**2024**
**M.Sc.**
**4th Semester Examination**
**PHYSICS**
**PAPER – PHS-403**
***Full Marks: 50***
***Time: 2 Hours***

**Paper code: 403.1 (Transport Properties and Semiconductor Devices)**

**ANSWER Q1, Q2, AND ANY ONE FROM Q3 AND Q4**

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

a) Name some devices where we can get negative differential resistance. Discuss the advantage of negative differential resistance.
b) Write down the conditions of a system to observe quantum Hall effect.
c) Draw the V-I characteristics for TRIAC.
d) When the reverse gate voltage of JFET changes from 4.0 to 3.9V, drain current changes from 1.3 mA to 1.6 mA. Find the value of transconductance.

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

a) Discuss the construction and the working principle of phototransistor and how phototransistor differ from the photodiode. (4)
b) Derive transconductance of an enhancement mode MOSFET. (4)
c) Draw a circuit diagram to study the current-voltage characteristics of SCR and explain the working mechanism of the SCR. (4)
d) Draw the band structure of the material, which leads Gunn oscillation. Why mobility varies with application of field in such material? (2+2)

3. a) What are nondegenerate semiconductors?
b) 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. (2+6)

***(Turn Over)***

4. a) What is the filling factor in quantum Hall effect? b) Plot the variation of longitudinal and transverse resistance with the applied magnetic field in case of quantum Hall effect. c) Justify the variation of longitudinal resistance using Drude model. (2+2+2)
(d) How heterojunction semiconductor laser become more efficient than homojunction laser. (2)

## Paper code: 403.2 (Applied Optics)

**ANSWER Q1, Q2, AND ANY ONE FROM Q3 AND Q4**

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

1. a) What is numerical aperture? Derive an expression of it.
b) Mention the restrictions for the types of nonlinear crystals showing the second-order and the third-order effects and explain.
c) What are the differences between SFG and DFG?
d) A multimode step index fiber with a core diameter of 80 μm and a refractive index difference of 1.5% is operating at a wavelength of 0.85 μm. If the core refractive index is 1.48, estimate the normalized frequency for the fiber.

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

a) What are the advantages of all optical logic gates? Discuss with the basic ray diagram the operation of simultaneous XOR and AND gates. (1+3)
b) Deduce the expression of pulse dispersion for a planar step-index fiber. For such a fiber of $L$ = 5 km, $n_1$ = 1.47 and $n_2$ = 1.46, calculate pulse dispersion. (3+1)
c) (i) Consider a symmetric step-index waveguide with $n_1$ = 1.5, $n_2$ = 1.46, $d$ = 4 μm operating at $\lambda_0$ = 0.6328 μm. Calculate the number of symmetric and anti-symmetric modes. (ii) When are the waveguides referred to as weakly guiding? (3+1)
d) Deduce expression of the material dispersion in fibers. (4)

***(Turn Over)***



3. a) What do you mean by second harmonic generation? How the phase matching condition is achieved? (2+3)
b) Explain the Kleinman symmetry condition and its relation with $d_{eff}$. (2)
c) What is optical parametric amplification? (1)

4. a) What is holography? Discuss the formation of a hologram of a point object. (2+4)
b) Discuss with basic ray diagram the operation of optical not gate. (2)

(All the symbols have their usual meanings)

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**Internal Assessment-10**