Teaching Plan

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

Course	L	Т	Р	S	Credits	Inst. Hours	Total		Marks	
Coue							Hours	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 suc	ecessful 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

tran	isitions	PSO -4	U

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

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
2	Microcanonical ensemble: Isolated systems- Microcanonical distribution - Principle of Equal a Priori Probabilities - Entropy	4	K3 (Ap)	Lecture, Seminar	Descriptive answers Problem
3	Connection between statistics and thermodynamics - Entropy of an ideal gas using the micro canonical ensemble -	5	K3 (Ap)	Descriptive lecture , Problem Solving	Formative assessment (I&II CIA)
4	Entropy of mixing and Gibb's paradox.	5	K4 (A)	Descriptive lecture, seminar	

III	Canon	ical and Grand Canonical Ensemble				
	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
	2	Trajectories and density of states: Canonical and Grand Canonical distribution - Equipartition theorem	4	K3 (Ap)	Lecture using Chalk and Talk, Seminar	Solving,
	3	Quantum Canonical Partition function - Calculation of statistical quantities – Free energy of an ideal gas-	5	K3 (Ap)	Descriptive lecture , Problem Solving	short questions

	4	Thermodynamic functions- Energy and density fluctuations.	4	K4 (A)	Group Discussion, Lecture, seminar	Descriptive answers
						Formative assessment
						(I CIA)
IV	Classic	al 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
	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	Assignment, Formative assessment (II CIA)
V	Real G	as, 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

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 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. 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)

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

Dr. C. Nirmala Louis

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	Р	S	Credits	Inst.	Total Hours		Marks	
						Hours	10015	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 su	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 Schrödinger equation to solve one	K2(U)&					
	dimensional problems and three dimensional problems.	K3 (Ap)					
CO3	apply and analyze various representations, space time	K3 (Ap)					
	symmetries and formulations of time evolution.	& K4 (An)					
CO4	construct and prioritize the approximation methods for various	K4((An)&					
	quantum mechanical problems.	KJ(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	Торіс	TopicTeaching HoursCognitiv level		Pedagogy	Assessment/ Evaluation		
Ι	1.	BASIC	4	K1(R)	Lecture using	Evaluation		
		FORMALISM			Chalk and talk	through: short		
					,Introductory	test Class Test		
		Interpretation of			session, Group			
		the wave function –			Discussion,			
		Postulates of			Mind mapping,	Quiz through		
		Quantum				Quizziz		
	2.	Time dependent	4	K1(R)	Peer tutoring,			
		Schrodinger			Lecture using			
		equation – Time			videos, Problem			
		independent			solving,	Formative		
		Schrodinger			Demonstration,	assessment		
		equation Stationary			PPT, Review	through Hot		
		states – Ehrenfest's				Potatoes		
		theorem						
	3.	Linear vector space	5	K2(U)	Lecture using			
		– Linear operator –			Chalk and talk			
		Eigen functions			,Introductory			
		and Eigen Values –			session, Group			
		Hermitian Operator			Discussion,			
					Mind mapping,			
	4.	Mechanics –	5	K2(U)	Peer tutoring,			
		Simultaneous			Lecture using			
		measurability of			videos, Problem			
		observables –			solving,			
		General			Demonstration,			
		Uncertainty			PP1, Review			
II	1	relation.	4		I a atura unin a	Evoluction		
11	1.	Square – well	4	K2(U)	Challs and talls	Evaluation		
		potential with rigid			Introductory	through: short		
		walls – Squale well			, introductory	test Class Test		
		finite walls			Discussion			
		Square potential			Mind manning			
		barrier			wind mapping			
	2	Alpha emission –	4	K 2(U)	Peer tutoring	Multiple choice		
	2.	Bloch waves in a		$\mathbf{R2}(0)$	Lecture using	questions Quiz		
		periodic potential –			videos. Problem	through		
		Kronig-penny			solving.	Nearpod		
		square – well			Derivation.	L		
		periodic potential			PPT, Review			
	3.	Linear harmonic	5	K3(Ap)	Lecture using			
		oscillator: Operator		× 1/	Chalk and talk			
		method – Particle			,Introductory			

