Course: Core Paper XIV – HPHCR6142T & HPHCR6142P

Semester	VI
Paper Number	HPHCR6142T & HPHCR6142P
Paper Title	STATISTICAL MECHANICS
No. of Credits	06 (Theory – 4, Lab – 2)
Theory/ Composite	Composite
No. of periods assigned	Th:4 periods/week Pr:3 periods/week
Name of Faculty member(s)	
Course description/ objective	1) Establish the position of statistical mechanics between Quantum Mechanics and Thermodynamics. 2) Ergodic hypothesis and the concept of equal apriori probability as fundamental hypothesis 3) Idea of macro and microstates. 4) The idea of ensembles and their suitable choice to describe systems 5) Establishing The link between thermodynamic parameters from statistical physics 6) Maxwell -Boltzmann Statistics, Bose-Einstien statistics and Fermi-Dirac statistics, their applicability criteria, applications as examples
Syllabus	As enclosed
Texts	As enclosed
Reading/ Reference Lists	As enclosed
Evaluation	Total – 100 (Theory – 60, Practical – 40) Theory – CIA – 10 Semester Examination – 50 Group A (25 marks) Group B (25 marks) One 10 marks qs out of two qs One 10 mark qs out of two qs Three 5 mark qs out of five qs Three 5 mark qs out of five qs

Syllabus:

HPHCR6142T - STATISTICAL MECHANICS (Credits – Theory – 4, Practicals – 2)

Module A [26 lectures]

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, SackurTetrode 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]**

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.**[8 Lectures]**

Module B [26 lectures]

Quantum Theory of Radiation: Spectral Distribution of Black Body Radiation. Planck's Quantum Postulates. Planck's Law of Blackbody Radiation. 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]**

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.**[9 Lectures]**

Fermi-Dirac Statistics: Fermi-Dirac Distribution Law, Thermodynamic functions of a Completely and strongly Degenerate Fermi Gas, Fermi Energy, Electron gas in a Metal, Sommerfeld model of conductivity, Widemann-Franz Law, Specific Heat of Metals
[12 Lectures]

References :

1. Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
2. Statistical and Thermal Physics, S. Loknathan and R.S. Gambhir. 1991, Prentice Hall
3. Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
4. Fundamentals of Statistical and Thermal Physics, F. Reif , McGraw-Hill Company
5. Fundamentals of Statistical Mechanics, B.B. Laud, New Age International Publishers

HPHCR6142P - Statistical Mechanics Lab (Credits – 2) (39 periods)

1.Study of random numbers generating modules & applications.

2.Plot Planck's law for Black Body radiation and compare it with Rayleigh-Jeans Law at high temperature and low temperature.

3. 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.

4. Plot the following functions with energy at different temperatures

a) Maxwell-Boltzmann distribution

b) Fermi-Dirac distribution

c) Bose-Einstein distribution

5) Kinetic theory of gases and approach to equilibrium

6) Study of Brownian motion

Paper Structure for computation

(a) (i) One computation examination – 20 marks
(ii) L.N.B. – 10 marks

(b) Grand Viva – **8 marks**
(c) Attendance – **2 marks**