Teaching Plan

Department : Physics
Class : II M.Sc. Physics
Title of the Course: Statistical Mechanics
Semester : II
Course Code: PP232CC1

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PP232CC1	6	-	-	-	5	6	90	25	75	100

Learning Objectives:

1. To identify the relationship between statistic and thermodynamic quantities.
2. To comprehend the concept of partition function, canonical, grand canonical ensembles, ideal, real gases and fluctuations.

Course Outcomes

On the successful completion of the course, student will be able to**:**		
CO1	examine and elaborate the effect of changes in thermodynamic quantities on the states of matter during phase transition	**K1 & K2**
CO2	interpret the macroscopic properties such as pressure, volume, temperature, specific heat, elastic module etc. using microscopic properties like intermolecular forces, chemical bonding, atomicity etc. describe the peculiar behaviour of the entropy by mixing two gases. relate the connection between statistics and thermodynamic quantities	**K2& K3**
CO3	distinguish canonical and grand canonical ensembles and to interpret the relation between thermodynamical quantities and partition function	**K3 & K4**
CO4	analyze and apply the different statistical concepts to assess the behaviour of ideal Fermi gas and ideal Bose gas and also to compare and distinguish the three types of statistics.	**K4& K5**
CO5	evaluate and generalise the thermodynamical behaviour of gases under fluctuation and also using Ising model	**K5& K6**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6**– Create

CO - 5	understand the concept of heat capacities and phase transitions	**PSO -4**	**U**

Unit	Module	Topics	Teaching hours	Cognitive Level	Pedagogy	Assessment/ Evaluation
I	**Phase Transitions**					
	1	Thermodynamic potentials - Phase Equilibrium - Gibb's phase rule - Phase transitions and Ehrenfest's classifications	4	K2 (U)	PPT using GAMMA AI, Descriptive lecture and Group Discussion	Evaluation through: SLIDO Problem solving Descriptive answers Short questions Formative assessment (I CIA)
	2	Third law of Thermodynamics: Nernst Heat Theorem. Order parameters - Landau's theory of phase transition	4	K3 (Ap)	Illustration, Descriptive lecture, Problem Solving	
	3	Critical indices - Scale transformations and dimensional analysis:	4	K2 (U)	Illustration, Lecture using Chalk and Talk	
	4	Scaling Hypothesis - Universality of Critical Behaviour- Law of Corresponding states	3	K3 (Ap)	Illustration, Descriptive lecture, Problem Solving	

II	**Statistical Mechanics and Thermodynamics**					
	1	Foundations of statistical mechanics - Specification of states of a system: Microscopic and Macroscopic States - Phase space – Liouville's theorem-	4	K2 (U)	PPT using GAMMA AI, Illustration, Descriptive Lecture	Evaluation through: MENTIMETER Short questions Descriptive answers Problem solving Formative assessment (I&II CIA)
	2	Microcanonical ensemble: Isolated systems- Microcanonical distribution - Principle of Equal a Priori Probabilities - Entropy	4	K3 (Ap)	Lecture, Seminar	
	3	Connection between statistics and thermodynamics - Entropy of an ideal gas using the micro canonical ensemble -	5	K3 (Ap)	Descriptive lecture , Problem Solving	
	4	Entropy of mixing and Gibb's paradox.	5	K4 (A)	Descriptive lecture, seminar	

III	**Canonical and Grand Canonical Ensembles**					
	1	Canonical and grand canonical ensembles: Systems at fixed temperature- Systems with fixed chemical potential	5	K2 (U)	Illustration, Descriptive lecture	Evaluation through: quiz, Problem Solving, short questions
	2	Trajectories and density of states: Canonical and Grand Canonical distribution - Equipartition theorem	4	K3 (Ap)	Lecture using Chalk and Talk, Seminar	
	3	Quantum Canonical Partition function - Calculation of statistical quantities – Free energy of an ideal gas-	5	K3 (Ap)	Descriptive lecture , Problem Solving	

	4	Thermodynamic functions- Energy and density fluctuations.	4	K4 (A)	Group Discussion, Lecture, seminar	Descriptive answers Formative assessment (I CIA)
IV	**Classical and Quantum Statistics**					
	1	Statistical density matrix – Equilibrium Statistical ensemble - Statistics of indistinguishable particles – The ideal gases in the microcanonical ensemble	6	K3 (Ap)	PPT using SLIDESPILOT Illustration, Descriptive lecture.	Evaluation through quiz, Descriptive answers
	2	Maxwell-Boltzmann statistics - Fermi-Dirac statistics – Ideal Fermi gas – Degeneracy: Weakly degenerate – strongly degenerate –	6	K4 (A)	Lecture, Group discussion , Demonstration, Problem Solving	Short questions Assignment, Formative assessment (II CIA)
	3	Bose Einstein statistics – Black-body radiation: The Photon Gas- Planck radiation formula - Ideal Bose gas – Bose Einstein condensation.	6	K4 (A)	Lecture, Seminar using STEVE.AI	
V	**Real Gas, Ising Model and Fluctuations**					

	1	Cluster expansion for a classical gas - Virial equation of state – Calculation of the first Virial coefficient in the cluster expansion - Ising model -	5	K3 (Ap)	PPT Illustration, Descriptive lecture	Evaluation through: quiz, short questions
	2	Mean-field theories of the Ising model in three, two and one dimensions - Exact solutions in one dimension.	5	K4 (A)	Descriptive lecture , Problem Solving	Descriptive answers
	3	Correlation of space-time dependent fluctuations - Fluctuations and transport phenomena -	4	K4 (A)	Descriptive lecture, Seminar, Assignment	Problem solving
	4	Brownian motion - Langevin's theory – Fluctuation dissipation theorem - The Fokker-Planck equation	4	K4 (A)	Illustration, Descriptive lecture	Formative assessment (II CIA)

PO- Program outcome; LO – Learning outcome; Cognitive Level U – Understand; Ap- Apply; A- Analyze; C-Create

Course Focussing on Employability/ Entrepreneurship/ Skill Development :**Employability**

Activities (Em/ En/SD): **Project**

Course Focussing on Cross Cutting Issues (Professional Ethics/ Human Values/Environment Sustainability/ Gender Equity): -

Activities related to Cross Cutting Issues : -

Assignment :**Fluctuations and transport phenomena: Online Assignment**

Seminar Topic: **Ideal Fermi gas – Degeneracy: Weakly degenerate**

Part A

1. Microscopic parameters of a system those which are independent of size of the system is called _____.**(K2-U, CO1)**

a) Intensive b) Extensive c) Additive d) Multiplicative.

2. The ensemble distribution according to Gibb's microcanonical distribution function is called a _____.**(K3- Ap, CO2)**

a) canonical ensemble b) Microcanonical ensemble c) Partition function d) Grand canonical ensemble

3. Chemical potential of boson is _____ **(K3 – Ap, CO2)**

4. State Virial theorem.**(K2- U, CO1)**

5. In P-T diagram, the state in which three phases co-exist will be represented on the phase boundary line by a point called _____. **(K2- U, CO5)**

Part B

1. Interpret microstates and macrostates. **(K2- U, CO1)**

2. How is grand canonical and canonical partition functions related? **(K4 – Ap, CO2)**

3. A Fermi Dirac gas has two particles in the i^{th} state whose degeneracy is three. Find out the number of independent ways of selecting the particles in the state. **(K6-C, CO3)**

4. Explain Joule Thompson process. **(K4-A, CO4)**

5. Depict the phase diagram for pure system. **(K2-U, CO-5)**

Part C

1. Describe the basic postulates of Thermodynamics. **(K2 – U, CO1)**

2. Apply the concept of Gibb's Paradox and deduce the equation of state. **(K3 – Ap, CO2)**

3. Derive the number density of photons and discuss Bose condensation. **(K4- A, CO4)**

4. Show that the diffusion process is irreversible for Brownian particles. **(K3 – Ap, CO2)**

5. Derive the exact solution for one dimensional Ising model. **(K4 – A, CO4)**

C. Nirmala Louis

Dr. C. NIRMALA LOUIS, M.Sc., Ph.D., PGDCA
Head & Assistant Professor,
PG & Research Department of Physics,
Holy Cross College (Autonomous),
Nagercoil, Kanyakumari District,
Tamil Nadu. PIN: 629 004.

Dr. C. Nirmala Louis

M. PriyaDharshini S. Virgin Jeba

Dr. M. PriyaDharshini & Dr.S. Virgin Jeba

Head of the Department **Course Instructor**

Teaching Plan

Department : Physics
Class : I M.Sc. Physics
Title of the Course : CORE COURSE V: QUANTUM MECHANICS - I
Semester : II
Course Code : PP232CC2

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PP232CC2	**6**	**-**	**-**	**-**	**5**	**6**	**90**	**25**	**75**	**100**

Learning Objectives

1. To develop the physical principles and the mathematical background important to quantum mechanical descriptions.
2. To discuss the Approximation methods like perturbation theory, Variational and WKB methods for solving the Schrödinger equation.