	4.	moving in a spherically symmetric potential System of two interacting particles – Hydrogen atom –	5	K3(Ap)	session, Group Discussion, Mind mapping, Peer tutoring, Lecture using videos, Problem solving,	Formative assessment through Mentimetre
III	1.	GENERAL	4	K2(U)	PPT, Review Lecture using	Evaluation
		FORMALISM Dirac's notation- Equations of motions – Schrodinger representation –			Chalk and talk ,Introductory session, Group Discussion, Mind mapping,	through: short test Class Test
	2.	Heisenberg representation – Interaction representation – Coordinaterepresen tation –	5	K3(Ap)	Peer tutoring, Lecture using videos, Problem solving, Demonstration, PPT, Review	Match the following through Hot Potatoes
	3.	Momentum representati on: 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				
	2	Degenerate energy	4	K4(An)	Peer tutoring,	
		effect in Hydrogen			videos, Problem	
		atom – Ground and			solving,	Multiple choice
		excited state –			Derivation, PPT	questions Quiz
	2	Variation method	~		T a stand and in a	through Slido
	3.	WKB	5	K3(E)	Chalk and talk	
		approximation:			,Introductory	
		The WKB method			session, Group	Formative
		formulae (no			Mind manning	assessment
		derivation)			wind mapping,	through
	4.	WKB quantization	4	K5(E)	Peer tutoring,	Nearpod
		– Application to			Lecture using	
		simple harmonic			videos, Problem	
		oscillator.			solving,	
					Derivation, PPT Review	
V	1.	Eigenvalue	4	K5(E)	Lecture using	Evaluation
		spectrum of		()	Chalk and talk	through: short
		general angular			,Introductory	Class Test
		momentum –			session, Group	
		Ladder operators			Discussion,	
		and their algebra –			Derivation	
		momentum				Multiple choice
		matrices				auestions Ouiz
	2.	Matrix	4	K5(E)	Peer tutoring,	1 (
		representation –			Lecture using	
		Spin angular			videos, Problem	
		momentum: spin-			solving, PPT,	E
		(1/2) systems-				Formative
		angular momenta				through Hot
	3.	Clebsh- Gordan	5	K6(C)	Lecture using	Potatoes
		Coefficients –		- (-)	Chalk and talk	
		Symmetry and anti			,Derivation,	
		– symmetry of			Group	
		wave functions			Discussion,	
					Mind mapping,	
	4.	Construction of	5	K6(C)	Peer tutoring,	
		wave-functions and			Lecture using	
		Pauli's exclusion			videos, Problem	
		principle.			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 $|a\rangle$ and $|b\rangle$ are orthogonal then $\langle a|b\rangle$ (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)

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Head of the Department

S.S. Ahu

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	L	Т	Р	S	Credits	Inst.Hours	Total		Marks	
Code							Hours	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

Onthesu	Onthesuccessful completion of the course, student will be able to:						
CO1	Discuss the transverse character of light waves and different polarization	K1					
	phenomenon						
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	K3,K4					
	and advantages						
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	K5					
	applied magnetic and electric field						

Modules

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

Unit	Module	Торіс	Teaching Hours	Cognitive Level	Pedagogy	Assessment/Evalua tion
Ι	POLARI	ZATIONAND DOUBL	E REFRAC	ΓΙΟΝ		
	1	Classification of	3	K1(R)	Lecture	
		polarization –			Discussion	
		Transverse			with PPT	
		character of light			mustration	
		waves -Polarizer				

