**Govt. PG College, Ambala Cantt**

**Session: 2023-24**

**Name of Assistant Professor: Mrs. Neelam**

**Department: Physics**

**Class: B.Sc. II/ 4TH Semester/ Section: Computer Science**

**Subject Code & Name: PH-401/ STATISTICAL PHYSICS**

**SYLLABUS**

**Max Marks: 50 External: 40**

**Minimum Pass Marks: 14 Internal: 10**

**Time: 3 hours**

**Note:**

1. The syllabus is divided into 4 units. 9 questions will be set.

2. Question no 1 will be compulsory, it contains 6 parts (form all the four units) and answer should be brief but not in yes / no.

3. Four more questions are to be attempted, selecting one question from each unit. Questions 2-9 may contain two or more parts. All questions carry equal marks.

4. 20% numerical problems are to be set.

5. Use of scientific (non-programmable) calculator is allowed.

**Unit –I: Statistical Physics I**

Microscopic and Macroscopic systems, events-mutually exclusive, dependent and independent. Probability, statistical probability, A- priori Probability and relation between them, probability theorems, some probability considerations, combinations possessing maximum probability, combination possessing minimum probability, Tossing of 2,3 and any number of Coins, Permutations and combinations, distributions of N (for N= 2,3,4) distinguishable and indistinguishable particles in two boxes of equal size, Micro and Macro states, Thermodynamical probability, Constraints and Accessible states, Statistical fluctuations, general distribution of distinguishable particles in compartments of different sizes, Condition of equilibrium between two systems in thermal contact-- β parameter, Entropy and Probability (Boltzmann’s relation).

**Unit –II: Statistical Physics II**

Postulates of statistical physics, Phase space, Division of Phase space into cells, three kinds of statistics, basic approach in three statistics. M. B. statistics applied to an ideal gas in equilibrium- energy distribution law (including evaluation of ơ and β), speed distribution law & velocity distribution law. Expression for average speed, r.m.s. speed, average velocity, r. m. s. velocity, most probable energy & mean energy for Maxwellian distribution.

**Unit-III: Quantum Statistics**

Need for Quantum Statistics: Bose-Einstein energy distribution law, Application of B.E. statistics to Planck's radiation law B.E. gas, Degeneracy and B.E. Condensation, Fermi Dirac energy distribution law, F.D. gas and Degeneracy, Fermi energy and Fermi temperature, Fermi Dirac energy distribution law, Fermi Dirac gas and degeneracy, Fermi energy and Fermi temperature, Fermi Dirac energy distribution law for electron gas in metals, Zero point energy, Zero point pressure and average speed (at 0 K) of electron gas, Specific heat anomaly of metals and its solution. M.B. distribution as a limiting case of B.E. and F.D. distributions, Comparison of three statistics.

**Unit-IV: Theory of Specific Heat of Solids**

Dulong and Petit law. Derivation of Dulong and Petit law from classical physics. Specific heat at low temperature, Einstein theory of specific heat, Criticism of Einstein theory, Debye model of specific heat of solids, success and shortcomings of Debye theory, comparison of Einstein and Debye theories.

**REFERENCE BOOKS:**

1. Prakash S and Agarwal J P, Statistical Mechanics, Kedar Nath Ram Nath & co, Meerur

2. ReifF. statistical Physics, Berleley Physics Course Volume 5, Mc Graw Hill Book Co Ltd, New Delhi

3. Mc Quarrie D A. Statistical Mechanics, Viva Books Pvt Ltd, New Delhi.

4. Ashley Cmter (August 1999), Classical and Statistical Thermodynamics.

5.Richard Fitzpatrick, Thermodynamics and Statistical Mechanics: An intermediate level course Lulu.com,2007

**COURSE OBJECTIVES:**

* Core understanding about probability and its related terms and to calculate probabilities under various situations.
* Students will know about the concept of Microstates and Macrostates and will corelate them with Statistical Fluctuations.
* Students will be able to distinguish between three kinds of Statistical Laws and apply them under different situations.
* Students will gain core knowledge about Maxwell Boltzmann Distribution Law and will be able to apply it for their future use.
* This course will provide them deep knowledge about Quantum Statistical Laws and their applications in Bose Einstein Gas, B E Condensation, Bose Einstein Gas degeneracy, Fermi Dirac gas, its degeneracy and electron gas in metals.
* This course will provide them detailed knowledge about Laws to calculate Specific heat of Solids i.e. Dulong and Petit law, Einstein theory of specific heat & Debye model of specific heat of solids and to apply this knowledge for their future use.

