هيئة تقويم التعليم والتدريب
Education & Training Evaluation Commission
اعتماد
NCAAA
2024
TP-153

Course Specification
(Bachelor)

Course Title:	Statistical physics
Course Code:	PHY 1332
Program:	Bachelor of Science in Physics
Department:	Physics
College:	Science
Institution:	Imam Mohammad Ibn Saud Islamic University
Version:	4
Last Revision Date:	*26/09/2024*

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A. General information about the course:

1. Course Identification

1. Credit hours: (3)

2. Course type

A.	☐University	☐ College	☒ Department	☐Track	☐Others
B.	☒ Required		☐Elective		

3. Level/year at which this course is offered: (Level 6/ Year 3)

4. Course General Description:

This course presents the mathematics and quantum mechanics needed to understand statistical thermodynamics. It covers several important topics, including a mathematically sound presentation of statistical thermodynamics; the kinetic theory of gases including transport processes; and thorough, modern treatment of the thermodynamics of magnetism.

5. Pre-requirements for this course (if any)**:**

Thermal Physics, PHY 1230 and Quantum Mechanics (1), PHY 1312

6. Co-requisites for this course (if any)**:**

7. Course Main Objective(s):

At the end of the course, students will be able to:

- **Define and discuss the concepts of macro state and microstate of a model system.**
- **Discuss the Boltzmann distribution and the role of the partition function.**
- **Define the Fermi-Dirac and Bose-Einstein distributions; state where they are applicable; understand how they differ and show when they reduce to the Boltzmann distribution.**
- **Apply the Fermi-Dirac distribution to the calculation of thermal properties of electrons in metals.**
- **Apply the Bose-Einstein distribution to the calculation of properties of black body radiation.**

2. Teaching mode (mark all that apply)

No	Mode of Instruction	Contact Hours	Percentage
1	Traditional classroom	60	100%
2	E-learning		
3	Hybrid • Traditional classroom • E-learning		
4	Distance learning		

3. Contact Hours (based on the academic semester)

No	Activity	33
1.	**Lectures**	**30**
2.	**Laboratory/Studio**	**0**
3.	**Field**	**0**
4.	**Tutorial**	**30**
5.	**Others (specify)**	**0**
Total		60

B. Course Learning Outcomes (CLOs), Teaching Strategies and Assessment Methods

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
1.0	Knowledge and understanding			
1.1	**Outline the background and main features of the historical development of quantum mechanics.**	**K1, K2**	• Lectures. • Tutorials. Class discussions.	▪ Exams. ▪ Participation. Discussions.
1.2	**State the historical importance of De Broglie's hypothesis, Schrödinger's wave function, and Born's probabilistic interpretation of the wave function.**	**K1, K2**	• Lectures. • Tutorials. Class discussions.	▪ Exams. ▪ Homework. Quizzes.
1.3	**Describe and solve the Schrödinger equation in the standard one-**	**K1, K2**	• Lectures. • Class discussions. Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions.

Code	Course Learning Outcomes	Code of PLOs aligned with the program	Teaching Strategies	Assessment Methods
	dimensional examples- infinite and finite square wells, infinite well potentials, free particle, harmonic oscillator, and hydrogen atom.			Homework.
1.4	**Define and describe the Hilbert space, Dirac notation, and Basic postulates of Quantum Mechanics.**	**K1, K2**	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
1.5	**Outline the Laws of thermodynamics and understand their statistical foundations.**	**K1, K2**	• Lectures. • Class discussions. • Tutorials.	▪ Participation. ▪ Exams. ▪ Discussions. ▪ Homework.
2.0	**Values, autonomy, and responsibility**			
2.1	**Explain and summarize the basic knowledge gained from studying electromagnetic fields course.**	**S1, S2**	▪ Lectures. ▪ Class discussions. ▪ Tutorials.	▪ Exams. ▪ Discussions. ▪ Participation.
2.2	**Develop the students ability to solve and analyze problems in physics related the topics covered by the course.**	**S2, S3**	▪ Problem classes and group tutorial. ▪ Homework assignments as well as problems solutions.	▪ Exams. ▪ Discussions. ▪ Homework.
2.3	**Communicate in a clear and concise manner orally, and using IT for acquiring and analyzing information.**	**S4, S5**	• Lectures. • Class discussions. • Tutorials. • Encourage students to use electronic mail and internal network for submitting homework and assignments. • Use digital library.	▪ Exams. ▪ Participation and activities of students in the course community and blackboard. ▪ Homework.
3.0	**Values, autonomy, and responsibility**			
3.1	**Show the collaboration and inter-professionalism in class discussions or team works, as well as solve problems independently.**	**V1, V2, V3**	• Small team tasks • Open discussion at classroom. • Office hours.	▪ Participation. ▪ Homework. ▪ Mini-project(s).

