Expected learning outcomes: *At the end of this course the students are expected to understand the concepts of microstate, macrostate, ensemble, phase space, thermodynamic probability and partition function, understand the combinatory studies of particles with their nature and conditions which lead to the three different distribution laws, develop the ability to derive radiation laws of black body radiation. Students are also expected to learn Gibb's paradox & its resolution, understand the macroscopic properties of degenerate photon gas and degenerate fermi gas. Finally, the students are expected to know the basic ideas of plasma state of matter with ideas of composition, behaviour, magnetic confinement etc.*

Reference Books:

i. Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.
ii. Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
iii. Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill.
iv. Statistical and Thermal Physics, S. Lokanathan and R.S. Gambhir. 1991, Prentice Hall.
v. Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
vi. An Introduction to Statistical Mechanics & Thermodynamics, R.H. Swendsen, 2012, Oxford Univ. Press.
vii. Introduction to Plasma Physics & Controlled fusion, Francis F. Chen, Springer.
viii. Elements of Plasma Physics, S. N. Goswami, NCBA, Publisher.
ix. Text book of Plasma Physics, Suresh Chandra, CBS Publishers & Distributors Pvt, Ltd.

PHYDSC353T

SOLID STATE PHYSICS

Contact Hours: 60

Full Marks = 100 [ESE (70) CCA(30)]

Course objective: *This course aims to introduce the basic phenomena in solid state physics. On successful completion of this course the students would be able to elucidate the main features of crystal lattices and phonons, understand the elementary lattice dynamics and its influence on the properties of materials, describe the main features of the physics of electrons in solids; explain the dielectric ferroelectric and magnetic properties of solids and understand the basic concept in superconductivity.*

Unit 1:

Crystal Structure: Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Unit Cell, Lattice with a Basis, Types of Lattices, Bravais lattice, symmetry, point groups and space groups. Miller Indices. Reciprocal Lattice. Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law. Theory of Laue Spots. **(11 Lectures)**

Unit 2:

Elementary Lattice Dynamics: Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the Phonon Spectrum in Solids. Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids. T^3 law.

Bonding in Solids: Types of bonding in solids, covalent, Ionic bindings, metallic bonding, Vander waal's bonding, hydrogen bond. **(13 Lectures)**

Unit 3:

Magnetic Properties of Matter: Magnetic moment due to spin and orbital motion of the electron in atom, Effect of magnetic field on the angular momentum of electron; Dia, Para, Ferro and Ferrimagnetic Materials. Classical Langevin Theory of dia and Paramagnetic Domains Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss. **(11 Lectures)**

Unit 4:

Dielectric Properties of Materials: Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Classical Theory of Electric Polarizability. Normal and Anomalous Dispersion, Lorenz theory of dispersion for both Normal and Anomalous Dispersion. Cauchy and Sellmeier relations. Raman effect and its theory.

Ferroelectric Properties of Materials: Classification of crystals, Piezoelectric effect, Pyroelectric effect, Ferroelectric effect. **(13 Lectures)**

Unit 5:

Elementary Band Theory: Qualitative description of free electron theory, Band Gap, Conductor, Semiconductor (P and N type) and insulator. Conductivity and mobility of Semiconductor. Hall Effect and Hall coefficient. Effective mass of election.

Superconductivity: Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, London's Equation and Penetration Depth. Isotope effect. Idea of BCS theory (No derivation). **(12 Lectures)**

Expected learning outcomes: *At the end of this course the students are expected to learn the basics of crystal structure and physics of lattice dynamics, the physics of different types of magnetic materials and their properties, understand the physics of insulators, semiconductor and conductors with special emphasis on the elementary band theory, comprehend the basic theory of superconductors, Type I and II superconductors, their properties and concept of BCS theory.*

Reference Books:

i. Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd.

ii. Elements of Solid State Physics, J.P. Srivastava, 4th Edition, 2015, Prentice-Hall of India.

iii. Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill.
iv. Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning.
v. Solid-state Physics, H. Ibach and H. Luth, 2009, Springer.
vi. Solid State Physics, Rita John, 2014, McGraw Hill.
vii. Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India.
viii. Solid State Physics, M.A. Wahab, 2011, Narosa Publications.
ix. Solid state Physics, S.O. Pillai, New age publisher.

PHYDSC354P

LAB: SOLID STATE PHYSICS AND DIGITAL ELECTRONICS

Contact Hours: 60

Full Marks = 100

Course objective: *In this course, the students will learn to use various instruments, estimate various physical parameters for every experiment performed and report the result of experiments related to solid state physics and digital electronics.*

Two Experiments are to be performed – one from each part

Part-A: Solid State Physics

1. To measurement the susceptibility of paramagnetic solution by (Quinck`s Tube Method)/suitable method.
2. To measure the Magnetic susceptibility of Solids.
3. To measure the Dielectric Constant of a dielectric Material by suitable method.
4. To study the P-E Hysteresis loop of a Ferroelectric Crystal.
5. To draw the B-H curve of Fe using Solenoid/transformer & determine energy loss from Hysteresis.
6. To measure the resistivity of a semiconductor (Ge) with temperature by four-probe method (room temperature to 150 ^{o}C) and to determine its band gap.
7. To determine the Hall coefficient of a semiconductor sample.
8. To determine magnetic field as a function of the resonance frequency for studying electron spin resonance
9. To Study the Zeeman effect: with external magnetic field; Hyperfine splitting.
10. To determine Planck’s constant using LEDs of at least 4 different colours.
11. To determine Boltzmann’s constant using V-I characteristics of PN junction diode.