NEHRU MEMORIAL COLLEGE [AUTONOMOUS]

PUTHANAMPATTI – 621 007.

M.Sc., PHYSICS

SYLLABUS

UNDER CHOICE BASED CREDIT SYSTEM [CBCS]

[FOR THE CANDIDATES ADMITTED FROM THE YEAR 2019-2020 ONWARDS]

2019

M.Sc. Physics

SEM	Course Code	Title of Course	Inst. Hours/ Week	Credits	Int.	Ext.	Total
I	19PP101	CC-I Mathematical Physics – I	6	5	25	75	100
	19PP102	CC-II Classical Dynamics and Special Relativity	6	5	25	75	100
	19PP103	CC-III Electronics and Instrumentation	6	5	25	75	100
	19PP104	OEC- PIC Microcontroller and Its Applications	6	5	25	75	100
	19PP205L	CC-IV Practical –I General Physics and Electronics					
	19PP206L	CC-V Practical –II Microcontroller Programming Lab		--	--	--	--
II		CC-IV Practical –I General Physics and Electronics	3	4	40	60	100
		CC-V Practical –II Microcontroller Programming Lab	3	4	40	60	100
	19PP207 19PP208	CC- VI Mathematical Physics – II	6	5	25	75	100
	19PP209	CC-VII Statistical Mechanics	6	5	25	75	100
		CC-VIII Quantum Mechanics	6	5	25	75	100
	19PP210	CC-IX Computational Methods	6	4	25	75	100
III	19PP311	CC-X Electromagnetic Theory	6	5	25	75	100
	19PP312	CC-XI Solid State Physics	6	5	25	75	100
	19PP313L	CC-XII Practical – III Advanced General Physics and Instrumentation	3	--	--	--	--
	19PP314L	CC-XIII Practical – IV Digital Electronics and Computer Programming	3	-	-	-	-
	19PP315	EC-I	6	4	25	75	100
	19PP316	EC-II	6	4	25	75	100
IV	19PP313L	CC-XII Practical – III Advanced General Physics and Instrumentation	3	4	40	60	100
	19PP314L	CC-XIII Practical – IV Digital Electronics and Computer Programming	3	4	40	60	100
	19PP417	CC- XIV Nuclear and Particle Physics	6	4	25	75	100
	19PP418	EC-III	6	4	25	75	100
	19PP419	EC- IV	6	4	25	75	100
	19PP420	PW-Project Work*	6	5			100
		Total	120	90			2000

Elective Courses: EC - I Atomic and Molecular Physics
EC - II Crystal Growth and Thin films
EC - III Electronic Communication Systems
EC - IV Nano Science

PROGRAM OUTCOME(PO)

PO1	**CORE KNOWLEDGE**: Graduate has substantial knowledge in physics, knowledge in mathematics ,principles and applications of the core discipline
PO2	**RESOURCES**: graduate are cultivate the new technologies like library, e-content, ICT tolls
PO3	**life long learning**: **graduates are** engage in lifelong learning process by exploring their knowledge independently.
PO4	**PROJECT**: **graduates are** identify research problems, design experiments/demo/project, use appropriate methodologies, analyse and interpret data and provide Solutions.
PO5	**PROBLEM SOLVING**: **GRADUATES ARE** Identify and critically analyse pertinent problems in the relevant discipline using appropriate tools and techniques
PO6	**COMMUNICATION** : Graduates must to have the ability of effectively communicating the findings
PO7	**Environment**
PO7	**Individual and team work**: GARDUATES ARE Exhibit the potential to effectively accomplish tasks independently in multidisciplinary FIELDS
PO8	**Ethics**: Commitment to professional ethics and responsibilities

PROGRAM SPECIFIC OUTCOME (PS0)

PSO1	Understand principles of physics for the scientific phenomena in classical domain.
PSO2	EPOSURE TO THE Research – Acquire recent knowledge towards research
PSO3	Students will be skilled in problems solving, critical thinking, and analytical reasoning as applied to scientific problems.
PSO4	Students will be able to explain how the physics concepts are helpful for addressing social, economic, and environmental problems
PSO5	Students are exposure in various specializations of Physics
PSO6	Entrepreneurship and Employability
PSO7	Adopt new technology

SEMESTER	I	CC- I MATHEMATICAL PHYSICS-I	HOURS	6
COURSE CODE	19PP101		CREDIT	5

Objectives

- **To provide students the ability to hone the mathematical skills necessary to approach problems in advanced physics courses.**
- **To introduce the concepts of Vector Analysis and Vector Space.**
- **To learn the concepts of Fourier Serious and Laplace Transform.**
- **To learn the concepts of first and second order Differential Equations.**
- **To learn the concepts of Special Function and Green Function.**

UNIT – I VECTOR ANALYSIS

Scalar and Vector Fields – Gradient, Divergence and Curl – Rectangular, Cylindrical and Spherical Polar Co-ordinates Systems – Line, Surface and Volume Integrals – Stokes Theorem – Gauss Divergence Theorem – Green's Theorem.

