# GUJARAT TECHNOLOGICAL UNIVERSITY

**BACHELOR OF ENGINEERING SYLLABUS**

**1st Year, Subject Code : 3110018**

| | |
|---|---|
| **WEF Academic Year** | **: 2022-23** |
| **Semester/Year** | **: 1** |
| **Category of the Course** | **: Basic Science (Physics)** |
| **Subject Name & Code** | **: Physics (3110018)** |

For group - 2 branches.

**Type of course :** Basic Science (Physics)

**Prerequisite :** Basic understanding of Math's, Physics and chemistry.

**Rationale :** The basic science physics program is to prepare students for careers in engineering where physics principles can be applied to the advancement of technology. This education at the intersection of engineering and physics will enable students to seek employment in engineering upon graduation while, at the same time, provide a firm foundation for the pursuit of graduate studies in engineering.

**Teaching and Examination Scheme :**

| Teaching Scheme | | | Credits | Examination Marks | | | | Total Marks |
|---|---|---|---|---|---|---|---|---|
| | | | | Theory Marks | | Practical Marks | | |
| L | T | P | C | ESE (E) | PA (M) | ESE (V) | PA (I) | |
| 3 | 0 | 2 | 4 | 70 | 30 | 30 | 20 | 150 |

**Content :**

| Sr. No | Topic | Teaching Hrs. | Module Weightage |
|---|---|---|---|
| 1 | **MODULE 1: ELECTRONIC MATERIALS**<br>• Free electron theory<br>• Density of states and energy band diagrams,<br>• Kronig-Penny model (to introduce origin of band gap),Energy bands in solids,<br>• E-k diagram, Direct and indirect bandgaps,<br>• Types of electronic materials: metals, semiconductors, andinsulators,<br>• Density of states, Occupation probability,<br>• Fermi level, Effective mass, Phonons. | 8 | 22% |
| 2 | **MODULE 2: SEMICONDUCTORS (10)**<br>• Intrinsic and extrinsic semiconductors<br>• Dependence of Fermi level on carrier-concentrationand temperature (equilibrium carrier statistics)<br>• Carrier generation and recombination, Carrier transport:diffusion and drift, p-n junction,<br>• Metal-semiconductor junction (Ohmic and Schottky),Semiconductor materials of interest for optoelectronicdevices | 10 | 27% |
| **3** | **MODULE 3: LIGHT-SEMICONDUCTOR INTERACTION**<br>• Optical transitions in bulk semiconductors: absorption, spontaneous emission, and stimulated emission;<br>• Joint density of states<br>• Density of states for photons,<br>• Transition rates (Fermi's golden rule)<br>• Optical loss and gain; Photovoltaic effect, Exciton<br>• Drude model. | **6** | **17%** |
| **4** | **Module 4: Measurements**<br>• Four-point probe and Van Der Pauw measurements for carrier density,<br>• Resistivity and hall mobility<br>• Hot-point probe measurement, capacitance-voltage measurements,<br>• Parameter extraction from diode I-V characteristics, DLTS,<br>• band gap by UV-Vis spectroscopy, absorption/transmission. | **6** | **17%** |

| | | | |
|---|---|---|---|
| **5** | **Module 5: Superconductivity**<br>• Introduction of Superconductivity<br>• Properties of superconductor<br>• Effect of magnetic field<br>• Meissner effect<br>• Pressure effect<br>• Impurity effect<br>• Isotopic mass effect<br>• Mechanism of Superconductivity : BCS Theory<br>• Penetration depth : Magnetic field<br>• Josephson's junction and its application Application of superconductors | **6** | **17%** |

**Suggested Specification table with Marks (Theory) :**

| **Distribution of Theory Marks** | | | | | |
|---|---|---|---|---|---|
| R Level | U Level | A Level | N Level | E Level | C Level |
| **30** | **40** | **30** | **0** | **0** | **0** |

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Createand above Levels (Revised Bloom's Taxonomy).**

**References :**

1. 1. J. Singh, Semiconductor Optoelectronics: Physics and Technology, McGraw-Hill Inc. (1995).
2. 2. B. E. A. Saleh and M. C. Teich, Fundamentals of Photonics, John Wiley & Sons, Inc.,(2007).
3. 3. S. M. Sze, Semiconductor Devices: Physics and Technology, Wiley (2008).
4. 4. A. Yariv and P. Yeh, Photonics: Optical Electronics in Modern Communications, Oxford
5. University Press, New York (2007).
6. 5. P. Bhattacharya, Semiconductor Optoelectronic Devices, Prentice Hall of India (1997).
7. Engineering Physics by Dattu R Joshi, McGraw hill Publications.Extra Study Material
    1. Online course: "Semiconductor Optoelectronics" by M R Shenoy on NPTEL
    2. Online course: "Optoelectronic Materials and Devices" by Monica Katiyar and Deepak Guptaon NPTEL

**Course Outcome :**

| Sr. No. | CO statement | % weightage |
|---|---|---|
| CO-1 | The student will gain knowledge of basic theoretical and mathematical concept of electronic materials. | 22% |
| CO-2 | The student will demonstrate understanding of basic principles, properties and applications associated with semiconducting materials. | 27% |
| CO-3 | The student will demonstrate understanding of basic theory and properties associated with optoelectronic materials. | 17% |
| CO-4 | The student will gain knowledge of the different measurements techniques to characterize various semiconducting, electrical and opto electrical materials and devices. | 17% |
| CO-5 | The student will demonstrate understanding of basic theory, properties and applications of Superconductivity. | 17% |

**List of Experiments :**

1. To measure the dielectric constant of a material
2. To study the Hall-Effect.
3. To study the I-V Characteristic of Silicon diode.
4. To study the I-V Characteristic of Zenerdiode.
5. To study the I-V Characteristic of LED.
6. To determine the efficiency of given solar cell.
7. To measure the Resistivity & Band gap of Germanium Crystal (N-type)by Four Probe Method.
8. To measure the numerical aperture of optical fiber.
9. To Study of propagation & bending loss in optical fiber.
10. P-N Junction diode as Bridge Rectifier.
11. Energy gap of Semiconductor
12. Study of cathode ray oscilloscope
13. Time constant of an R-C circuit.
14. L-C-R Circuit.15.Logic Gates
15. Logic gates
16. Virtual Laser Optics Lab
17. Virtual Solid-State Physics Lab
18. Virtual Harmonic Motion & Waves Lab
19. Virtual Optics Lab
20. Virtual Modern Physics Lab
21. Virtual Physical Sciences Lab