3. **Course Outcomes**

On the successful completion of the course, student will be able to**:**		
CO1	understand the basic postulates of quantum mechanics which serve to formalize the rules of quantum mechanics.	K1(R) & K2 (U)
CO2	interpret and relate the Schrodinger equation to solve one dimensional problems and three dimensional problems.	K2(U)& K3 (Ap)
CO3	apply and analyze various representations, space time symmetries and formulations of time evolution.	K3 (Ap) & K4 (An)
CO4	construct and prioritize the approximation methods for various quantum mechanical problems.	K4((An)& K5(E)
CO5	apply and formulate non-commutative algebra for angular and spin angular momentum and assess spectral line splitting.	K5(E) & K6(C)

Teaching plan

Total Contact hours: 60 (Including lectures, assignments and tests)

Unit	Module	Topic	Teaching Hours	Cognitive level	Pedagogy	Assessment/ Evaluation
I	1.	**BASIC FORMALISM** Interpretation of the wave function –—– Postulates of Quantum	4	K1(R)	Lecture using Chalk and talk ,Introductory session, Group Discussion, Mind mapping,	Evaluation through: short test Class Test Quiz through Quizziz Formative assessment through Hot Potatoes
	2.	Time dependent Schrodinger equation –Time independent Schrodinger equation Stationary states – Ehrenfest's theorem	4	K1(R)	Peer tutoring, Lecture using videos, Problem solving, Demonstration, PPT, Review	
	3.	Linear vector space – Linear operator – Eigen functions and Eigen Values – Hermitian Operator	5	K2(U)	Lecture using Chalk and talk ,Introductory session, Group Discussion, Mind mapping,	
	4.	Mechanics – Simultaneous measurability of observables – General Uncertainty relation.	5	K2(U)	Peer tutoring, Lecture using videos, Problem solving, Demonstration, PPT, Review	
II	1.	Square – well potential with rigid walls – Square well potential with finite walls – Square potential barrier	4	K2(U)	Lecture using Chalk and talk ,Introductory session, Group Discussion, Mind mapping	Evaluation through: short test Class Test Multiple choice questions Quiz through Nearpod
	2.	Alpha emission – Bloch waves in a periodic potential – Kronig-penny square – well periodic potential	4	K2(U)	Peer tutoring, Lecture using videos, Problem solving, Derivation, PPT, Review	
	3.	Linear harmonic oscillator: Operator method – Particle	5	K3(Ap)	Lecture using Chalk and talk ,Introductory	

		moving in a spherically symmetric potential			session, Group Discussion, Mind mapping,	Formative assessment through Mentimetre
	4.	System of two interacting particles – Hydrogen atom – Rigid rotator.	5	K3(Ap)	Peer tutoring, Lecture using videos, Problem solving, Demonstration, PPT, Review	
III	1.	**GENERAL FORMALISM** Dirac's notation- Equations of motions – Schrodinger representation –	4	K2(U)	Lecture using Chalk and talk ,Introductory session, Group Discussion, Mind mapping,	Evaluation through: short test Class Test
	2.	Heisenberg representation – Interaction representation – Coordinaterepresentation –	5	K3(Ap)	Peer tutoring, Lecture using videos, Problem solving, Demonstration, PPT, Review	Match the following through Hot Potatoes
	3.	Momentum representation: Probabilty Density– Operator for Position Coordinate- Operator for Momentum	4	K4(An)	Lecture using Chalk and talk ,Introductory session, Group Discussion, Mind mapping,	
	4.	Equation of Motion- Symmetries and conservation laws- Unitary transformation – Parity and time reversal.	5	K4(An)	Peer tutoring, Lecture using videos, Problem solving, Demonstration, PPT, Review	Formative assessment through Quizziz
IV	1.	Time independent perturbation theory : Basic Concepts- Non-degenerate energy levels: First and second order correction to the	5	K4(An)	Lecture using Chalk and talk ,Introductory session, Group Discussion, Mind mapping	Evaluation through: short Class Test

		Energy and Wave function				
	2	Degenerate energy levels – Stark effect in Hydrogen atom – Ground and excited state – Variation method	4	K4(An)	Peer tutoring, Lecture using videos, Problem solving, Derivation, PPT	Multiple choice questions Quiz through Slido
	3.	Helium atom – WKB approximation: The WKB method – Connection formulae (no derivation)	5	K5(E)	Lecture using Chalk and talk ,Introductory session, Group Discussion, Mind mapping,	Formative assessment through Nearpod
	4.	WKB quantization – Application to simple harmonic oscillator.	4	K5(E)	Peer tutoring, Lecture using videos, Problem solving, Derivation, PPT, Review	
V	1.	Eigenvalue spectrum of general angular momentum – Ladder operators and their algebra – Angular momentum matrices	4	K5(E)	Lecture using Chalk and talk ,Introductory session, Group Discussion, Derivation	Evaluation through: short Class Test Multiple choice questions Quiz
	2.	Matrix representation – Spin angular momentum: spin-(1/2) systems-Addition of angular momenta	4	K5(E)	Peer tutoring, Lecture using videos, Problem solving, PPT,	Formative assessment through Hot Potatoes
	3.	Clebsh- Gordan Coefficients – Symmetry and anti – symmetry of wave functions	5	K6(C)	Lecture using Chalk and talk ,Derivation, Group Discussion, Mind mapping,	
	4.	Construction of wave-functions and Pauli's exclusion principle.	5	K6(C)	Peer tutoring, Lecture using videos, Problem solving, PPT	

Course Focussing on Employability/ Entrepreneurship/ Skill Development :
Entrepreneurship

Activities (Em/ En/SD): Problem solving on one and two dimensional system

Course Focussing on Cross Cutting Issues (Professional Ethics/ Human Values/Environment Sustainability/ Gender Equity): - Environment Sustainability

Activities related to Cross Cutting Issues : -

Assignment : Clebsh- Gordan Coefficients

Seminar Topic: Hydrogen atom problem

Sample questions

Part A

1.A …….. state is a bound one if the corresponding wave function vanishes at infinity.**(K1-R, CO-1)**

2. The alpha particles strikes the barrier wall at the rate of ---------- times per second. **(K2-U, CO-3)**

a) 10^{21} b) 10^{8} c)10^{-21} d) 10^{-8}

3. If |a> and |b> are orthogonal then <a|b> ……. **(K3-Ap, CO-3)**
4. Eigen value of momentum is _____**(K4-An, CO-2)**

5. The spin angular momentum of the electron is……..(**K3-Ap, CO-5)**

Part B

1. Derive time dependent schodinger equation in one diamension.**(K2-U, CO-1)**

2. Determine the time period of alpha emission. **(K2-U, CO-2).**

3. Derive Heisenberg equation of motion that replaces Schrodinger equation of motion.**(K3-Ap, CO- 3)**

4. Obtain the ground state energy of helium using WKB Approximation.**(K4-An, CO-4)**
5.Explain in detail about spin vector for the spin half system. **(K3-Ap, CO-5)**

Part C

1. State and derive Ehrenfests theorem **(K2-U, CO-1)**

2. Derive an expression for Kronig-Penny square well potential. **(K3-Ap, CO-2)**

3. Derive an expression for equation of motion in the momentum representation. **(K3-Ap, CO-3)**

4. DefineStark effect. Explain the effect of electric field on the ground state of Hydrogen. **(K5-E, CO-4)**

5. Describe the Clebsh Gordan coefficients with suitable example **.(K6-C,CO-5)**

Dr. C. NIRMALA LOUIS, M.Sc., Ph.D., PGDCA.
Head & Assistant Professor,
PG & Research Department of Physics.
Holy Cross College (Autonomous),
Nagercoil. Kanyakumari District.
Tamil Nadu. PIN: 629 004.

Head of the Department

Dr. M. Abila Jeba Queen & Dr. S. Sonia
Course Instructors

TeachingPlan

Department : Physics
Class : I M.Sc Physics
Title of the Course : Elective Course II: a) Advanced Optics
Semester : II
Course Code : PP232EC1

Course Code	L	T	P	S	Credits	Inst.Hours	Total Hours	Marks		
								CIA	External	Total
PP232EC1	4	-	-	-	3	4	60	25	75	100

LearningObjectives:

1. To impart an extensive understanding of the optical phenomenon of various optical strategies like laser, fiber optics, non-linear optics and electro magneto optics.
2. To study the working of different types of Lasers and optical fibers.