			0			
		and analyzer –				
		Malu's law –				
		Production of				
		polarized light –				Evaluation
		Wire grid				through: Online
		whe gild				quiz (Kahoot)
	2	polorizor and the	2	V1/D)	Locturo	
	2	polarizei anu me	5		discussion	Formative
		Polarization by			discussion	assessment I
		reflection –				
		Polarization by				
		double refraction –				
		Polarization by				
		scattering				
	3	The phenomenon	3	K1(R)	PPT	
		of double			Illustration	
		refraction –			(nearpod)	
		Normal and				
		oblique incidence –				
		Interference of				
		polarized light				
	4	Quarter and half	3	K1(R)	Lecture	
		wave plates –			discussion	
		Analysis of				
		polarized light –				
		Optical activity				
II	LASER	S				
	1	Basic principles –	3		PPT and	
		Spontaneous and		K1(R)	group	Evaluation
		stimulated			Discussion	through: Online
		emissions –				quiz (Slido),
		Components of the				Short questions
		laser – Resonator				Descriptive
		and lasing action				answers
	2	Types of lasers and	3	K2(U)	Lecture	Formative
		its applications –			Discussion	assessment I
		Solid state lasers –			with PPT	
		Ruby laser			Illustration	
			-			4
	3	Nd:YAG laser –	3	K2(U)		
		gas lasers			Illustration	
		– He-Ne laser –				
		CO2 laser				
	4	Chemical lasers –	3	K2(U)	Lecture	
		HCl laser –			Discussion	

		Semiconductor			with PPT				
		laser			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		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	l			
IV	NON-L	INEAROPTICS							
	1	Basic principles – Harmonic generation	3	K1(R)	Lecture Discussi on with PPT Illustrati on	Evaluation through: Online quiz, Problem solving short questions Descriptive answers Formative			
	2	Second harmonic generation –	3	K2(U)	Lecture discussi on	assessment II			

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

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
- 4. Harmonic generation involves the production of frequency components that are integermultiples of the original frequency.

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TRUE/FALSE(K4- An, CO-4)
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- 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)

Rairmaladouir

Head of the Department

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

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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	Ар
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	Secti on	Topics	Lecture hours	Cognitiv e level	Pedagogy	Assesment/ Evaluation
Ι		X-RAYS AND TRANSDU	CERS		I	
	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

	3	Tube – X-Ray Tube Design – Thermistors photo electric transducers – Photo voltaic cells – photo emissive cells Photoconductive cells– piezoelectric transducer.	3	K1(R) K1(R)	Lecture Discussion using gamma Illustration and AI tool	Evaluation through short test using nearpod
II	1	BLOOD PRESSURE MEA	ASUREM	IENTS	T11 / .' '	
	1	Sphygmomanometer – Measurement of heart rate	3	K2(U)	OLAB	n through: quiz using hotpotatoe
	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	
	1	RADIATION PHYSICS	2		T / 1	
	1	Addition Units – Exposure – Absorbed Dose – Rad to Gray	3	K1(K)	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 PH	YSICS			
	1	Radiological Imaging – Radiography – Filters – Grids	3	K1(R)	Lecture Illustration,	Evaluation through: quiz, using quizzes,slid
	2	Cassette – X-Ray Film – Film processing – Fluoroscopy	3	K3(Ap)	Illustration	Problem
	3	ComputedTomographyScanner–Function	3	K2(U)	Lecture Discussion using gamma	solving Theoretical derivation
	4	Display – Mammography – Ultrasound Imaging	3	K2(U)	Lecture ,Illustration using AI tool	Formative
V		RADIATION PROTECTION	ON			
	1	Principles of Radiation Protection	3	K2(U)	Lecture Illustration,	Evaluation through:
	2	Protective Materials	3	K4(An)	Illustration	quiz, Montimator
	3	RadiationEffects-Somatic-GeneticStochasticandDeterministic Effect	3	K3(Ap)	Lecture Discussion using gamma	Problem solving Formative Assessment
	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)
- 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)

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Jenipha Mary Rhylldhaye.

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	Т	Р	Credits	Inst.	Total		Marks	
					Hours	Hours	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 su	accessful 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	Торіс	Teaching Hours	Cognitive level	Pedagogy	Assessment/Evaluation		
Ι	I HEAT TRANSFER AND RADIATION ANALYSIS:							
	1	Conduction:	4	K1(R)	Lecture	Evaluation through:		
		Conduction in			discussion	Online quiz,		
		extended surface			with	Class test,		
		- Radiation and			illustration	Formative		
		Convection –				assessment I		

