2023
M.Sc.
4th Semester Examination
PHYSICS
PAPER – PHS-403
Full Marks: 50
Time: 2 Hours
Paper code: 403.1 (Semiconductor Devices)

1. Answer any two (02) from the following **2×2=4**

a) A Copper strip is placed inside a uniform magnetic field of 2.5 T. The Hall electric field is measured to be 1.5 x 10^{-3} V/m (a) calculate the drift speed of the electron? Assuming that n= 8.0 × 10^{28} / m^3 and cross-sectional area of 5.0 × 10^{-6} m^2, (b) Calculate the current flowing through the strip.
b) Show that there is a gain in photocurrent in case of phototransistor.
c) Explain the population inversion in case of semiconductor laser.
d) What do you mean by Depletion MOSFET?

2. Answer any two (02) from the following **2×4=8**

a) Describe the band structure of the material, which leads to Gunn Effect oscillation. Why does the mobility in such a material vary with the application of field?

b) Draw a circuit diagram to study the current-voltage characteristics of SCR and explain the working mechanism of the SCR.

c) Describe the operational principle of Triac and draw the characteristic curve.

d) Sketch the energy band diagrams of a tunnel diode in which both the n and p regions are degenerately doped for the case of (a) zero bias, (b) $0 < V < V_p$,(c) $V_p < V < V_v$, $V_p < V < V_v$, and (d)$V > V_v$. V_p, V_v are the peak and valley voltages respectively. Draw the characteristics of the Tunnel diode also.

(Turn Over)

Answer any one (01) from the following **1×8=8**

3.a) Discuss the characteristics of quantum Hall effect. In which way is it different from classical Hall Effect? 3

b) Explain the conditions to observe the quantum Hall effect. 2
c) Write down the numerical value of Klitzing Constant 1
d) Explain the difference between super lattice structure and multiple quantum-well structure. 2

4. Assuming Boltzmann transport equation derive the Seebeck-Coefficient of n-type nondegenerate semiconductors $S_n = -\frac{1}{eT}\left[\frac{\langle \tau E \rangle}{\langle \tau \rangle} - E_f\right]$, where symbols have their usual meaning. 8

Paper code: 403.2 (Applied Optics)

1. Answer any two (02) from the following: **2×2=4**

(a) Write some characteristics of V parameter.
(b) Consider a symmetric step-index waveguide with n_1 = 1.5, n_2 = 1.46, d = 4 μm operating at λ_0 = 0.6328 μm. Calculate the number of symmetric and antisymmetric modes.
(c) Give differences, with necessary diagrams, between the step-index and graded-index optical fibers.
(d) Design and explain all optical AND logic gates

2. Answer any two (02) from the flowing: **2×4=8**

(a) Derive one-dimensional ray equation in a planar optical waveguide and trace the path for a homogeneous medium. (3+1)
(b) Describe schematically, using block diagram, the basic elements of a fiber optics communication system.
(c) Discuss the basic principle of holography.
(d) What do you mean by second harmonic generation? Discuss, in detail, how the phase matching condition is obtained in a nonlinear material.

(Continued)

3 Answer any one (01) from the following: **1×8=8**

(a) (i) Write down the differential equation of TE modes in case of light propagating along z direction through a symmetric step-index planar waveguide where the refractive indices [n(x)] are n_1 in the core ($|x| < d/2$) and n_2 in the cladding ($|x| > d/2$) regions. 2+2

(ii) For the symmetric modes prove the expression $\xi \tan\xi = \left(\frac{1}{4}V^2 - \xi^2\right)^{1/2}$, where all the symbols have their usual meanings. 4

(b) Discuss the recording and reconstruction of hologram of a point object and deduce the expression for the radii of the bright fringes of the hologram. Discuss the resolution of hologram with a mathematical deduction using Rayleigh criterion. 5+3

(All the symbols have their usual meanings)

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Internal Assessment-10