CourseOutcomes

Onthesuccessfulcompletionof thecourse,studentwillbeableto**:**		
CO1	Discuss the transverse character of light waves and different polarization phenomenon	**K1**
CO2	Discriminate all the fundamental processes involved in laser devices and to analyze the design and operation of the devices	**K2**
CO3	Demonstrate the basic configuration of a fiber optic–communication system and advantages	**K3,K4**
CO4	Identify the properties of nonlinear interactions of light and matter	**K4**
CO5	Interpret the group of experiments which depend for their action on an applied magnetic and electric field	**K5**

Modules

Total contact hours: 90 (Including lectures, assignment and tests)

Unit	Module	Topic	Teaching Hours	Cognitive Level	Pedagogy	Assessment/Evaluation
I	**POLARIZATIONAND DOUBLE REFRACTION**					
	1	Classification of polarization – Transverse character of light waves –Polarizer	3	K1(R)	Lecture Discussion with PPT Illustration	

		and analyzer – Malu's law – Production of polarized light – Wire grid				Evaluation through: Online quiz (Kahoot) Formative assessment I
	2	polarizer and the polaroid Polarization by reflection – Polarization by double refraction – Polarization by scattering	3	K1(R)	Lecture discussion	
	3	The phenomenon of double refraction – Normal and oblique incidence – Interference of polarized light	3	K1(R)	PPT Illustration (nearpod)	
	4	Quarter and half wave plates – Analysis of polarized light – Optical activity	3	K1(R)	Lecture discussion	
II	**LASERS**					
	1	Basic principles – Spontaneous and stimulated emissions – Components of the laser – Resonator and lasing action	3	K1(R)	PPT and group Discussion	Evaluation through: Online quiz (Slido), Short questions Descriptive answers Formative assessment I
	2	Types of lasers and its applications – Solid state lasers – Ruby laser	3	K2(U)	Lecture Discussion with PPT Illustration	
	3	Nd:YAG laser – gas lasers – He-Ne laser – CO2 laser	3	K2(U)	PPT Illustration	
	4	Chemical lasers – HCl laser –	3	K2(U)	Lecture Discussion	

		Semiconductor laser			with PPT Illustration	
III	**FIBER OPTICS**					
	1	Introduction – Total internal reflection – The optical fiber – Glass fibers – The coherent bundle – The numerical aperture – multimode optical fibers	3	K2(U)	Lecture discussion	Evaluation Evaluation through: Online quiz, Short questions Descriptive answers Formative assessment I/II
	2	Attenuation in optical fibers – Single and multi-mode fibers – Pulse dispersion	3	K2(U)	Lecture Discussion with PPT Illustration	
	3	Ray dispersion in multimode step index fibers – Parabolic- index fibers – Fiber-optic	3	K3(Ap)	Lecture discussion	
	4	sensors: precision displacement sensor – Precision vibration sensor	3	K4(An)	PPT and group Discussion	
IV	**NON-LINEAROPTICS**					
	1	Basic principles – Harmonic generation	3	K1(R)	Lecture Discussion with PPT Illustration	Evaluation through: Online quiz, Problem solving short questions Descriptive answers Formative assessment II
	2	Second harmonic generation –	3	K2(U)	Lecture discussion	

		Phase matching				
	3	Third harmonic generation – Optical mixing	3	K3(Ap)	PPT Illustration	
	4	Parametric generation of light – Self-focusing of light	3	K4(An)	Lecture Discussion with PPT Illustration	
V	**MAGNETO OPTICS AND ELECTRO OPTICS**					
	1	Magneto-optical effects – Zeeman effect – Inverse Zeeman effect – Faraday effect	3	K2(U)	Short Learning Object (Zoom)	Evaluation through: Online quiz, Short questions Descriptive answers Formative assessment II
	2	Voigt effect – Cotton-mouton effect – Kerr magneto- optic effect – Electro-optical effects	3	K3(Ap)	Lecture Discussion with PPT Illustration	
	3	Stark effect – Inverse stark effect – Electric double refraction	3	K4(An)	Lecture discussion	
	4	Kerr electro-optic effect – Pockels electro-optic effect	3	K5(E)	PPT Illustration	

PO- Program outcome; LO – Learning outcome; Cognitive Level R – Remember; U – Understand; Ap- Apply, An- Analyze; E-Evaluate; C- Create

CourseFocussingonEmployability/Entrepreneurship/SkillDevelopment: **Employability**

Activities(Em/En/SD):**Practical**

Course Focussing on Cross Cutting Issues (Professional Ethics/ Human Values/EnvironmentSustainability/Gender Equity):-

Activities related to Cross Cutting Issues: Nil

Assignment : (Mention Topic and Type): Single and multi-mode fibers- Google Classroom

Seminar Topic: (if applicable):Polarization by double refraction, Total Internal reflection, Zeeman effect.

Part A (1 mark)

1. Malu's law is associated with **(K1- R, CO-1)**
   A) Reflection
   B) Refraction
   C) Polarization
   D) Interference
2. Which laser type uses a solid-state medium? **(K2- U, CO-2)**
   A) He-Ne laser
   B) CO2 laser
   C) Ruby laser
   D) Semiconductor laser
3. Numerical Aperture (NA) in fiber optics is a measure of the fiber's ability to _____ light. **(K3- Ap, CO-3)**
4. Harmonic generation involves the production of frequency components that are integermultiples of the original frequency.
   TRUE/FALSE**(K4- An, CO-4)**

4. Which effect involves the splitting of spectral lines in the presence of a magnetic field?**(K5- E, CO-5)**
   A) Voigt effect
   B) Faraday effect
   C) Zeeman effect
   D) Cotton-Mouton effect

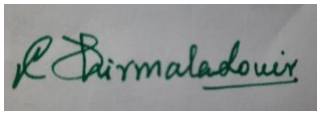
Part B (6 marks)

1. What are the different classifications of polarization, and how do they relate to the transverse character of light waves?**(K1- R, CO-1)**
2. Outline the basic principles of lasers, including the concepts of spontaneous and stimulated emissions. Explain the role of a resonator in lasing action.**(K2- U, CO-2)**
3. Illustrate the characteristics of optical fibers, emphasizing the types of glass fibers and the concept of a coherent bundle.**(K3- Ap, CO-3)**
4. Analyze the concept optical mixing and its applications in the field of non-linear optics. **(K4- An, CO-4)**
5. Interpret the concept inverse Zeeman effect and how it contrasts with the regular Zeeman effect. **(K5- E, CO-5)**

Part C (12 marks)

1. Describe the methods of production of polarized light. Discuss the use of wire grid polarizers and polaroids in achieving polarization.**(K1- R, CO-1)**

2. Explore chemical lasers and semiconductor lasers. Provide an overview of their principles and applications.**(K2- U, CO-2)**
3. Illustrate the significance of numerical aperture in optical fibers and discuss the factors contributing to attenuation in these fibers. **(K3- Ap, CO-3)**
4. Analyze the process of second harmonic generation and its significance in non-linear optics**. (K4- An, CO-4)**
5. Interpret Kerr magneto-optic effect and how it influences the polarization of light in a magnetic field. **(K5- E, CO-5)**



Head of the Department

Ms. V. Shally & Ms. A. Lesly Fathima
Course Instructor

Holy Cross College (Autonomous)

Nagercoil-629004.

M.Sc. Physics

Semester II

Name of the Course: Medical Physics

Subject code: PP232EC4

No. of hours per week	No. of Credits	Total No. of hours	Marks
4	3	60	100

Objectives

1. To understand the major applications of Physics to Medicine.
2. To study the aid of different medical devices such as X-ray machines, gamma camera, accelerator and nuclear magnetic resonance.

Course Outcomes

COs	Upon completion of this course, students will be able to:	PSO addressed	CL
CO-1	Learn the fundamentals, production and applications of X-rays.	PSO - 4	U
CO-2	Understand the basics of blood pressure measurements. Learn about sphygmomanometer, EGC, ENG and basic principles of MRI.	PSO - 4	Ap
CO-3	apply knowledge on Radiation Physics	PSO - 4	U
CO-4	analyse Radiological imaging and filters	PSO - 4	An
CO-5	assess the principles of radiation protection	PSO- 4	An

Modules

Credit: 5 **Total Hours: 60**

Unit	Section	Topics	Lecture hours	Cognitive level	Pedagogy	Assesment/ Evaluation
I		**X-RAYS AND TRANSDUCERS**				
	1	Electromagnetic Spectrum – Production of X-Rays – X-Ray Spectrum – Bremsstrahlung	3	K1(R)	Illustration and PPT using gamma	Evaluation through: quiz nearpod
	2	Characteristic X-Ray – X-Ray Tubes – Coolidge	3	K1(R)	Illustration, PPT	Formative assessment