		Forced				
		convection and				
		wind loss				
	2	Solar radiation at	4	K2(U)	РРТ	
	-	the Earth's	-	112(0)	Lecture	
		surface Basic			discussion	
		Forth sin angles			with	
		Latur sin angles			illustration	
					musuation,	
					alla group	
	2		4		discussion	
	3	Determination of	4	K2(U)	Lecture	
		solar time –			discussion	
		Solar energy			with	
		measuring			illustration	
		instruments and				
		its				
	~ ~ ~ ~ ~	classifications.				
II	SOLAR (COLLECTORS:				
	1	Introduction –	4		Lecture	Evaluation
		Physical		K2(U)	discussion	through: Online
		Principle of the			with	quiz,
		conversion of			illustration	Short questions,
		solar radiation				Descriptive
		into heat				answers,
	2	Description of	4	K1(R)	Discussion	Formative
		flat plate			And	assessment I
		collectors-			Illustration	
		General			with PPT	
		characteristics of				
		flat plate				
		collectors				
	3	Selection of	4	K2(U)	Lecture	
		materials of flat			Illustration,	
		plate collectors			group	
		1			discussion	
III	SOLAR	HEATERS:				
	1	Introduction –	4		PPT.	Evaluation
		Types of solar		K2(U)	Lecture	through: Online
		water heaters –		(-)	discussion	quiz.
		Collectors and			with	Short questions.
		storage tanks			illustration	Descriptive
	2	Combined heating	4	K3(An)	Lecture	answers.
		and cooling	•	····(··p)	discussion	Formative
		systems - Solar			with	assessment I/II
		pond:			illustration	
		Introduction			mastration	
	3	Principle of	4	K3(Ap)	PPT,	
		operation of solar			Lecture	
		pond – Types of			discussion	

		solar ponds –			with	
		Application of			illustration	
		solar ponds				
IV	SOLAR	ENERGY CONVI	ERSION :			
	1	Photovoltaic principle: Semiconductor	4	K5(E)	Discussion And	Evaluation through: Online
		junction, Basic Photovoltaic system for power generation			with PPT	quiz, short questions, Descriptive answers,
	2	Advantages and disadvantages of photovoltaic solar energy conversion	4	K3(Ap)	Lecture discussion with illustration	assessment II
	3	Types of solar cells – Applications of solar photovoltaic system	4	K3(Ap)	Discussion And Illustration with PPT	
V	NANON	IATERIALS IN FU	EL CELL A	PPLICATIO	NS:	
	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
	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	answers, Formative assessment II
	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
- 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)
 - 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)
- 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)

Rairmaladouir

Head of the Department

S. Sebartianmal

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	Hours/Week Credits		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	Е
СО-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	С
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)

			Lectur	Learning	Pedagogy	Assessment/Evaluat
Uni	Sectio		e	outcomes		ion
t	n	Topics	Hours			
Ι	Nuclear	r Forces				
	1	Characteristics	4	Define the	PPT using	
		of Nuclear		basis of	Gamma	Evaluation:
		Forces –		nuclear	with AI,	Slido, Class test, oral
		Exchange		forces and	Lecture	question
		forces and		stability of	discussion	Assignment

		tensor forces –		nucleus		Ι
		charge				
		independence				Formative
	2	Spin	4	Apply	Derivation	assessment I
		dependence of		various	and group	
		Nuclear Forces		Nuclear	discussion	
		- Meson theory		Forces		
		of nuclear		relations		
		forces- Ground				
		state of				
		deuteron				
	3	Nucleon-	5	solution of	Derivation,	
		nucleon		Nuclear	problem	
		scattering		magnetic	solving	
		singlet and		moment	and group	
		triplet			discussion	
		parameters –				
		Nucleon-				
		Nucleon				
		scattering:				
		Cross-section,				
		Differential				
		Cross-section,				
		Scattering				
		Cross-sections				
	4	Magnetic	5	Apply	PPT using	
		moment-		Nuclear	Gamma	
		Quadrupole		forces in	with AI,	
		moment –S and		different	Derivation	
		D state		models	and group	
		admixtures -			discussion	
		Effective range				
		theory of n-p				
		scattering at				
тт	NT II.	low energies.				
11	Nuclear	r Models	_	0.1	DDT '	1
	1	Binding energy	5	Solve	Commo with	Evolution
		Waizaakar'a		Radioactive		Evaluation:
		formula mass		parabolo	AI	oral question
		normula – Illass		parabola	discussion	Assignment
	2	Liquid drop	5	Define and	Derivation	Assignment
	4	model - Rohr -		derive	and group	I/II
		Wheeler theory		Radioactive	discussion	1/11
		of fission-		decay	nrohlem	Formative
		Activation		accuj	solving	assessment I
		Activation			solving	assessment I