UNIT – II FOURIER SERIES AND LAPLACE TRANSFORM

Fourier series of periodic functions in different possible periods – Fourier Cosine and Sine Series. Laplace Transform: Properties – Convolution Theorem – Inverse Laplace Transform – Evaluation of Second Order Linear Ordinary Differential Equation.

UNIT – III LINEAR ORDINARY DIFFERENTIAL EQUATIONS:

Linear first & second order differential equations with constants coefficients: Elementary Methods – Linear second order differential equations with variable coefficients: Frobenius method, Method of Variation of Parameters.

UNIT - IV SPECIAL FUNCTIONS

Gamma and Beta functions – Legendre, Laguerre, Bessel and Hermite differential equations: Series Solutions, Generating function, Rodrigue formula, Recurrence Relations and Orthogonality Relations.

UNIT - V GREEN FUNCTION AND PROBABILITY

Delta functions - Symmetry property of Green function – Methods of Evaluations. Probability- Addition-Multiplication theorems- Baye's theorem-Normal distribution-Poison distribution and Binomial distribution-Properties.

Course Outcomes (CO):

- **The students will be able to understand and apply the mathematical skills to solve quantitative problems in the study of physics.**
- **Learn about Gradient, Divergence and Curl in orthogonal curvilinear and their typical applications in physics. The students should be able to formulate and express a physical law in terms of vectors, and simplify it by use of coordinate transforms.**
- **Learn different ways of solving second order differential equations and familiarized with singular points and Frobenius method.**
- **Learn the fundamentals and applications of Fourier series, Fourier and Laplace transforms,their inverse transforms etc. Will enable students to apply integral transform to solve mathematical problems of interest in physics.**
- **The students will be able to use Fourier transforms as an aid for analyzing experimental data.**
- **Get introduced to Special functions like Gamma function, Beta function, Bessel functions and their recurrence relations.**
- **To become familiar with the method of Green's function to solve linear differential equations with inhomogeneous term.**

Books for Study

1. Satya Prakash, "Mathematical Physics", Sultan Chand and Sons, New Delhi (2008), (Unit I,III, IV and V)
2. P.K.Chattopadhyay, Mathematical Physics, New Age International Pvt., Ltd., New Delhi, (2004) (Unit II, V)

Books for Reference

1. E. Kreyszig, "Advanced Engineering Mathematics" Wiley (8th Ed), New York (1999)
2. M. D. Greenbreg, "Advanced Engineering Mathematics" Pearson Education P. Ltd, (2nd Ed), Singapore, (1999).
3. B. D. Guptha, "Mathematical Physics", Vikas Publishing House, New Delhi **(2004).**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4	PSO5	PS06	PSO7	MEAN SCORE OF COS
C01	4	4	3	3	3	3	3	4	3	4	3	3	4	3	3	3	3.31
C02	4	4	4	4	4	4	3	4	3	4	4	4	2	4	4	3	3.68
CO3	4	4	4	4	4	3	3	3	3	5	4	4	2	4	3	3	3.56
CO4	4	4	4	4	4	3	3	4	3	4	4	4	2	4	4	3	3.63
CO5	4	4	4	4	4	4	3	4	3	4	4	4	3	4	3	4	3.75
CO6	4	4	4	4	4	4	3	4	3	5	3	3	3	4	3	3	3.62
C07	4	4	4	4	4	3	3	3	3	4	4	4	2	4	3	3	3.5
																	3.60

SEMESTER	I	CC- II CLASSICAL DYNAMICS AND SPECIAL RELATIVITY	HOURS	6
COURSE CODE	19PP102		CREDIT	5

Objectives

- **This course is to understand the development of Newton's, Lagrange's and Hamilton's Formulations.**
- **To learn the tools to study the dynamics of Rigid Bodies and Small Oscillations.**
- **It is also to study the Special theory of Relativity.**

UNIT - I NEWTONS AND LAGRANGE'S FORMULATIONS

Mechanics of a Particle and System of Particles - Conservation Laws - Constraints - Generalized Coordinates - D'Alemberts Principle and Lagrangian Equations - Hamilton's Principle - Lagrange's Equations of Motion – Examples - Conservation Theorems and Symmetry Properties.