		Tube – X-Ray Tube Design – Thermistors				Evaluation through short test using nearpod
	3	photo electric transducers – Photo voltaic cells – photo emissive cells	3	K1(R)	Lecture Discussion using gamma	
	4	Photoconductive cells– piezoelectric transducer.	3	K1(R)	Illustration and AI tool	
II		**BLOOD PRESSURE MEASUREMENTS**				
	1	Introduction – Sphygmomanometer – Measurement of heart rate	3	K2(U)	Illustration using OLAB	Evaluation through: quiz using hotpotatoes
	2	basic principles of electrocardiogram (ECG)	3	K2(U)	Lecture Discussion using PPT	
	3	Basic principles of electro-neurography (ENG)	3	K3(Ap)	Lecture ,Illustration using AI tool	Class test using nearpod
	4	Basic principles of magnetic resonance imaging (MRI).	3	K3(Ap)	Lecture Discussion using gamma	
III		**RADIATION PHYSICS**				
	1	Radiation Units – Exposure – Absorbed Dose – Rad to Gray	3	K1(R)	Lecture and Discussion using slido	Evaluation through: quiz using quizzes Formative assessment Evaluation through short test Multiple choice questions
	2	Kera Relative Biological Effectiveness – Effective Dose – Sievert (Sv)functions - objects as function arguments	3	K2(U)	Illustration	Lecture Illustration , Writing simple programmes
	3	Inverse Square Law – Interaction of radiation with Matter – Linear Attenuation Coefficient	2	K3(Ap)	Lecture Discussion using gamma	Lecture Illustration , Writing simple

						programmes
	4	Radiation Detectors – Thimble Chamber – Condenser Chambers – Geiger Counter – Scintillation Counter	4	K3(Ap)	Lecture ,Illustration using AI tool	Lecture Illustration , Writing simple programmes
IV		**MEDICAL IMAGING PHYSICS**				
	1	Radiological Imaging – Radiography – Filters – Grids	3	K1(R)	Lecture Illustration ,	Evaluation through: quiz, using quizzes,slido Problem solving Theoretical derivation Formative assessment
	2	Cassette – X-Ray Film – Film processing – Fluoroscopy	3	K3(Ap)	Illustration	
	3	Computed Tomography Scanner – Principal Function	3	K2(U)	Lecture Discussion using gamma	
	4	Display – Mammography – Ultrasound Imaging	3	K2(U)	Lecture ,Illustration using AI tool	
V		**RADIATION PROTECTION**				
	1	Principles of Radiation Protection	3	K2(U)	Lecture Illustration ,	Evaluation through: quiz, Mentimeter Problem solving Formative Assessment
	2	Protective Materials	3	K4(An)	Illustration	
	3	Radiation Effects – Somatic – Genetic Stochastic and Deterministic Effect	3	K3(Ap)	Lecture Discussion using gamma	
	4	– Personal Monitoring Devices, TLD Film Badge – Pocket Dosimeter	3	K3(Ap)	Lecture ,Illustration using slido	

Course Focussing on Employability/ Entrepreneurship/ Skill Development: **Employability**

Activities (Em / En /SD): **Problem solving and analysing using the images**

Course Focusing on Cross Cutting Issues (Professional Ethics/ Human Values/Environment Sustainability/ Gender Equity): - Environment Sustainability activities related to Cross Cutting Issues:-

Assignment: (Mention Topic and Type): Solve problems, Analyse X-RAYS

Seminar Topic: (if applicable):-

Sample questions (minimum one question from each unit)

Part A (1 mark)

1. The frequency of gamma rays is--------.**(K1-U, CO-1)**
2. In the electromagnetic spectrum ----- has the high penetrating power**(K2-R, CO-2)**
3. The protective material used for radiation protection **is -----(Ap, CO3)**
4. Analyze the energy in terms of wavelength and frequency**(K4-An,CO3)**
5. Evaluate the amount of energy released by 10R of radiation(**K5-E, CO4)**

Part B (4 marks)

1. Briefly explain the electromagnetic spectrum. **(K1-U, CO-1)**
2. Explain the basic principles of a electrocardiogram.**(K1-U, CO-1)**
3. Analyse the biological effect of radiations. **(K4-An,CO3)**
4. Explain the construction and working of a Computed Tomography Scanner **(K1-U, CO-3)**
5. Explain the Thyroid Uptake System in medical imaging**(K3-Ap, CO-4)**

Part C (8 marks)

1. With neat sketch explain the construction and working of Geiger **K1-U, CO-1)**
2. With neat sketch explain the construction and working of counterMammography.**(K2-R, CO-2)**
3. Determine the amount of radiation using Thimble chamber. **(K3-Ap, CO-3)**
4. AnalyseSomatic, Genetic Stochastic, and Deterministic Effectof radiations**(K4-An, CO-4)**
5. Explain the various radiation protective materials**(K1-, CO-1)**

Dr. C. NIRMALA LOUIS, M.Sc., Ph.D., PGDCA.
Head & Assistant Professor,
PG & Research Department of Physics.
Holy Cross College (Autonomous),
Nagercoil. Kanyakumari District,
Tamil Nadu. PIN: 629 004.

Dr.C.Nirmala Louis
Head of the Department

Dr.S.J.Jenepha Mary & Dr. P. Aji Udhaya

Course Instructors

Teaching Plan

Department : Physics

Class : I M.Sc., Physics

Title of the Course: SKILL ENHANCEMENT COURSEI – NME-I
Solar Energy Utilization

Semester : II

Course Code : PP232SE1

Course Code	L	T	P	Credits	Inst. Hours	Total Hours	Marks		
							CIA	External	Total
AP2041	4			2	4	60	25	75	100

Learning Objectives:
1. To impart fundamental aspects of solar energy utilization.
2. To develop an industrialist mindset by utilizing renewable source of energy.

Course Outcomes

On the successful completion of the course, student will be able to**:**		
CO1	gained knowledge in fundamental aspects of solar energy utilization	**K1 & K2**
CO2	equipped to take up related job by gaining industry exposure	**K1 & K2**
CO3	develop entrepreneurial skills	**K2 & K3**
CO4	skilled to approach the needy society with different types of solar cells	**K3 & K5**
CO5	gained industrialist mindset by utilizing renewable source of energy	**K5 & K6**

Modules

Total Contact hours: 60 (Including lectures, assignments and tests)

Unit	Module	Topic	Teaching Hours	Cognitive level	Pedagogy	Assessment/Evaluation
I	**HEAT TRANSFER AND RADIATION ANALYSIS:**					
	1	Conduction: Conduction in extended surface – Radiation and Convection –	**4**	K1(R)	Lecture discussion with illustration	Evaluation through: Online quiz, Class test, Formative assessment I

		Forced convection and wind loss				
	2	Solar radiation at the Earth's surface – Basic Earth sin angles	**4**	K2(U)	PPT, Lecture discussion with illustration, and group discussion	
	3	Determination of solar time – Solar energy measuring instruments and its classifications.	**4**	K2(U)	Lecture discussion with illustration	
II	**SOLAR COLLECTORS:**					
	1	Introduction – Physical Principle of the conversion of solar radiation into heat	**4**	K2(U)	Lecture discussion with illustration	Evaluation through: Online quiz, Short questions, Descriptive answers, Formative assessment I
	2	Description of flat plate collectors- General characteristics of flat plate collectors	**4**	K1(R)	Discussion And Illustration with PPT	
	3	Selection of materials of flat plate collectors	**4**	K2(U)	Lecture Illustration, group discussion	
III	**SOLAR HEATERS:**					
	1	Introduction – Types of solar water heaters – Collectors and storage tanks	**4**	K2(U)	PPT, Lecture discussion with illustration	Evaluation through: Online quiz, Short questions, Descriptive answers, Formative assessment I/II
	2	Combined heating and cooling systems - Solar pond: Introduction	**4**	K3(Ap)	Lecture discussion with illustration	
	3	Principle of operation of solar pond – Types of	**4**	K3(Ap)	PPT, Lecture discussion	

		solar ponds – Application of solar ponds			with illustration	
IV	**SOLAR ENERGY CONVERSION :**					
	1	Photovoltaic principle: Semiconductor junction, Basic Photovoltaic system for power generation	**4**	K5(E)	Discussion And Illustration with PPT	Evaluation through: Online quiz, short questions, Descriptive answers, Formative assessment II
	2	Advantages and disadvantages of photovoltaic solar energy conversion	**4**	K3(Ap)	Lecture discussion with illustration	
	3	Types of solar cells – Applications of solar photovoltaic system	**4**	K3(Ap)	Discussion And Illustration with PPT	
V	**NANOMATERIALS IN FUEL CELL APPLICATIONS:**					
	1	Use of nanostructures and nanomaterials in fuel cell technology	**4**	K6(C)	Discussion And Illustration with PPT	Evaluation through: Online quiz, MCQ, True/False, short questions, Descriptive answers, Formative assessment II
	2	High and low temperature fuel cells, cathode and anode reactions, fuel cell catalysts, electrolytes, ceramic catalysts.	**4**	K5(E)	Discussion And Illustration with PPT	
	3	Use of Nanotechnology in hydrogen production and storage.	**4**	K5(E)	Lecture Illustration	

Course Focussing on Employability/ Entrepreneurship/ Skill Development : **Skill Development**

Activities (Em/ En/SD): **Project**

Course Focussing on Cross Cutting Issues (Professional Ethics/ Human Values/Environment Sustainability/ Gender Equity): Nil

Activities related to Cross Cutting Issues : Nil

Assignment : (Mention Topic and Type): **Solar Energy Panel**

Seminar Topic: (if applicable): **Solar Energy Radaition**

Sample questions (minimum one question from each unit)