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

		Wigner		Fission bomb	Gamma	
		dispersion			with AI	
		formula) –				
		Scattering				
		matrix				
	4	Reciprocity	5	Define derive	Derivation	
	•	theorem – Breit	C	and apply	and group	
		-Wigner one		Absorption	discussion	
		level formula _		cross section	PPT using	
		Resonance		at high energy	Gamma	
		scattering		Hydrogen	with AI	
		Absorption cross		homb	with AI	
		Absorption cross		UOIIIU		
		section at high				
TX 7	D	energy.				
IV	Radioa	ctive Decays		D'		
	I	Alpha decay -	4	Discuss	Derivation	Evaluation
		Beta decay –		different types	discussion	Slido, Class test,
		Energy release		of Radiation		oral question
		in beta decay –		Decays		Assignment
		Fermi theory of				II/III
		beta decay				
	2	Shape of the	5	Define and	Derivation	Formative
		beta spectrum –		derive beta	and group	assessment II
		decay rate		spectrum	discussion,	
		Fermi-Curie plot			PPT using	
		– Fermi & G.T			Gamma	
		Selection rules			with AI	
	3	Comparatives	4	Define and	Derivation	
		half - lives and		Derive	and group	
		forbidden		different types	discussion	
		decays- Gamma		of Gamma		
		decay -		decay		
		Multipole		2		
		radiation				
	4	Angular	5	Define,	PPT using	
		momentum and		derive and	Gamma	
		parity selection		apply Internal	with AI	
		rules – Internal		conversion –	.Derivation	
		conversion –		Nuclear	and group	
		Nuclear		isomerism	discussion	
		isomerism.				
V	Elemen	tary Particle Phys	ics	1	1	
	1	Classification of	5	Analvse	Discussion	Evaluation:
		elementary	-	Fundamental	PPT using	Slido, Class test.
		particles - Types		Interactions	Gamma	oral question
		of interaction			with AI	Assignment

	between elementary				III
	particles –				Formative
	Hadrons and				assessment II
	leptons				
2	Symmetry and conservation laws – Strangeness and associate production -	4	Analyse conservation laws of elementary particles	Derivation and group discussion, PPT using Gamma with AI	
	CPT theorem – classification of hadrons				
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**)

Wirmala down Dr. C. NIRMALA LOUIS, M.Sc., Ph.D., PODCA C. NIRMALA LOUIS, M.Sc. IN.D. POOC Nead & Assistant Professor,
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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	С

Modules

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

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

		Rotor (Diatomic		Semiconduc	theoretical	through:
		Molecules)		tor	derivation	Slido
	2	Expression for the	4	Derive the	Derivation and	Online quiz,
		Rotational Constant		expression	group discussion,	Problem
		- Intensity of		for the		solving
		Spectral Lines		Rotational		short
				Constant		questions
	3	Effect of Isotopic	4	Explain the	PPT using Gamma	Descriptive
		Substitution -		effect of	with AI,	answers
		Molecular		Isotopic	Illustration,	T
		Parameters (Bond		substitution	derivation	Formative
		Length, Bond Angle		of	and group	assessment
		, Dipole Moment		molecules	discussion	1
		from Rotation		and derive		
		Spectra)		the		
				Notecular		
				(Bond		
				Length		
				Bond Angle		
				from		
				Rotation		
				Spectra)		
	4	Techniques and	3	Explain the	Derivation and	
		Instrumentation		instrumentat	group discussion	
				ion		
				techniques		
				of		
				microwave		
				spectromete		
				r		
II	Infrared	Spectroscopy				[
	1	Vibrational energy	4	Derive the	PPT using Gamma	
		of a diatomic		vibration	AI, Derivation	Evaluation
		molecule- infrared		energy of a	discussion	through:
		Vibrating distance				Slido Online quiz
		viorating diatonne		molecule		Droblem
		spectrophotometer				solving
	2	Distomic vibrating	4	Derive	PPT using Gamma	short
	4	rotator- Vibrations	-	equation for	with AI Derivation	questions
		of polyatomic		diatomic	and group	Descriptive
		molecules-Fermi		vibrating	discussion problem	answers
		resonance		rotator and	solving	Formative
		lobomunee		vibrations	sorting	assessment
				of		Ι