**COURSE OUTCOMES:**

After the successful completion of the course, students will be able to:

* Define probability and related terms with probability.
* Calculate numerical based on Probability problems and apply the concept to their daily life too.
* Understand the concept of Macrostates and Microstates and calculate numerical problems based on these concepts.
* Define Statistical fluctuations and have a fair idea about its use.
* Explain the basic concepts of Statistical laws and able to derive each law.
* Apply the Statistical laws to calculate numerical problems.
* Differentiate between B E Statistics and F D Statistics and explain on its basis the concepts of B E gas and F D gas and calculate the degeneracies for both types of these gases.
* Understand the concept of Specific heat of metals and very well apply it to derive the various models to calculate Specific Heat of metals and apply these results also to calculate the numerical problems.
* Apply the concepts learnt in this course for their future goals also.

**LESSON PLAN**

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| **Sr. No.** | **Schedule of Weeks** | **Topics to be covered** |
|  | **08.01.24 to 13.1.24** | Microscopic and Macroscopic systems, events-mutually exclusive, dependent and independent. Probability, statistical probability, A- priori Probability and relation between them, probability theorems, some probability considerations, combinations possessing maximum probability, combination possessing minimum probability. |
|  | **15.1.24 to 20.1.24** | Tossing of 2,3 and any number of Coins, Permutations and combinations, distributions of N (for N= 2,3,4) distinguishable and indistinguishable particles in two boxes of equal size, Micro and Macro states, Thermodynamical probability. |
|  | **22.1.24 to 27.1.24** | Constraints and Accessible states, Statistical fluctuations, general distribution of distinguishable particles in compartments of different sizes, Condition of equilibrium between two systems in thermal contact-- β parameter, Entropy and Probability (Boltzmann’s relation). |
|  | **29.1.24 to 3.2.24** | **Numerical problems of Unit 1 will be discussed followed by test and assignment.** Postulates of statistical physics, Phase space, Division of Phase space into cells. |
|  | **5.2.24 to 10.2.24** | Three kinds of statistics, basic approach in three statistics. M. B. statistics applied to an ideal gas in equilibrium- energy distribution law (including evaluation of ơ and β), Maxwell Boltzmann speed distribution law. |
|  | **12.2.24 to 17.2.24** | Maxwell Boltzmann velocity distribution law. Expression for average speed, r.m.s. speed, average velocity, r. m. s. velocity, most probable energy & mean energy for Maxwellian distribution. |
|  | **19.2.24 to 24.2.24** | **Numerical problems of Unit 2 will be discussed followed by assignment.**  Need for Quantum Statistics: Bose-Einstein energy distribution law, Application of B.E. statistics to Planck's radiation law. |
|  | **26.2.24 to 2.3.24** | B.E. gas, Degeneracy and B.E. Condensation, Fermi Dirac energy distribution law. |
|  | **4.3.24 to 9.3.24** | F.D. gas and Degeneracy, Fermi energy and Fermi temperature Fermi Dirac energy distribution law for electron gas in metals. |
|  | **11.3.24 to 13.3.24** | Zero-point energy, Zero-point pressure and average speed (at 0 K) of electron gas, Specific heat anomaly of metals and its solution. |
|  | **18.3.24 to 22.3.24** | M.B. distribution as a limiting case of B.E. and F.D. distributions, Comparison of three statistics.  **Numerical problems of Unit 3 will be discussed followed by test.** |
|  | **23.3.24 to 31.3.24** | **HOLI BREAK** |
|  | **1.4.24 to 6.4.24** | Dulong and Petit law. Derivation of Dulong and Petit law from classical physics followed by its numerical problems. |
|  | **8.4.24 to 13.4.24** | Specific heat at low temperature, Einstein theory of specific heat, Criticism of Einstein theory, followed by its numerical problems. |
|  | **15.4.24 to 20.4.24** | Debye model of specific heat of solids, success and shortcomings of Debye theory, comparison of Einstein and Debye theories. |
|  | **22.4.24 to 27.4.24** | **REVISION AND DOUBTS SOLUTION** |
|  | **29.4.24 to 4.5.24** | **REVISION AND DOUBTS SOLUTION** |

**(NEELAM)**

**ASSISTANT PROFESSOR**

**PHYSICS DEPARTMENT**

**GOVT P G COLLEGE, AMBALA CANTT**