Part A (1 mark)

1. The incident solar radiation which comes directly from the apparent solar disc, without reflection from other objects is _____ **(K4- An, CO1)**
2. A _____ is a device designed to absorb incident solar radiation. **(K3 – Ap, CO2)**
   (a) solar heater (b)solar plate (c) solar collector (d) solar receiver
3. The solar pond combines solar energy collection and sensible heat storage. **(True/False) (K5 – E, CO3)**
4. A basic use of solar water heating is ----------. **(K6 – C, CO4)**
5. Schottky junction photo voltaic cell made with the ----------.**(K3 – Ap, CO5)**

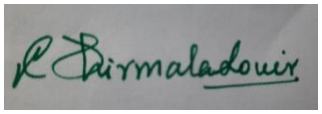
Part B (3 marks)

6. Differentiate radiation and conduction. **(K4 – An, CO1)**
7. Summarize the general characteristics of flat plate solar collectors. **(K5 – E, CO2)**
8. Criticize the classification of solar ponds. **(K5- E, CO3)**
9. Design combined solar heating and cooling systems. **(K6- C, CO4)**
10. Illustrate the concept of crysial growth. **(K3 – Ap, CO5)**

Part C (7 marks)

11. Interpret the solar radiation at the earth's surface. **(K3 – Ap, CO1)**
12. Predict the concept of general description of flat plate solar collectors. **(K5 – E, CO2)**
13. Describe the principle of operation of a solar pond. **(K6- C, CO3)**

14. Derive an expression for photo voltaic principles. **(K3 – Ap, CO4)**
15. Explain in detail about the applications of solar photo voltaic system . **(K5- E, CO5)**



Head of the Department

S.Sebastiammal

Sr.S.Sebastiammal

Course Instructor

Department : Physics

Class : II M.Sc. Physics

Course Name : Nuclear and Elementary Particle Physics
Course Code : PP2041
Semester : IV

Hours/Week	Credits	Total Hours	Marks
6	**5**	**90**	**100**

Learning Objectives

1. To know about the fundamental principles and concepts governing nuclear and particle physics and their social, economic and environmental implications.
2. To understand the concept of elementary particles.

COs	Upon completion of this course, students will be able to:	PSO addressed	CL
CO-1	Understand the properties of Nuclear forces and outline their behavioral formulation.	**PSO - 1**	**U**
CO-2	Analyze the different nuclear models of the nucleus and examine the application of the shell model of nucleus.	**PSO - 4**	**E**
CO-3	Explain the characteristics and effect of radioactive decay phenomena. (alpha,beta,gamma)	**PSO - 1**	**U**
CO-4	Discuss the outcome of various types of nuclear reactions.	**PSO - 4**	**C**
CO-5	Examine the Particle Physics phenomena and their basic theoretical description.	**PSO - 3**	**An**

Module

Total contact hours: 90 (Including lectures, assignment and tests)

Unit	Section	Topics	Lecture Hours	Learning outcomes	Pedagogy	Assessment/Evaluation
I	**Nuclear Forces**					
	1	Characteristics of Nuclear Forces – Exchange forces and	**4**	Define the basis of nuclear forces and stability of	PPT using Gamma with AI, Lecture discussion	Evaluation: Slido, Class test, oral question Assignment

		tensor forces – charge independence		nucleus		I Formative assessment I
	2	Spin dependence of Nuclear Forces - Meson theory of nuclear forces- Ground state of deuteron	**4**	Apply various Nuclear Forces relations	Derivation and group discussion	
	3	Nucleon-nucleon scattering singlet and triplet parameters – Nucleon-Nucleon scattering: Cross-section, Differential Cross-section, Scattering Cross-sections	**5**	solution of Nuclear magnetic moment	Derivation, problem solving and group discussion	
	4	Magnetic moment-Quadrupole moment –S and D state admixtures - Effective range theory of n-p scattering at low energies.	**5**	Apply Nuclear forces in different models	PPT using Gamma with AI, Derivation and group discussion	
II	**Nuclear Models**					
	1	Binding energy & mass defect – Weizacker's formula – mass parabola	**5**	Solve Radioactive reactions parabola	PPT using Gamma with AI ,Derivation discussion	Evaluation: Slido, Class test, oral question Assignment I/II Formative assessment I
	2	Liquid drop model - Bohr - Wheeler theory of fission- Activation	**5**	Define and derive Radioactive decay	Derivation and group discussion problem solving	

		energy for fission				
	3	Shell model- Spin –Orbit coupling-Spins of nuclei- Magnetic moments – Schmidt lines- Electric quadrupole moments	**4**	Statement and proof of Schmidt lines	Derivation and group discussion problem solving	
	4	Collective model of Bohr and Mottelson: Nuclear vibration – Nuclear rotation –Nelson model	**4**	Nuclear vibration and its applications	PPT using Gamma with AI ,Derivation and group discussion problem solving	
III	**Nuclear Reactions**					
	1	Nuclear reaction - Q- value – Nuclear reaction cross section – Direct Nuclear Reactions	**4**	Analyse Conservation laws in nuclear Reactions	PPT using Gamma with AI Derivation discussion	Evaluation: Slido, Class test, oral question Assignment II Formative assessment I/ II
	2	Knock out reaction, Pick-up reaction, Stripping reaction – Compound nucleus theory – Formation – Disintegration energy levels – Partial wave analysis of Nuclear reaction cross-section	**5**	Define and derive nuclear Reactions , Reaction mechanisms &Nuclear fission	Derivation and group discussion	
	3	Resonance Scattering and Reaction cross-section (Breit-	**4**	Define and Derive Nuclear chain reaction,	Derivation and group discussion, PPT using	

		Wigner dispersion formula) – Scattering matrix		Fission bomb	Gamma with AI	
	4	Reciprocity theorem – Breit -Wigner one level formula – Resonance scattering – Absorption cross section at high energy.	**5**	Define, derive and apply Absorption cross section at high energy Hydrogen bomb	Derivation and group discussion, PPT using Gamma with AI	
IV	**Radioactive Decays**					
	1	Alpha decay - Beta decay – Energy release in beta decay – Fermi theory of beta decay	**4**	Discuss different types of Radiation Decays	Derivation discussion	Evaluation Slido, Class test, oral question Assignment II/III Formative assessment II
	2	Shape of the beta spectrum – decay rate Fermi-Curie plot – Fermi & G.T Selection rules	**5**	Define and derive beta spectrum	Derivation and group discussion, PPT using Gamma with AI	
	3	Comparatives half - lives and forbidden decays- Gamma decay - Multipole radiation	**4**	Define and Derive different types of Gamma decay	Derivation and group discussion	
	4	Angular momentum and parity selection rules – Internal conversion – Nuclear isomerism.	**5**	Define , derive and apply Internal conversion – Nuclear isomerism	PPT using Gamma with AI ,Derivation and group discussion	
V	**Elementary Particle Physics**					
	1	Classification of elementary particles - Types of interaction	**5**	Analyse Fundamental Interactions	Discussion PPT using Gamma with AI	Evaluation: Slido, Class test, oral question Assignment

		between elementary particles – Hadrons and leptons				**III** Formative assessment II
	2	Symmetry and conservation laws – Strangeness and associate production - CPT theorem – classification of hadrons	**4**	Analyse conservation laws of elementary particles	Derivation and group discussion, PPT using Gamma with AI	
	3	Quark model - Isospin multiples - SU(2)- SU(3) multiplets- Gell-Mann - Okubo mass formula for octet and decouplet hadrons	**5**	Explain symmetry classification of elementary particles	Derivation and group discussion, PPT using Gamma with AI	
	4	Phenomenology of weak interaction hadrons and leptons- Universal Fermi interaction – Elementary concepts of weak interactions.	**4**	Define , derive and apply Quark model	Derivation and group discussion, PPT using Gamma with AI	

Course Focussing on Employability/ Entrepreneurship/ Skill Development : Employability

Activities (SD): Model Making

Course Focusing on Cross Cutting Issues (Professional Ethics/ Human Values/Environment Sustainability/ Gender Equity): - Environment Sustainability

Activities related to Cross Cutting Issues:-

Assignment : Seminar Topic: - Classification of elementary particles

Sample questions (minimum one question from each unit)

Part A

1. The tensor operator S_{12}=

2. Nuclear fission was explained by

(a) liquid drop model (b) shell model

(c) collective model (d) Nilsson model

3. For an inelastic nuclear collision the Q value is

a) $Q>0$ b) $Q<0$ c) $Q=0$ d) *infinite*

4. A neutrino is emitted in

(a)α-decay (b) γ-ray

(c)β-decay (d) proton

5. Protons comes under ---------- classification of elementary particles.

a) hadrons b) hyperons c) mesons d) leptons

Part B

1. Define binding energy and packing fraction of nuclei. Briefly explain Yukawa's meson theory of nuclear forces. **(K2-U, CO-3)**

2. What do you know about mass parabola for isobaric nucleus

(K5-E, CO-2)

