glass interface.

11. To verify the Stefan`s law of radiation and to determine Stefan's constant.
12. To determine the Boltzmann constant using V-I characteristics of PN junction diode.

Recommended readings:

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
- Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer

Mode of Assessment/ Assessment Tools (%)

Internal:	**20**	
Assignment /Presentation/ attendance/ Class room interaction/quiz etc.:		10
Written Test for theory and/or Viva Voce for Laboratory:		10
Final (End Semester):	**80**	
Written Test for theory and/or Laboratory experiments:		80

(Equal weightage to be assigned to each credit)

Expected learner Outcomes: This course will enable a student to

1. Solve problems relevant to interfaces between media with defined boundary conditions.
2. Use Maxwell's equations to describe the behaviour of electromagnetic waves in vacuum as well as medium.
3. Describe states and methods of polarization and analyze the polarization state of a light source.

Course Code: PHYSICS-C-XIV
Course Title: STATISTICAL MECHANICS
Nature of the Course: Core
Total credits assigned: 06
Distribution of credits: Theory – 04, Practicals-02

Course objectives:
The Statistical Mechanics is one of the most important branches of Physics which is required to understand the properties of matter in bulk on the basis of the dynamical behaviors of its microscopic constituents. As such the objectives of this course are to

1. Introduce the basic concepts of Statistical Mechanics so that students will be able to cope-up with higher level of such course in future.
2. Develop the critically thinking ability of students to understand the diverse physical phenomena.
3. Develop the interest and ability among students to solved challenging physical problems by the application of techniques of Statistical Mechanics in future.

PHYSICS-C XIV: STATISTICAL MECHANICS (THEORY)
60 Lectures, 60 Marks

Classical Statistics:
Macrostate & Microstate, Elementary Concept of Ensemble, Phase Space, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partition Function, Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression, Gibbs Paradox, Sackur Tetrode equation, Law of Equipartition of Energy (with proof) – Applications to Specific Heat and its Limitations, Thermodynamic Functions of a Two-Energy Levels System, Negative Temperature. **(18 Lectures, 18 Marks)**

Classical Theory of Radiation:
Properties of Thermal Radiation. Blackbody Radiation. Pure temperature dependence. Kirchhoff's law. Stefan-Boltzmann law: Thermodynamic proof. Radiation Pressure. Wien's Displacement law. Wien's Distribution Law. Saha's Ionization Formula. Rayleigh-Jean's Law. Ultraviolet Catastrophe. **(9 Lectures, 9 Marks)**

Quantum Theory of Radiation:
Spectral Distribution of Black Body Radiation. Planck's Quantum Postulates. Planck's Law of Blackbody Radiation: Experimental Verification. Deduction of (1) Wien's Distribution Law, (2) Rayleigh-Jeans Law, (3) Stefan-Boltzmann Law, (4) Wien's Displacement law from Planck's law. **(5 Lectures, 5 Marks)**

Bose-Einstein Statistics:
B-E distribution law, Thermodynamic functions of a strongly Degenerate Bose Gas, Bose Einstein condensation, properties of liquid He (qualitative description), Radiation as a photon gas and Thermodynamic functions of photon gas. Bose derivation of Planck's law. **(13 Lectures, 13 Marks)**

Fermi-Dirac Statistics:
Fermi-Dirac Distribution Law, Thermodynamic functions of a Completely and strongly Degenerate Fermi Gas, Fermi Energy, Electron gas in a Metal, Specific Heat of Metals, Relativistic Fermi gas, White Dwarf Stars, Chandrasekhar Mass Limit.

(15 Lectures, 15 Marks)

Recommended readings:

- Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
- Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill
- Statistical and Thermal Physics, S. Lokanathan and R.S. Gambhir. 1991, Prentice Hall
- Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
- Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer
- An Introduction to Statistical Mechanics & Thermodynamics, R.H. Swendsen, 2012, Oxford Univ. Press

PHYSICS -C XIV: STATISTICAL MECHANICS (LAB)
60 Lectures, 20 Marks

Use C/C++/Scilab/other numerical simulations for solving the problems based on Statistical Mechanics like

