Seat No.: _____ Enrolment No._____

# GUJARAT TECHNOLOGICAL UNIVERSITY

**BE- SEMESTER–I & II(NEW)EXAMINATION – SUMMER 2022**

**Subject Code:3110018 Date:04-08-2022**

**Subject Name:Physics**

**Time:10:30 AM TO 01:00 PM Total Marks:70**

**Instructions:**

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

| | | | Marks |
|---|---|---|---|
| **Q.1** | **(a)** | What is physical significance of the negative effective mass? | **03** |
| | **(b)** | Find the probability of an electron occupying an energy level 0.02 eV above the Fermi level at 200 K and 400 K in a material. | **04** |
| | **(c)** | Derive an expression for electrical and thermal conductivity in a material and hence verify Wiedemann-Franz law. | **07** |
| **Q.2** | **(a)** | Show that for an intrinsic semiconductor the Fermi level lies at the middle of the energy gap. | **03** |
| | **(b)** | The intrinsic carrier density of given semiconductor is $1.5 \times 10^{16}$ $m^{-3}$. If the mobility of the electrons and holes are 0.13 and 0.05 $m^2 V^{-1} s^{-1}$ respectively, calculate the conductivity. | **04** |
| | **(c)** | Obtain an expression for concentration of holes in valance band in intrinsic semiconductor. | **07** |
| | | **OR** | |
| | **(c)** | Derive the formula for concentration of electrons in conduction band in n-type semiconductor. | **07** |
| **Q.3** | **(a)** | Write the difference between spontaneous emission and stimulated emission. | **03** |
| | **(b)** | Explain Ohmic junction with necessary diagram. | **04** |
| | **(c)** | What do you mean by joint density of state? Derive mathematical expression for optical joint density of states. | **07** |
| | | **OR** | |
| **Q.3** | **(a)** | Write short note on exciton. | **03** |
| | **(b)** | If the light having wavelength of 4000 A° falls on semiconductor having bandgap of 2.1 eV. Assuming mass of electron in conduction band and valance band is same as rest mass of electron, calculate the optical joint density of states for given semiconductor. | **04** |
| | **(c)** | For bulk semiconductor show that the ratio of Einstein's co-efficient is directly proportional to cube of frequency. | **07** |
| **Q.4** | **(a)** | Write the drawbacks of two probe method. | **03** |
| | **(b)** | An n-type Ge sample has donor density of $10^{21}$ $m^{-3}$. It is arranged in a Hall effect experiment having $B_z$ = 0.5 $Wb/m^2$ and $J_x$ = 500 $A/m^2$. Find Hall voltage if the width of sample is 3 mm. | **04** |
| | **(c)** | What is Hall effect? Obtain expressions for Hall Voltage and Hall mobility. | **07** |

**OR**

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|---|---|---|---|
| **Q.4** | **(a)** | Explain Hot point probe measurement. | **03** |
| | **(b)** | A 20.0 mm wide and 1.0 mm thick silver strip is placed in 1.5 $Wb/m^2$ magnetic field in such a way that magnetic field remains perpendicular to strip. A current of 200 A is set-up in the strip. Calculate the Hall voltage of the strip. (given: $n = 8.4 \times 10^{28}\ m^{-3}$) | **04** |
| | **(c)** | Explain Current-Voltage characteristic of Solar cell. | **07** |
| **Q.5** | **(a)** | Define: (1) Critical Temperature (2) Critical Magnetic field (3) Critical Current density. | **03** |
| | **(b)** | For specimen of $V_3Ga$, the critical fields are $1.4 \times 10^5$ A/m and $4.2 \times 10^5$ A/m at 14 K and 13 K respectively. Calculate the value of transition temperature. | **04** |
| | **(c)** | Write and explain characteristics of superconductors. | **07** |

**OR**

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|---|---|---|---|
| **Q.5** | **(a)** | The critical temperature for Hg with isotopic mass 199.5 is 4.185 K. Calculate its critical temperature when its isotopic mass changes to 203.4. | **03** |
| | **(b)** | Write the difference between Type-I and Type-II superconductor. | **04** |
| | **(c)** | Explain BCS theory. | **07** |

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