3. State and prove the conservation laws in nuclear reactions **(K4-An, CO-5)**

4. Distinguish between α and β decay **(K4-An, CO-5)**

5. Explain the classification of elementary particles and its properties. **(K2-U, CO-1)**

Part – C

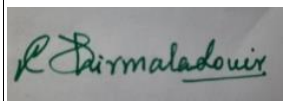
1. Discuss the properties of tensor forces? What do you infer from the measured quadrupole moment and magnetic moment of deuteron?
(K2-U, CO-3)

2. On the basis of liquid drop model give a simple derivation of Weizascker semi-empirical mass formula giving arguments for each term. What are the important conclusions drawn from this formula? **(K4-An, CO-5)**

3. Define threshold energy of a nuclear reaction. State the conservation laws that can be applied to a nuclear reaction and derive an expression for the Q-value. **(K5-E, CO-2)**

4. Describe the special features of β-ray spectra. Explain how Pauli' s hypothesis of neutrino-β particle emission solved the anomalies in β-ray spectra. **(K4-An, CO-4)**

5. What are quarks?. Describe the quark model of elementary particles. Also discuss the quark content of some of baryons and mesons. **(K2-U, CO-1)**



Dr.C.Nirmala Louis
Head of the Department

Dr.C.Nirmala Louis & Dr. R. Krishna Priya
Course Instructors

Holy Cross College (Autonomous), Nagercoil-629004.

M.Sc. Physics

Semester IV

Name of the Course: Spectroscopy

Subject code: PP2042

Hours/Week	Credits	Total Hours	Marks
6	5	90	100

Learning Objectives

1. To gain knowledge about the basic principles of spectroscopy.
2. To gain insight about the spectroscopic instruments and its applications.

Course Outcome

Cos	Upon completion of this course, students will be able to:	PSO addressed	CL
CO - 1	Apply basic spectroscopic techniques. (Microwave, IR, Raman and NMR)	**PSO - 4**	**U**
CO - 2	Infer basic spectroscopic techniques. (Microwave, IR, Raman, ESR, NQR and NMR)	**PSO - 6**	**Ap**
CO - 3	Understand the molecular interactions in different spectroscopic methods.	**PSO - 1**	**An**
CO - 4	Analyze the characteristics of rotational spectra and vibrational energy of molecules.	**PSO - 3**	**An**
CO - 5	Utilize various spectroscopic methods suitable for characterizing molecules.	**PSO - 6**	**C**

Modules

Total contact hours: 90 (Including lectures, assignment and tests)

Unit	Section	Topics	Lecture Hours	Learning outcomes	Pedagogy	Assessment/ Evaluation
I	**Microwave Spectroscopy**					
	1.	Rotation of Molecules – Rigid	**4**	Define the basis of	Gamma PPT, Illustration and	Evaluation

		Rotor (Diatomic Molecules)		Semiconductor	theoretical derivation	through: Slido Online quiz, Problem solving short questions Descriptive answers Formative assessment I
	2	Expression for the Rotational Constant - Intensity of Spectral Lines	**4**	Derive the expression for the Rotational Constant	Derivation and group discussion,	
	3	Effect of Isotopic Substitution - Molecular Parameters (Bond Length, Bond Angle , Dipole Moment from Rotation Spectra)	**4**	Explain the effect of Isotopic substitution of molecules and derive the Molecular Parameters (Bond Length, Bond Angle from Rotation Spectra)	PPT using Gamma with AI, Illustration, derivation and group discussion	
	4	Techniques and Instrumentation	**3**	Explain the instrumentation techniques of microwave spectrometer	Derivation and group discussion	
II	**Infrared Spectroscopy**					
	1	Vibrational energy of a diatomic molecule- Infrared selection rules- Vibrating diatomic molecule- IR spectrophotometer	**4**	Derive the vibration energy of a diatomic molecule	PPT using Gamma AI, Derivation discussion	Evaluation through: Slido Online quiz, Problem solving short questions Descriptive answers Formative assessment I
	2	Diatomic vibrating rotator- Vibrations of polyatomic molecules-Fermi resonance	**4**	Derive equation for diatomic vibrating rotator and vibrations of	PPT using Gamma with AI Derivation and group discussion problem solving	

				polyatomic molecules		
	3	Rotation vibration spectra of polyatomic molecules-Normal modes of vibration in crystal Interpretation of vibrational spectra-Group frequencies -	**3**	Explain the normal modes of vibration in crystal Interpret the vibration spectra and Group frequencies	PPT using Gamma with AI ,Illustration, Derivation and group discussion problem solving	
	4	Instrumentation-Sample handling techniques-Fourier Transform Infrared spectroscopy-Applications	**4**	Explain the Instrumentation of IR spectrophotometer Discuss its applications	Derivation and group discussion problem solving	
III	**Raman Spectroscopy**					
	1	Introduction-Theory Of Raman Scattering-Rotational Raman Spectra-Vibrational Raman Spectra-Mutual Exclusion Principle	**4**	Devive the theories of Raman spectrometer	PPT using Gamma with AI ,Derivation discussion	Evaluation through: Slido Online quiz, Problem solving short questions Descriptive answers Formative assessment I/II
	2	Raman Spectrometer-Sample Handling Techniques-Polarization Of Raman Scattered Light-Structure Determination Using IR And Raman Spectroscopy-Raman Investigation Of Phase Transitions	**3**	Explain the Raman Spectrometer and discuss its sample Handling Techniques Discuss the Structure determination Using IR And Raman Spectroscopy	PPT using Gamma with AI ,Illustration, Theoretical formulation Derivation and group discussion,PPT	

	3	Resonance Raman Scattering-Nonlinear Raman Phenomena-Preliminaries-Hyper Raman Effect	**4**	Define Nonlinear Raman Phenomena, Preliminaries and Hyper Raman Effect	Derivation and group discussion, PPT	
	4	Stimulated Raman Scattering-Inverse Raman Effect-Coherent Anti-Stokes Raman Scattering.	**4**	Discuss the anti-Stokes lines of Raman Scattering	PPT using Gamma with AI, Illustration, Theoretical formulation	
IV	**Nuclear Magnetic and Electron Spin Resonance Spectroscopy**					
	1	Basic principles – Quantum theory of NMR - magnetic resonance – relaxation processes	**4**	Explain the basic principles of NMR .relaxation processes	Derivation discussion , PPT using Gamma with AI	Evaluation through: Slido , Online quiz, Problem solving short questions Descriptive answers Formative assessment II
	2	chemical shifts – spin-spin coupling - Spectra and molecular structure – Fourier Transform NMR Instrumentation – Applications	**3**	Define and derive chemical shifts Explain the Instrumentation and Applications of NMR	Derivation and group discussion, PPT using Gamma with AI	
	3	Basic principles – Quantum theory – g-factor – Nuclear Interaction and Hyperfine structure – Relaxation effects	**4**	Explain the Nuclear Interaction and Hyperfine structure	Derivation and group discussion	
	4	Hyperfine interaction – line widths – ESR spectrometer – Instrumentation – applications	**4**	Discuss the ESR spectrometer, Instrumentation and its applications	Derivation and group discussion	
V	**Nuclear Quadrupole Resonance and Mossbauer Spectroscopy**					
	1	Basic theory - Nuclear Electric	**3**	Discuss the nuclear	Discussion PPT using	Evaluation through: Slido,

		quadrupole interaction – Energy levels – Transition frequency – Excitation and Detection		electric quadrupole interaction	Gamma with AI	Online quiz, Problem solving short questions Descriptive answers Formative assessment II
	2	Effect of magnetic field - Instrumentation – Applications. Mossbauer effect - recoilless emission and absorption	**4**	Discuss the effect of magnetic Field and its instrumentation	Derivation and group discussion, PPT using Gamma with AI	
	3	hyperfine interaction - chemical isomer shift - magnetic hyperfine and electric quadruple interactions	**4**	Explain the magnetic hyperfine and electric quadruple interactions	Derivation and group Discussion, PPT using Gamma with AI	
	4	Instrumentation applications.	**4**	Explain the instrumentation and its application	Derivation and group discussion, PPT using Gamma with AI	

Course Focussing on Employability/ Entrepreneurship/ Skill Development: **Employability**

Activities (Em / En /SD): **Problem solving and programming**

Course Focusing on Cross Cutting Issues (Professional Ethics/ Human Values/Environment Sustainability/ Gender Equity): - Environment Sustainability activities related to Cross Cutting Issues:-

Assignment: (Mention Topic and Type): Solve problems, Sample anaysus

Seminar Topic: (if applicable):-

Sample questions (minimum one question from each unit)

Part A (1 mark)

1. Drenche-Quenche method is used to reduce---------- in Raman spectroscopy(K2-U, CO-2)
2. The lowest energy level at which the molecule vibrates is known as ----------(K2-U, CO-2)
3. In Raman scattering the scattered photons have the frequency shift in the range -------(K2-U, CO-