UNIT - II CENTRAL FORCE AND SCATTERING PROBLEMS

Reduction to Equivalent one Body Problem - Equations of Motion and First Integrals - Equivalent 1D Problem and Classification of Orbits - Equation of the Orbit and Integral Power law Potentials - Kepler Problem - Inverse Square law of Force - Scattering in Central Force Problem - Virial Theorem.

UNIT - III RIGID BODY DYNAMICS AND SMALL OSCILLATIONS

Rigid Body Dynamics: Euler Angles - Moments and Products of Inertia – Euler's Equations - Symmetrical Top. Small Oscillations: Theory of Small Oscillations - Frequencies of Vibration and Normal Coordinates - Linear Triatomic Molecule.

UNIT - IV HAMILTON'S FORMULATION

Hamilton's Equation from Variational Principle - Principle of Least Action – Applications - Canonical Transformations - Lagrange and Poisson Brackets - Equation of Motion and Conservation Theorems in Poisson Brackets - Hamilton Jacobi Method – Action Angle Variables - Kepler Problem in Action Angle Variables.

UNIT - V SPECIAL THEORY OF RELATIVITY

Postulates of Relativity - Lorentz Transformation- Addition of Velocities - Mass-Energy Relation - Lorentz Transformation in four Dimensional Space - Invariance of Maxwell's Equations under Lorentz Transformation.

Course Outcomes (CO) :

Upon completion of this course students will be able to

- **Solve the simple physical system using all the three formalisms.**
- **Realize the physical concepts involved in rigid body dynamics.**
- **Apply special theory of relativity to elementary particles.**

Books for Study

1. J. C. Upadhyaya, Classical Mechanics, Himalaya Publishing House, New Delhi, 2007.
2. G. Aruldhas, Classical Mechanics, PHI Learning Private Ltd., New Delhi, 2009.

Books for Reference

1. H. Goldstein, Classical Mechanics, 2nd Edition, Narosa Publication House, New Delhi, 1980.
2. N. C. Rana, and P. S. Joag, Classical Mechanics, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2008.
3. R. G. Takwale and P. S. Puranik, Introduction to Classical Mechanics, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2007.

	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO 9	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PS O6	PS O7	**MEAN SCORE OF COS**
CO1	4	4	4	3	4	3	2	3	2	4	4	4	4	3	2	3	**3.32**
CO2	4	4	3	3	5	3	2	3	2	4	4	4	4	3	2	3	**3.32**
CO3	4	4	3	3	3	3	3	3	3	4	4	3	3	3	3	3	**3.25**
																	3.30

SEMESTER	I	CC- III ELECTRONICS AND INSTRUMENTATION	HOURS	6
COURSE CODE	19PP103		CREDIT	5

Objectives

- **Educating the students to understand the basic concepts of electronics**
- **To introduce the basics of digital communication methods.**
- **To introduce the construction and working of nonlinear electronic circuits.**

UNIT - I ANALOG ELECTRONICS

Operational amplifiers: Introduction – differential amplifier – op-amp parameters – feedback – comparators – mathematical operations - analog simulation circuits – oscillators – active filters: low and high pass filter – instrumentation amplifiers – isolation amplifiers - active diode circuits: OTAs – sample & hold circuits. Voltage regulators: principles and operations.

UNIT - II DIGITAL ELECTRONICS

Introduction – overview of logic functions and logic gates – Combinational logic: universality NAND, NOR – Multiplexers – Demultiplexers – Sequential logic: flip flops – JK, T – Shift registers (SIPO) – Ring counter – RAM, DRAM.

UNIT - III OPTOELECTRONICS

LEDs – semiconductor lasers photodiodes – solar cells – photo detectors – optical fibres – communication – optoelectronic modulation and switching devices – optocoupler – optical data storage devices – display devices.

UNIT - IV ELECTRONIC INSTRUMENTATION

Basics of instrumentation system – transducers – types of transducers – strain gauges – RTDs – LVDT – piezoelectric transducers – load cell – flow meters – signal conditioning – data acquisition and conversion – data transmission – digital signal processing.

