, & |x| < a \end{cases}$ (2+4)

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(Internal Assessment – 10)