				polyatomic		
				molecules		
	3	Rotation vibration	3	Explain the	PPT using Gamma	3
	e	spectra of	e	normal	with AI	~
		polyatomic		modes of	.Illustration.	
		molecules-Normal		vibration in	Derivation and	
		modes of vibration		crystal	group discussion	
		in crystal		Interpret	problem solving	
		Interpretation of		the	proceedings	
		vibrational spectra-		vibration		
		Group frequencies -		spectra and		
		r		Group		
				frequencies		
	4	Instrumentation-	4	Explain the	Derivation and	
		Sample handling		Instrumenta	group discussion	
		techniques-Fourier		tion of IR	problem solving	
		Transform Infrared		spectrophot		
		spectroscopy-		ometer		
		Applications		Discuss its		
		11		applications		
III	Raman S	Spectroscopy				
	1	Introduction-Theory	4	Devive the	PPT using	Evaluation
		Of Raman		theories of	Gamma with AI	through: Slido
		Scattering-		Raman	,Derivation	Online quiz,
		Rotational Raman		spectromete	discussion	Problem
		Spectra-Vibrational		r		solving short
		Raman Spectra-				questions
		Mutual Exclusion				Descriptive
		Principle				answers
	2	Raman	3	Explain the	PPT using	Formative
		Spectrometer-		Raman	Gamma with AI	assessment I/II
		Sample Handling		Spectromete	,Illustration,	
		Techniques-		r and	Theoretical	
		Polarization Of		discuss its	formulation	
		Raman Scattered		sample		
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	levels – Transition		interaction		solving short
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	Excitation and				Descriptive
	Detection				answers
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	Mossbauer effect -		Field and its		
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	and absorption		ion		
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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)
- 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)

Dirmala domi

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 Nagercoil, Kanyakumari District, Tamil Nadu, PIN: 629 004.

Dr.C.Nirmala Louis

Head of the Department

Genepha Mary , And

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	CL
		addressed	
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	Ар
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	Cognitive Level	Pedagogy	Assessment/		
			hours			Evaluation		
Ι	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		K2 (U)	PPT using GAMMA AI, Descriptive lecture and Group Discussion	Evaluation through: SLIDO Problem		
	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	solving		
	3	Microstates and macrostates Ideal gas –Microstate an macrostate in classical systems Microstate and macrostate i quantum systems–	- 4 d n	K2 (U)	Illustration, Lecture using Chalk and Talk	Descriptive answers		
	4	Density of states and volum occupied by a quantum state	e 3	K3 (Ap)	Illustration, Descriptive lecture, Problem Solving	Short questions		
						Formative assessment		
						(I CIA)		

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
2	The canonical distribution function – Contact with thermodynamics	4	K3 (Ap)	Lecture, Seminar	Descriptive answers Problem
3	Partition function and free energy of an ideal gas - the grand partition function	5	K3 (Ap)	Descriptive lecture , Problem Solving	Formative assessment (I&II CIA)
4	Relation between grand canonical and canonical partition functions – Oneorbital partition function	5	K4 (A)	Descriptive lecture, seminar	

III	Bose-E	instein, Fermi-Dirac and Maxwell-B				
	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
	2	Thermodynamic quantities – Noninteracting Bose gas and thermodynamic relations - The principle of detailed balance	4	K3 (Ap)	Lecture using Chalk and Talk, Seminar	Solving,

	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	Transp	oort 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 C	apacities, Ising Model and Phase Tra	ansitions			
	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)

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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