UNIT - V NONLINEAR CIRCUIT ELEMENTS AND OSCILLATORS

Introduction – Linear and nonlinear circuit elements - Piecewise linear (PWL) circuit elements – Negative Impedance Converter (NIC) - Chua’s diode - Memristive Elements (Flux and Charge control) - autonomous and nonautomous nonlinear circuits - Chua’s oscillator - Lorenz oscillator - Duffing’s oscillator - MLC oscillator - Memristive oscillators (memristive Chua's oscillator, Diode Bridge-Based Memristive oscillator).

Course Outcomes (CO) :

1. Acquire knowledge about analog and digital electronic devices and circuits.
2. Acquire knowledge about sensors and transducers
3. Apply circuit theory to design analog and digital circuits
4. Design op-amp circuits
5. Understand analog and digital signals and conversion techniques
7. Analyse and design combinational and sequential logic circuits
8. Analyse and design nonlinear circuit elements and oscillators

Books for Study

1. V.K. Metha Principles of Electronics,S.Chand and company , New Delhi, 2008.
2. A.P.Malvino. Electronic principles. Tata McGraw-Hill, New Delhi, 2011.

Books for Refrences

1. T.L. Floyd. Electronic devices. Pearson education Inc., New Delhi, 2012.
2. P.Horowitz and Hill. Art of electronics. Cambridge Univ. Press, New Delhi, 2006
3. L.O.Chua, C.A.Desoer and E.S.Kuh. Linear and Nonlinear Circuits. McGraw-Hill, New delhi,1997
4. M.Lakshmanan and K.Murali. Chaos in Nonlinear oscillators. World Scientific, Singapore,1996
5. Bhattacharya. Semiconductor optoelectronic Devices. Pearson Education Inc., New Delhi,2002
6. H.S.Kalsi. Electronic Instrumentation. Tata McGraw-Hill, New Delhi,2004
7. W.D.Cooper. Electronic instrumentation and measurement Techniques. Prentice Hall of India, 1991.
8. G.W.Hanson. Fundamentals of Nano electronics. Pearson Education Inc., New Delhi, 2009.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	MEAN SCORE OF COS
CO1	5	5	4	5	5	4	3	4	3	5	4	4	5	4	5	5	**4.38**
CO2	5	4	5	4	4	4	4	4	3	5	4	4	5	4	4	5	**4.25**
CO3	5	4	4	4	4	4	4	4	3	5	4	4	4	4	4	4	**4.10**
CO4	5	4	4	5	5	4	4	4	3	5	4	4	5	5	5	5	**4.44**
CO5	5	4	5	4	4	5	3	4	3	4	5	4	4	5	4	5	**4.25**
CO6	5	5	4	4	5	4	3	4	3	5	4	4	5	4	4	4	**4.20**
CO7	5	4	4	5	5	4	3	4	3	5	5	4	4	4	4	4	**4.20**
CO8	5	4	5	5	5	4	3	4	3	5	5	4	4	5	4	5	**4.38**
																	4.30

SEMESTER	I	OEC- PIC MICROCONTROLLER AND APPLICATIONS	HOURS	6
COURSE CODE	19PP104		CREDIT	5

Objectives

- **To understand the function of RISC architecture and On-Chip peripherals of PIC microcontroller.**
- **To know how to interface the I/O port with the external peripherals**
- **To learn the I/O and Timer programming**
- **To know the concept serial communication**
- **To learn the concept of interfacing devices**

UNIT-I PIC18 Microcontroller architecture

Overview of the PIC18 Microcontroller- WREG Register – File register – Status register – PIC data format and directives – Program counter – Instructions: Data transfer instructions – Arithmetic instructions – Logical instructions- Rotate instruction – Branch and Call instructions – simple time delay programs

UNIT-II PIC I/O Port programming

I/O Port programming – I/O bit manipulation programming – Interfacing of LEDs and DAC- Interfacing of DC motor and Stepper motor – LCD interfacing – ADC programming– Sensor interfacing

UNIT-III Timer Programming

Programming timers 0 and 1 – Counter Programming - Programming Timers 2 and 3 – squarwave generation using timer 0 – time delay program using timer 0- Program for count the pulses

UNIT-IV Serial Port Programming and Interrupts

Basics of serial communication – serial port programming – programming the PIC 18 to transfer data serially –receive data serially – PIC18 interrupts – External hardware interrupts – serial communication interrupts

UNIT-V CCP, ECCP programming

Standard and enhanced CCP modules – compare mode programming – Capture mode programming –PWM programming – ECCP programming – PWM motor control with CCP- DC motor control with ECCP.