4. In NQR, the set of nuclear levels are _____in origin. (K2- U, CO-2)
   (a) magnetic (b) electric (c) IR rays (d) micro waves
5. If A is even and Z is odd nuclei, then the nuclear spin I is _____.(K4- An, CO-3)
   (a) zero b) integer c) unity d) infinity

Part B (4 marks)

1. Explain quantum theory of Raman scattering(K2- U, CO-2)
2. Explain sample handling techniques in Infrared spectroscopy(K4-An, CO-2)
3. Examine in detail the Relaxation process. (K4-An, CO-2)
4. Explain the principle of NMR. How does the NMR frequency related to the external magnetic field.(K4- An, CO-3)
5. Discuss the quantum theory of ESR.(K4- An, CO-3)

Part C (8 marks)

1. Explain the rotational Raman spectra of symmetric top molecule. (K2- U, CO-2)
2. Describe the instrumentation of Infrared selection rules for diatomic molecule . (K4-An, CO-2)
3. Illustrate and explain the hyperfine structure of ESR spectrum.(K4-An, CO-2)
4. Describe the principal and working of a NMR spectrometer.(K2- U, CO-1)
5. Explain the principle of NQR and its applications. .(K2- U, CO-1)

Dr. C. NIRMALA LOUIS, M.Sc., Ph.D., PGDCA.
Head & Assistant Professor,
PG & Research Department of Physics.
Holy Cross College (Autonomous),
Nagercoil. Kanyakumari District,
Tamil Nadu. PIN: 629 004.

Dr.C.Nirmala Louis
Head of the Department

Dr. S.J.Jenepha Mary& Dr. V.Shally
Course Instructors

Teaching Plan

Department : Physics
Class : II M.Sc. Physics
Title of the Course: Thermodynamics and Statistical Mechanics
Semester : IV
Course Code: PP2043

No. of hours per week	No. of credits	Total No. of hours	Marks
6	5	90	100

Learning Objectives

1. To provide a phenomenological introduction to thermodynamics through thermodynamics postulates, quantities and relations.
2. To understand the micro and macroscopic properties of the matter through the statistical probability laws and distribution of particles and study the transport properties, different phases of maters, equilibrium and nonequilibrium process.

Course Outcomes

Cos	Upon completion of this course, students will be able to:	PSO addressed	CL
CO - 1	understand the basic concepts related to thermodynamics, microstates and macrostates	**PSO - 4**	**U**
CO - 2	apply principles to find relation between grand canonical and canonical partition functions	**PSO - 1**	**Ap**
CO - 3	solve the Bose-Einstein, Fermi-Dirac and Maxwell-Boltzmann distributions	**PSO - 4**	**C**
CO - 4	analyze the origin of transport and non-equilibrium processes	**PSO - 3**	**An**
CO - 5	understand the concept of heat capacities and phase transitions	**PSO -4**	**U**

Unit	Module	Topics	Teaching hours	Cognitive Level	Pedagogy	Assessment/ Evaluation
I	**Thermodynamics, Microstates and Macrostates**					
	1	Basic postulates of thermodynamics – Phase space and ensembles – Fundamental relations and definition of intensive variables – Intensive variables in the entropic formulation	4	K2 (U)	PPT using GAMMA AI, Descriptive lecture and Group Discussion	Evaluation through: SLIDO Problem solving Descriptive answers Short questions Formative assessment (I CIA)
	2	Equations of state – Euler relation, densities - Gibbs-Duhem relation for entropy - Thermodynamic potentials– Maxwell relations – Thermodynamic relations	4	K3 (Ap)	Illustration, Descriptive lecture, Problem Solving	
	3	Microstates and macrostates – Ideal gas –Microstate and macrostate in classical systems – Microstate and macrostate in quantum systems–	4	K2 (U)	Illustration, Lecture using Chalk and Talk	
	4	Density of states and volume occupied by a quantum state	3	K3 (Ap)	Illustration, Descriptive lecture, Problem Solving	

II	**Microcanonical, Canonical and Grand Canonical Ensembles**					
	1	Microcanonical distribution function – Two level system in microcanonical ensemble – Gibbs paradox and correctformula for entropy	4	K2 (U)	PPT using GAMMA AI, Illustration, Descriptive Lecture	Evaluation through: MENTIMETER Short questions Descriptive answers Problem solving Formative assessment (I&II CIA)
	2	The canonical distribution function – Contact with thermodynamics	4	K3 (Ap)	Lecture, Seminar	
	3	Partition function and free energy of an ideal gas - the grand partition function	5	K3 (Ap)	Descriptive lecture , Problem Solving	
	4	Relation between grand canonical and canonical partition functions – Oneorbital partition function	5	K4 (A)	Descriptive lecture, seminar	

III	**Bose-Einstein, Fermi-Dirac and Maxwell-Boltzmann Distributions**					
	1	Bose-Einstein and Fermi-Dirac distributions – Chemical potential of bosons – Number density of photons and Bose condensation	5	K2 (U)	Illustration, Descriptive lecture	Evaluation through: quiz, Problem Solving,
	2	Thermodynamic quantities – Noninteracting Bose gas and thermodynamic relations - The principle of detailed balance	4	K3 (Ap)	Lecture using Chalk and Talk, Seminar	

	3	Thermodynamic relations for non-interacting Fermi gas – Fermi gas at zero and low temperature – Fermi energy and Fermi momentum	5	K3 (Ap)	Descriptive lecture , Problem Solving	short questions
	4	Maxwell-Boltzmann distribution law for microstates in a classical gas – Physical interpretation of the classical limit – Fluctuations in different ensembles	4	K4 (A)	Group Discussion, Lecture, seminar	Descriptive answers Formative assessment (I CIA)
IV	**Transport and Non-Equilibrium Processes**					
	1	Derivation of Boltzmann transport equation for change of states without and with collisions – Boltzmann equation for quantum statistics – Equilibrium distribution in Boltzmann equation	6	K3 (Ap)	PPT using SLIDESPILOT Illustration, Descriptive lecture.	Evaluation through quiz, Descriptive answers
	2	Transport processes; One speed and one dimension - All speeds and all directions – Conserved properties - Distribution of molecular velocities – Equipartition and Virial theorems	6	K4 (A)	Lecture, Group discussion , Demonstration, Problem Solving	Short questions
	3	Random walk - Brownian motion - Non-equilibrium process; Joule-Thompson process - Free expansion and mixing - Thermal conduction - The heat equation.	6	K4 (A)	Lecture, Seminar using STEVE.AI	Assignment, Formative assessment (II CIA)

V	**Heat Capacities, Ising Model and Phase Transitions**					
	1	Heat capacities of heteronuclear diatomic gas – Heat capacities of homonuclear diatomic gas –Heat capacity of Bose gas	5	K3 (Ap)	PPT Illustration, Descriptive lecture	Evaluation through: quiz, short questions
	2	One-dimensional Ising model and its solution by variational method– Exact solution for one-dimensional Ising model	5	K4 (A)	Descriptive lecture , Problem Solving	Descriptive answers
	3	Phase transitions and criterion for phase transitions – Classification of phase transitions by order and by symmetry	4	K4 (A)	Descriptive lecture, Seminar, Assignment	Problem solving
	4	Phase diagrams for pure systems – Clausius-Clapeyron equation – Gibbs phase rule	4	K4 (A)	Illustration, Descriptive lecture	Formative assessment (II CIA)

PO- Program outcome; LO – Learning outcome; Cognitive Level U – Understand; Ap- Apply; A- Analyze; C-Create

Course Focussing on Employability/ Entrepreneurship/ Skill Development :**Employability**

Activities (Em/ En/SD): **Project**

Course Focussing on Cross Cutting Issues (Professional Ethics/ Human Values/Environment Sustainability/ Gender Equity): -

Activities related to Cross Cutting Issues : -

Assignment :**Homonuclear diatomic gas : Online Assignment**

Seminar Topic: **Maxwell Boltzmann Statistics**

Sample questions (minimum one question from each unit)

Part A

1. The entropy of the composite system is additive over constituent subsystem. State True/False. **(K2-U, CO1)**

2. The ensemble distribution according to Gibb's microcanonical distribution function is called a _____.**(K3- Ap, CO2)**

a) canonical ensemble b) Microcanonical ensemble c) Partition function d) Grand canonical ensemble

3. Chemical potential of boson is _____**(K3 – Ap, CO2)**

4. State Virial theorem.**(K2- U, CO1)**

5. In P-T diagram, the state in which three phases co-exist will be represented on the phase boundary line by a point called _____.**(K2- U, CO5)**

Part B

1. Interpret phase space and ensembles.**(K2- U, CO1)**

2. How is grand canonical and canonical partition functions related?**(K4 – Ap, CO2)**

3. A Fermi Dirac gas has two particles in the ith state whose degeneracy is three. Find out the number of independent ways of selecting the particles in the state. **(K6-C, CO3)**

4. Explain Joule Thompson process. **(K4-A, CO4)**

5. Depict the phase diagram for pure system. **(K2-U, CO-5)**

Part C

1. Derive Maxwell's relations.**(K2 – U, CO1)**

2. Apply the concept of Gibb's Paradox and deduce the equation of state.**(K3 – Ap, CO2)**

3. Derive the number density of photons and discuss Bose condensation.**(K4- A, CO4)**

4. Show that the diffusion process is irreversible for Brownian particles. **(K3 – Ap, CO2)**

5. Derive the exact solution for one dimensional Ising model. **(K4 – A, CO4)**

Dr. C. NIRMALA LOUIS, M.Sc., Ph.D., PGDCA
Head & Assistant Professor,
PG & Research Department of Physics,
Holy Cross College (Autonomous),
Nagercoil, Kanyakumari District,
Tamil Nadu, PIN: 629 004.