Unit	Module	Торіс	Teaching Hours	Cognitive	Pedagogy	Assessment/Evaluation
I	Introdu	 Iction to Nano and Ty	vpes of Nan	Level omaterials:	0.00	
	1	Need and origin of	4	K1(R)	Lecture	
	1	nano Nano and		i i i i i i i i i i i i i i i i i i i	Discussion	
		energetic-Top-			with PPT	
		down and bottom-			Illustration	
		up approaches				
	2	Introductory ideas	4	K2(U)	Lecture	
		of 1D, 2D and 3D			discussion	
		nanostructured				
		materials				Evaluation
	3	Quantum well:	5	K2(U)	PPT	through: Online
		Quantum well			Illustration	quiz (Kahoot)
		infrared detector-			(nearpod)	
		quantum well				Formative
		laser- quantum				assessment I
		cascade laser-				
		Quantum wire:				
		Production- VLS				
		growth				
		mechanism-				
		structure and uses-				-
	4	Quantum dots:	5	K2(U)	Lecture	
		Description-			discussion	
		Exciton				
		confinement in				
		quantum dots –				
		Epitaxially self-				
		assembled				
		quantum-dot-				
		Application:				
		Quantum dot laser				
11		Nanostructures	~	ſ		1
	1	Carbon molecules	5		PPT and	
		and carbon bond -		K2(U)	group	
		C60: Discovery			Discussion	through: Online
		and structure of				quiz (Slido),
		CoU and its crystal				Snort questions
		-Superconductivity				Descriptive
	2	Carbor News	4		Lecture	Tormative
	2	Carbon Nano	4	K5(A)	Lecture	Formative

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

1		Tubes (CNT):			Discussion	assessment I
		Types- Fabrication			with PPT	
		Flectric Δr_{c}			Illustration	
		discharge method-			musuation	
		Logar mathad				
	2		<i>г</i>		DDT	
	3	Solar production of	5	K4(An)	PPI	
		carbon nanotubes -			Illustration	
		Chemical vapour				
		deposition-				
		Electronic structure				
		– Electrical				
		properties				
	4	Vibrational	4	K5(E)	Lecture	
		properties –			Discussion	
		Mechanical			with PPT	
		properties –			Illustration	
		Applications (fuel				
		cells, chemical				
		sensors catalysts)				
		– Filling of carbon				
		nanotubes - CNT				
		amittar				
TTT	Fabrica	tion of Nonomotorial				
111			15	$\mathbf{V}_{1}(\mathbf{D})$	Tastan	E1
	1	Synthesis of oxide	4	KI(K)	Lecture	Evaluation
		nanoparticles by			discussion	Evaluation
		sol-gel method -				through: Online
		Synthesis of				quiz,
		metallic				Short questions
						1
		nanoparticles				Descriptive
		nanoparticles Electrochemical				Descriptive answers
		nanoparticles Electrochemical deposition method				Descriptive answers Formative
	2	nanoparticles Electrochemical deposition method Sonochemical	5	K2(U)	Lecture	Descriptive answers Formative assessment I/II
	2	nanoparticles Electrochemical deposition method Sonochemical reduction method –	5	K2(U)	Lecture Discussion	Descriptive answers Formative assessment I/II
	2	nanoparticles Electrochemical deposition method Sonochemical reduction method – Lithography	5	K2(U)	Lecture Discussion with PPT	Descriptive answers Formative assessment I/II
	2	nanoparticles Electrochemical deposition method Sonochemical reduction method – Lithography Atomic layer	5	K2(U)	Lecture Discussion with PPT Illustration	Descriptive answers Formative assessment I/II
	2	nanoparticles Electrochemical deposition method Sonochemical reduction method – Lithography Atomic layer deposition -	5	K2(U)	Lecture Discussion with PPT Illustration	Descriptive answers Formative assessment I/II
	2	nanoparticles Electrochemical deposition method Sonochemical reduction method – Lithography Atomic layer deposition - Synthesis of	5	K2(U)	Lecture Discussion with PPT Illustration	Descriptive answers Formative assessment I/II
	2	nanoparticles Electrochemical deposition method Sonochemical reduction method – Lithography Atomic layer deposition - Synthesis of semiconductor	5	K2(U)	Lecture Discussion with PPT Illustration	Descriptive answers Formative assessment I/II
	2	nanoparticles Electrochemical deposition method Sonochemical reduction method – Lithography Atomic layer deposition - Synthesis of semiconductor nanoparticles	5	K2(U)	Lecture Discussion with PPT Illustration	Descriptive answers Formative assessment I/II
	2	nanoparticles Electrochemical deposition method Sonochemical reduction method – Lithography Atomic layer deposition - Synthesis of semiconductor nanoparticles	5	K2(U)	Lecture Discussion with PPT Illustration	Descriptive answers Formative assessment I/II
	2	nanoparticles Electrochemical deposition method Sonochemical reduction method – Lithography Atomic layer deposition - Synthesis of semiconductor nanoparticles Arrested pracipitation	5	K2(U) K2(U)	Lecture Discussion with PPT Illustration	Descriptive answers Formative assessment I/II
	2	nanoparticles Electrochemical deposition method Sonochemical reduction method – Lithography Atomic layer deposition - Synthesis of semiconductor nanoparticles Arrested precipitation method. Corrested	5	K2(U) K2(U)	Lecture Discussion with PPT Illustration Lecture discussion	Descriptive answers Formative assessment I/II
	2 3	nanoparticles Electrochemical deposition method Sonochemical reduction method – Lithography Atomic layer deposition - Synthesis of semiconductor nanoparticles Arrested precipitation method- Core shell	5	K2(U) K2(U)	Lecture Discussion with PPT Illustration Lecture discussion	Descriptive answers Formative assessment I/II
	2	nanoparticles Electrochemical deposition method Sonochemical reduction method – Lithography Atomic layer deposition - Synthesis of semiconductor nanoparticles Arrested precipitation method- Core shell structures – Bio	5	K2(U) K2(U)	Lecture Discussion with PPT Illustration Lecture discussion	Descriptive answers Formative assessment I/II
	2 3	nanoparticles Electrochemical deposition method Sonochemical reduction method – Lithography Atomic layer deposition - Synthesis of semiconductor nanoparticles Arrested precipitation method- Core shell structures – Bio synthesis of	5	K2(U) K2(U)	Lecture Discussion with PPT Illustration Lecture discussion	Descriptive answers Formative assessment I/II
	2 3	nanoparticles Electrochemical deposition method Sonochemical reduction method – Lithography Atomic layer deposition - Synthesis of semiconductor nanoparticles Arrested precipitation method- Core shell structures – Bio synthesis of nanoparticles using	5	K2(U) K2(U)	Lecture Discussion with PPT Illustration Lecture discussion	Descriptive answers Formative assessment I/II

