M.Sc. Course					SC 512T - Thermodynamics and Statistical Mechanics					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	1	0	0	4	25	50	25	--	--	100

COURSE OBJECTIVES

- To explain the general laws of thermodynamics and their applications to pure and special systems.
- To demonstrates postulates of statistical mechanics and introduce students to quantum statistical mechanics, which is part of the foundation of several branches of physics and has many applications.
- To enable students to understand the physics of phase transition and employ the concepts for applications.
- To introduce with transport phenomenon and non-equilibrium systems.

UNIT 1: APPLICATION OF THERMODYNAMICS TO PURE SUBSTANCES AND SPECIAL SYSTEMS **15 Hrs.**

Laws of thermodynamics and their consequences. Thermodynamic potentials, Maxwell's equation, TdS equation, Theory of heat capacity, Gruneisen's equation, Joule Kelvin effect, Surface film, Reversible cell, The piezoelectric effect, Dielectrics, Thermoelectric Phenomenon, and Paramagnetic Solids.

UNIT 2: QUANTUM STATISTICAL MECHANICS **15 Hrs.**

Indistinguishable particles in quantum mechanics. Bosons and Fermions. Bose-Einstein statistics, ideal Bose gas, photons, Bose-Einstein condensation. Fermi-Dirac statistics, Fermi energy, ideal Fermi gas. Density operator, Quantum Liouville equation. Pure and mixed states.

UNIT 3: CRITICAL PHENOMENA AND PHASE TRANSITIONS **15 Hrs.**

Phase transitions, Condition for phase equilibrium, First order phase transition, Clausius - Clayperon equation, Scaling hypothesis, The Critical exponent, Second order phase transition, Co - operative processes, Curie - Weiss theory of Magnetic transition, Ising Model, Ising Model in zeroth approximation, Exact solution of one dimensional Ising Model, Order parameters, Renormalization, Landau theory.

UNIT 4 TRANSPORT PHENOMENON AND NON EQUILIBRIUM STATISTICAL MECHANICS **15 Hrs.**

Scattering cross section, Effusion and Diffusion equation, Random walk and Brownian motion, Boltzmann equation, Linear response theory, Fokker-Planck and Langevin equations.

Max. 60 Hrs.

COURSE OUTCOMES

After completion of this course students will be able to;

CO1: State and express basic terms of Thermodynamics and statistical mechanics
CO2: Apply foundation of thermodynamics to the several branches of physics and recognize its applications
CO3: Appraise postulates of quantum statistical mechanics
CO4: Recognize properties of quantum gases, other condensed matter systems in equilibrium
CO5: Formulate and solve the problems of phase transitions
CO6: Review Transport Phenomenon and Non Equilibrium Statistical Mechanics

TEXT/REFERENCE BOOK

1. Thermodynamics: An Engineering Approach by Michael A. Boles and Yungus A. Cengel
2. Heat and Thermodynamics by Mark W. Zemansky
3. Fundamentals of Statistical Mechanics by B. B. Laud
4. Statistical Mechanics by Kerson Huang
5. Statistical Mechanics and Properties of Matter by E.S. Raja Gopal
6. Statistical Mechanics - An Introduction by Evelyn Guha
7. Statistical Mechanics by R.K. Patharia
8. Funadamentals of Statistical Mechanics by F. Reif
9. Statistical Mechanics by R.K. Srivastava & J.Ashokm
10. Fundamentals of Statistical Mechanics by John D. Walecka
11. Landau and Lifshitz, Landau theory of phase transition Statistical Physics

Course Delivery Methods	

Lecture by use of boards/LCD projectors/OHP projectors	Yes
Tutorials/Assignments	Yes
Seminars	No
Mini projects/Projects	No
Laboratory experiments/teaching aids	No
Industrial/guest lectures	No
Industrial visits/in-plant training	No
Self- learning such as use of NPTEL materials and internets	Yes
Simulation	No

Course Outcome (CO) Attainment Assessment tools & Evaluation procedure

Direct Assessment:

Assessment Tool		% Contribution during CO Assessment	Maximum Marks	Exam Duration
Internal Assessment	Assignment	10 %	-	-
	Quiz	15%	-	-
Examiantion	Mid Semester Examination	25%	50	2 hours
	End Semester Examination	50%	100	3 hours