C. Course Content

No	List of Topics	Contact Hours
1.	**Statistical Thermodynamics:** Coin-tossing experiment. System of distinguishable particles. Thermodynamic probability and entropy. Quantum states and energy levels. Density of quantum states.	8
2.	**Classical Statistics of Maxwell-Boltzmann:** Boltzmann statistics. The Boltzmann distribution. Partition function. Dilute gases and the Maxwell-Boltzmann distribution. The connection between classical and statistical thermodynamics. Thermodynamic properties from the partition function. Partition function for a gas. Properties of a monatomic ideal gas. Applicability of the Maxwell-Boltzmann distribution. Distribution of molecular speeds. Equipartition of energy.	12
3.	**Quantum statistics:** The Fermi-Dirac distribution. The Bose-Einstein distribution. Comparison of the distributions.	10
4.	**Bose-Einstein and Fermi-Dirac Gases:** Blackbody radiation and properties of a photon gas. Bose-Einstein condensation. Properties of a boson gas. Application to liquid helium. The Fermi energy. The calculation of the chemical potential. Free electrons in a metal. Properties of a fermion gas. Application to white dwarf stars.	10
5.	**The heat Capacity of a diatomic gas and of a solid:** The quantized linear oscillator. Vibrational modes of diatomic molecules. Rotational modes of diatomic molecules. Electronic excitation. The total heat capacity. Einstein theory of the heat capacity of a solid. Debye's theory of the heat capacity of a solid.	10
6.	**The Thermodynamic of Magnetism:** Para magnetism. Properties of a spin ½ paramagnet. Adiabatic demagnetization. Negative temperature. Ferromagnetism.	10
Total		**60**

D. Students Assessment Activities

No	Assessment Activities *	Assessment timing (in week no)	Percentage of Total Assessment Score
1.	**Class Activities (class quizzes, homework, solving problems, etc......)**	**weekly**	**10 %**
2.	**Midterm Exam 1**	**6th week**	**25 %**
3.	**Midterm Exam 2**	**12th week**	**25 %**
4.	**Final Exam**	**16th week**	**40 %**

*Assessment Activities (i.e., Written test, oral test, oral presentation, group project, essay, etc.).

E. Learning Resources and Facilities

1. References and Learning Resources

Essential References	- Asheley H. Carter, ***Classical and Statistical Thermodynamics,*** Prentise Hall (2000).
Supportive References	- Lokanathan S. and Gambhir R.S., ***Statistical and Thermal Physics: an introduction,*** P. H. I. (1991). - Patharia R. K., ***Statistical Mechanics,*** Oxford: Butterworth (1996). - Mandel F., ***Statistical Physics,*** 2nd Edition, John Wiley (1988).
Electronic Materials	**https://units.imamu.edu.sa/colleges/en/science/Pages/default.aspx**
Other Learning Materials	

2. Required Facilities and equipment

Items	Resources
facilities (Classrooms, laboratories, exhibition rooms, simulation rooms, etc.)	**- Classrooms.** **- Labs.**
Technology equipment (projector, smart board, software)	- **Classroom equipped with a whiteboard and a projector.**
Other equipment (depending on the nature of the specialty)	

F. Assessment of Course Quality

Assessment Areas/Issues	Assessor	Assessment Methods
Effectiveness of teaching	- **Students** - **Second examiner**	- **Indirect (The students complete the evaluation forms at the end of term. Final exam is evaluated by the second examiner)**
Effectiveness of Students assessment	- **Instructors**	- **Direct (exams, HW, project, …)**
Quality of learning resources	- **Faculty** - **Students**	- **Indirect (surveys)**
The extent to which CLOs have been achieved	- **Instructors** - **Program Leaders**	- **Direct (excel sheet)**
Other		

Assessors (Students, Faculty, Program Leaders, Peer Reviewers, Others (specify)

Assessment Methods (Direct, Indirect)

G. Specification Approval

COUNCIL /COMMITTEE	Quality Unit-Physics Department
REFERENCE NO.	Department council No. 06
DATE	26/09/2024