	4	Preparation of	4	K2(U)	PPT and	
		magnetic			group	
		nanomaterials -			Discussion	
		Super				
		paramagnetism -				
		Coulomb blockade	e			
		– Single electron				
		transistor				
IV	Charac	terization of Nanor	naterials			
	1	Principles.	4	K1(R)	Lecture	Evaluation through:
		experimental set-			Discussio	Online quiz.
		up, procedure			n with	Problem solving
		and utility of X-			PPT	short questions
		ray diffraction			Illustratio	Descriptive
		(XRD)			n	answers
		Scanning				Formative
		electron				assessment II
		microscopy				
		(SEM)				
	2	Atomic force	5	K2(U)	Lecture	
	-	microscopy	C	(0)	discussion	
		(AFM)				
		Scanning				
		tunneling				
		microscope				
		(STM) and				
		scanning probe				
		microscopy				
		(SPM) Fourier				
		transform				
		infrared				
		spectroscopy				
	3	Quantum	5	$K3(\Delta n)$	ррт	
	5	cellular	5		Illustratio	
		Automoto			n	
		Spintropics			11	
		Cient				
		magnatoragistana				
		magnetoresistanc				
	4	Cuentum Hall	4		Lastura	
	4	Qualituiii Hall	4	N 2(U)	Diagnasia	
		erieci - Quantum			Discussio	
		spin Hall effect -			n with	
		Fractional				
		quantum Hall			Illustratio	
		effect			n	

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

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):**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**)

Rairmaladouir

Head of the Department

A. Leely Lathima S. Sebartianmal

Ms. A. Lesly Fathima& Sr. S. Sebastianmal **Course Instructor**