Assessment Components	CO1	CO2	CO3	CO4	CO5	CO6
Mid Sem Examination Marks	YES	YES	Yes	NO	NO	NO
End Sem Examination Marks	YES	YES	YES	YES	YES	YES
Assignment	YES	YES	YES	YES	YES	YES

Indirect Assessment :

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping of Course Outcomes onto Program Outcomes

Course Outcome	Programme Outcome				
	PO1	PO2	PO3	PO4	PO5
CO1: State and express basic terms of Thermodynamics and statistical mechanics	H	H	M	L	M
CO2: Apply foundation of thermodynamics to the several branches of physics and recognize its applications	L	H	H	M	M
CO3: Appraise postulates of quantum statistical mechanics	M	H	H	L	M
CO4: Recognize properties of quantum gases, other condensed matter systems in equilibrium	M	H	H	L	M
CO5: Formulate and solve the problems of phase transitions	H	M	H	M	L
CO6: Review Transport Phenomenon and Non Equilibrium Statistical Mechanics	H	H	M	M	L

Lecture wise Lesson planning Details:

Week No.	Lect. No.	Unit No.	Topics To be covered	CO Mapped	Remarks by Faculty
1	1	1	Laws of thermodynamics and their consequences	CO1, CO2	
	2		Thermodynamic potentials, Maxwell's equation	CO1, CO2	
	3		TdS equations	CO1, CO2	
	4		Tutorial	CO1, CO2	
2	5		Theory of heat capacity	CO1, CO2	
	6		Gruneisen's equation	CO1, CO2	
	7		Joule Kelvin effect,	CO1, CO2	
	8		Tutorial	CO1, CO2	
3	9		Joule Kelvin effect,	CO1, CO2	
	10		Surface film	CO1, CO2	
	11		Reversible cell	CO1, CO2	
	12		Tutorial	CO1, CO2	
4	13		The piezoelectric effect, Dielectrics	CO1, CO2	

	14		Thermoelectric Phenomenon	CO1, CO2	
	15		Paramagnetic Solids	CO1, CO2	
	16		Tutorial	CO1, CO2	
5	17	2	Indistinguishable particles in quantum mechanics	CO3, CO4	
	18		Bosons and Fermions	CO3, CO4	
	19		Bose-Einstein statistics	CO3, CO4	
	20		Tutorial	CO3, CO4	
6	21		Ideal Bose gas, Photons	CO3, CO4	
	22		Bose-Einstein condensation	CO3, CO4	
	23		Fermi-Dirac statistics	CO3, CO4	
	24		Tutorial	CO3, CO4	
7	25		Fermi energy	CO3, CO4	
	26		ideal Fermi gas	CO3, CO4	
	27		Density operator	CO3, CO4	
	28		Tutorial	CO3, CO4	
8	29		Quantum Liouville equation.	CO3, CO4	
	30		Pure and mixed states	CO3, CO4	
	31	3	Phase transitions, First order phase transition	CO3, CO4	
	32		Tutorial	CO3, CO4	
9	33		Condition for phase equilibrium, Clausius - Clayperon equation	CO1, CO5	
	34		Scaling hypothesis, The Critical exponent,	CO5	
	35		Second order phase transition, Co - operative processes,	CO1, CO5	
	36		Tutorial	CO1, CO5	
10	37		Curie - Weiss theory of Magnetic transition	CO5	
	38		Ising Model	CO3, CO5	
	39		Ising Model in zeroth approximation	CO3, CO5	
	40		Tutorial	CO3, CO5	
11	41		Exact solution of one dimensional Ising Model	CO3, CO5	
	42		Order parameters, Renormalization	CO5	
	43		Landau theory	CO5	
	44		Tutorial	CO5	
12	45		Landau theory	CO5	
	46	4	Scattering cross section	CO6	
	47		Scattering cross section	CO6	
	48		Tutorial	CO6	
13	49		Effusion and Diffusion equation	CO6	
	50		Effusion and Diffusion equation	CO6	
	51		Random walk and Brownian motion	CO6	
	52		Tutorial	CO6	
14	52		Random walk and Brownian motion	CO6	
	54		Boltzmann equation	CO6	
	55		Boltzmann equation	CO6	
	56		Tutorial	CO6	
15	57		Linear response theory	CO6	
	58		Fokker-Planck and Langevin equations	CO6	
	59		Fokker-Planck and Langevin equations	CO6	
	60		Tutorial	CO6	