1. Computational analysis of the behavior of a collection of particles in a box that satisfy Newtonian mechanics and interact via the Lenard-Jones potential, varying the total number of particles N and the initial conditions:

    a) Study of local number density in the equilibrium state (i) average; (ii) fluctuations
    b) Study of transient behavior of the system (approach to equilibrium)
    c) Relationship of large N and the arrow of time
    d) Computation of the velocity distribution of particles for the system and comparison with the Maxwell velocity distribution
    e) Computation and study of mean molecular speed and its dependence on particle mass
    f) Computation of fraction of molecules in an ideal gas having speed near the most probable speed

2. Computation of the partition function $Z(\beta)$ for examples of systems with a finite number of single particle levels (e.g., 2 level, 3 level, etc.) and a finite number of non-interacting particles N under Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein statistics:
    a) Study of how $Z(\beta)$, average energy $< E >$, energy fluctuation ΔE, specific heat at constant volume C_v, depend upon the temperature, total number of particles N and the spectrum of single particle states.
    b) Ratios of occupation numbers of various states for the systems considered above
    c) Computation of physical quantities at large and small temperature T and comparison of various statistics at large and small temperature T.

3. Plot Planck's law for Black Body radiation and compare it with Raleigh-Jeans Law at high

temperature and low temperature.

4. Plot Specific Heat of Solids (a) Dulong-Petit law, (b) Einstein distribution function, (c) Debye distribution function for high temperature and low temperature and compare them for these two cases.

5. Plot the following functions with energy at different temperatures

    a) Maxwell-Boltzmann distribution
    b) Fermi-Dirac distribution
    c) Bose-Einstein distribution

Recommended readings:

- Elementary Numerical Analysis, K.E.Atkinson, 3rd Edn. 2007, Wiley India Edition
- Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
- Introduction to Modern Statistical Mechanics, D. Chandler, Oxford University Press, 1987
- Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
- Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer
- Statistical and Thermal Physics with computer applications, Harvey Gould and Jan Tobochnik, Princeton University Press, 2010.
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández. 2014 Springer ISBN: 978-3319067896
- Scilab by example: M. Affouf, 2012. ISBN: 978-1479203444
- Scilab Image Processing: L.M.Surhone. 2010, Betascript Pub., ISBN: 978-6133459274

Mode of Assessment/ Assessment Tools (%)

Internal:	**20**	
Assignment /Presentation/ attendance/ Class room interaction/quiz etc.:		10
Written Test for theory and/or Viva Voce for Laboratory:		10
Final (End Semester):	**80**	
Written Test for theory and/or Laboratory experiments:		80

(Equal weightage to be assigned to each credit)

Expected Learner Outcome: This course will

1. Equip the students with basic knowledge of the Statistical Mechanics and hence will be able to look critically for analyzing any physical phenomena.
2. Create interest to the subject to pursue further higher study in future.
3. Enable the students to solve any challenging physical problem in statistical mechanics

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DISCIPLINE SPECIFIC ELECTIVES (DSE)

Semester V

Course code: **PHYSICS DSE -I**
Course title: CLASSICAL DYNAMICS
Nature of the course: DSE
Total credit assigned: 06
Distribution of credits: Theory – 05, Tutorials-01

Course objective: After completing the course, a student will be able to

1. Understand the underlying facts in the development of classical mechanics and the advantages of its formulation over Newtonian mechanics.
2. Describe mechanics of a system in terms of equation of motion.
3. Understand Lagrangian formulation and Hamiltonian formulation of mechanics and their applications in mechanical problems.
4. Study the theoretical analysis of systems oscillating with small amplitudes.
5. Observe the peculiar phenomena when transformed from Newtonian relativity to special relativity and to understand the concept of space-time.

PHYSICS-DSE I: CLASSICAL DYNAMICS (THEORY)
75 Lectures, 80 Marks

Classical Mechanics of Point Particles:
Review of Newtonian Mechanics; Application to the motion of a charge particle in external electric and magnetic fields- motion in uniform electric field, magnetic field- gyroradius and gyrofrequency, motion in crossed electric and magnetic fields. Generalized coordinates and velocities, Hamilton's principle, Lagrangian and the Euler-Lagrange equations, one-dimensional examples of the Euler-Lagrange equations- one-dimensional Simple Harmonic Oscillations and falling body in uniform gravity; applications to simple systems such as coupled oscillators Canonical momenta & Hamiltonian. Hamilton's equations of motion.