Dr. M. PriyaDharshini & Dr.P.Aji Udhaya

Dr. C. Nirmala Louis

Head of the Department **Course Instructor**

TeachingPlan

Department :Physics
Class : II M.Sc Physics
Title of the Course : Elective IV (b) Advanced Nano Physics
Semester :IV
Course Code : PP2045

Hours/Week	Credits	Total Hours	Marks
6	5	90	100

Learning Objectives

1. To understand the theoretical aspects of low dimensional semiconductor systems.
2. To learn the structures, properties, characterization and applications of nanomaterials.

Course Outcome

COs	Upon completion of this course the students will be able to:	PSO addressed	CL
CO- 1	Identify how basic physics can be used to describe the behaviour of electrons in nano-scale materials.	**PSO-1**	**R**
CO- 2	Explain the variation in the electron distribution in nanostructures for different dimensions (Quantum well, Quantum wires & quantum dots)	**PSO-3**	**U**
CO- 3	Analyze magneto electronics and applications of Nanotechnology in various fields.	**PSO-6**	**An**
CO -4	Explain Laser effect in Quantum well, Quantum wires and quantum dots .	**PSO-2**	**U**
CO- 5	Compare the structure and properties of Carbon nanostructures and their applications in the emerging nanotechnology	**PSO-6**	**E**
CO -6	Discuss the fabrication and characterization techniques of nanomaterials	**PSO-2**	**U**
CO -7	Develop key concepts in Single electron transistor, Spintronics and Giant magnetoresistance	**PSO-4**	**C**

Modules

Total contact hours: 90 (Including lectures, assignment and tests)

Unit	Module	Topic	Teaching Hours	Cognitive Level	Pedagogy	Assessment/Evaluation
I	**Introduction to Nano and Types of Nanomaterials:**					
	1	Need and origin of nano, Nano and energetic-Top-down and bottom-up approaches	4	K1(R)	Lecture Discussion with PPT Illustration	Evaluation through: Online quiz (Kahoot) Formative assessment I
	2	Introductory ideas of 1D, 2D and 3D nanostructured materials	4	K2(U)	Lecture discussion	
	3	Quantum well: Quantum well infrared detector- quantum well laser- quantum cascade laser- Quantum wire: Production- VLS growth mechanism- structure and uses-	5	K2(U)	PPT Illustration (nearpod)	
	4	Quantum dots: Description- Exciton confinement in quantum dots – Epitaxially self-assembled quantum-dot- Application: Quantum dot laser	5	K2(U)	Lecture discussion	
II	**Carbon Nanostructures**					
	1	Carbon molecules and carbon bond - C60: Discovery and structure of C60 and its crystal -Superconductivity in C60 -Fullerene	5	K2(U)	PPT and group Discussion	Evaluation through: Online quiz (Slido), Short questions Descriptive answers Formative
	2	Carbon Nano	4	K3(A)	Lecture	

		Tubes (CNT): Types- Fabrication: Electric Arc-discharge method- Laser method			Discussion with PPT Illustration	assessment I
	3	Solar production of carbon nanotubes - Chemical vapour deposition– Electronic structure – Electrical properties	5	K4(An)	PPT Illustration	
	4	Vibrational properties – Mechanical properties – Applications (fuel cells, chemical sensors, catalysts) – Filling of carbon nanotubes - CNT emitters	4	K5(E)	Lecture Discussion with PPT Illustration	
III	**Fabrication of Nanomaterials**					
	1	Synthesis of oxide nanoparticles by sol-gel method - Synthesis of metallic nanoparticles Electrochemical deposition method	4	K1(R)	Lecture discussion	Evaluation Evaluation through: Online quiz, Short questions Descriptive answers Formative assessment I/II
	2	Sonochemical reduction method – Lithography -- Atomic layer deposition - Synthesis of semiconductor nanoparticles	5	K2(U)	Lecture Discussion with PPT Illustration	
	3	Arrested precipitation method- Core shell structures – Bio synthesis of nanoparticles using plants	5	K2(U)	Lecture discussion	

	4	Preparation of magnetic nanomaterials - Super paramagnetism - Coulomb blockade – Single electron transistor	4	K2(U)	PPT and group Discussion	
IV	**Characterization of Nanomaterials**					
	1	Principles, experimental set-up, procedure and utility of X-ray diffraction (XRD), Scanning electron microscopy (SEM)	4	K1(R)	Lecture Discussion with PPT Illustration	Evaluation through: Online quiz, Problem solving short questions Descriptive answers Formative assessment II
	2	Atomic force microscopy (AFM), Scanning tunneling microscope (STM) and scanning probe microscopy (SPM), Fourier transform infrared spectroscopy	5	K2(U)	Lecture discussion	
	3	Quantum cellular Automata- Spintronics - Giant magnetoresistance	5	K3(An)	PPT Illustration	
	4	Quantum Hall effect - Quantum spin Hall effect - Fractional quantum Hall effect	4	K2(U)	Lecture Discussion with PPT Illustration	

V	**Applications**					
	1	Molecular electronics and nanoelectronics - Nanorobots - Biological applications of nanoparticles	5	K2(U)	Short Learning Object(Zoom)	Evaluation through: Online quiz, Short questions Descriptive answers Formative assessment II
	2	Catalysis by gold nanoparticles – Band-gap engineered quantum devices -Nanomechanics	4	K3(A)	Lecture Discussion with PPT Illustration	
	3	Photo electro chemical cells – Photonic crystals – Plasmon waveguides. Sensors – MEMS/NEMS – Solar cells – Displays	4	K4(An)	Lecture discussion	
	4	Optical switches – Graphene electronics – Biosensors – Biomarkers and Bio imaging – Targeted drug delivery	5	K6(C)	PPT Illustration	

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CourseFocussingonEmployability/Entrepreneurship/SkillDevelopment:**Employability**

Activities(Em/En/SD):**Project**

Course Focussing onCross Cutting Issues(Professional Ethics/ Human Values/EnvironmentSustainability/Gender Equity):-

ActivitiesrelatedtoCross CuttingIssues:Nil

Assignment : (Mention Topic and Type): Applications of nanoparticles in medicine - Google Classroom

Seminar Topic: (if applicable):MEMS/NEMS

Part A (1 mark)

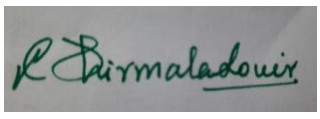
1. Quantum dots possess _____ energy levels. **(K2- U, CO-2)**
   a) discrete b) continuous c) both (a) and (b) d) none of the above
2. Armchair nanotubes are formed when the chiral angle is _____**(K5- E, CO-5)**
3. Semiconductor nanoparticles are commonly synthesized by arrested precipitation. TRUE/FALSE**(K2- U, CO-6)**
4. Give the Debye Scherrer formula.**(K2- U, CO-6)**
5. MEMS stand for _____.**(K4- An, CO-3)**
   a) Micro-electro mechanical system b) Macro-electro mechanical system
   c) Nano-electro mechanical system d) Mini-electro mechanical system

Part B (3 marks)

1. Enumerate the approaches used in nanotechnology for synthesizing nanmomaterials. **(K1- R, CO-1)**
2. Analyze the properties of Fullerene and carbon nanotubes.**(K5-E, CO-5)**
3. Explain the synthesis of metallic nanoparticles by sonochemical method? **(K2- U, CO-6)**
4. Construct and explain the principle and experimental setup of X-ray diffraction method. **(K6- C, CO-7)**
5. Classify the different types of optical switches.**(K4- An, CO-3)**

Part C (7 marks)

1. Describe in detail about Nanoscale in two dimension materials with suitable example. **(K1- R, CO-1)**
2. Evaluate the Electronic structure of Carbon nanotubes. **(K5-E, CO-5)**
3. Interpret the theory of Coulomb blockade and its application in single electron transistor. **(K2-U, CO-6)**
4. Explain the principle and working of Fourier Transform Infrared Spectroscopy. **(K2- U, CO-6)**
5. Correlate the internal and external control of nano robots and explain its functioning.**(K4-An, CO-3)**



Head of the Department

A. Lesly Fathima S. Sebastiammal

Ms. A. Lesly Fathima& Sr. S. Sebastiammal
Course Instructor