Course Outcomes (CO) :
At the completion of the subject, students should be able to

- **Understand the basic working of PIC Microcontroller**
- **Understand and apply the fundamentals of assembly programming for microcontroller.**
- **Get comprehensive knowledge on the interrupts and timers**
- **Understand the significance of input-output device interface**
- **Able to design a project or product with microcontroller**

Book for Study

1. Muhammad Ali Mazidi, Rolin D. McKinlay, Danny Causey, "PIC Microcontroller and Embedded Systems Using Assembly and C for PIC 18", Pearson, 2012.

Books for References

1. Han-Way Huang, "PIC Microcontroller an Introduction to Software and Hardware Interfacing", Delmar Cengage Learning, New Delhi, 2012.
2. Tim Wilmshurst,"Designing Embedded Systems With PIC Microcontrollers Principles and Applications", Newness An Imprint of Elsevier, Second Edition, 2010.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	MEAN SCORE OF COS
CO1	5	5	4	5	4	5	4	5	4	5	4	4	5	4	5	5	**4.56**
CO2	5	5	5	4	5	4	4	4	4	5	5	5	5	4	4	5	**4.56**
CO3	5	5	5	5	5	5	5	5	4	5	5	4	4	4	5	4	**4.68**
CO4	5	5	5	5	5	4	4	4	4	5	4	4	5	5	5	5	**4.62**
C05	5	5	5	5	5	5	5	5	4	5	5	5	4	4	5	5	**4.81**
																	4.65

SEMESTER	**II**	**CC-V PRACTICAL-I** **GENERAL PHYSICS AND ELECTRONICS LAB**	**HOURS**	**6**
COURSE CODE	**19PP205L**		**CREDIT**	**4**

General experiments (Any 7 experiments)

1. Determination of q, η,L by elliptical fringes method.
2. Determination of q, η,L by Hyperbolic fringes method.
3. Determination of Stefan's Constant.
4. Determination of e/m of an electron by Thomson's method.
5. Determination of e/m of an electron by Magnetron method.
6. Four Probe method-Determination of resistivity.
7. Charge of electron by spectrometer.
8. Laser Grating – Determination of wave length.
9. Determination of Band gap in a semiconductor using P.N Junction diode.
10. Polarizability of liquids using Hollow prism.
11. Measurement of Refractive index in liquids- Abbe's Refractometer.

Electronics experiments (Any 8 experiments)

1. Design of Wien Bridge Oscillator using op-amp.
2. Design of Phase Shift Oscillator using op-amp.
3. Construction and study of active filters using op-amp.
4. Design and study of Instrumentation amplifier using op-amp.
5. Voltage to frequency/frequency to voltage converter using op-amp.
6. V/I and I/V converter circuits using op-amp
7. Solving simultaneous equation using op-amp.
8. Construction of Schmitt trigger using IC 555
9. Construction of Dual regulated power supply.
10. Characteristics of LED's
11. Characteristics of Photo Transistor/Photodiode.
12. Study of FM modulation and demodulation.

SEMESTER	II	CC-V PRACTICAL-II MICROCONTROLLER PROGRAMMING LAB	HOURS	6
COURSE CODE	19PP206L		CREDIT	4

LEARNING OBJECTIVES

- ✓ Understand the logical steps in interfacing and programming of microcontrollers
- ✓ Program and download to PIC microcontrollers using Assembly and C Languages
- ✓ To learn the Integrated Development Environment tools (MPLAB)

Microcontroller Programming (Any 12 Programme)

1. Interfacing of LED (Perform arithmetic and logical operations)
2. Interfacing of LCD
3. Interfacing of Stepper Motor
4. ADC programming
5. Digital to Analog Convertor.
6. Generation of waveform in different frequency
7. Counting of pulses
8. Serial data transmission and reception
9. Voltage measurement
10. Temperature Measurement

11. Speed control of DC motor using PWM
12. Speed control of DC motor using CCP
13. Implementation of chaotic attractor- Lorenz model
14. Generation of pseudo random number generator
15. Key board interfacing

COURSE OUTCOMES

At the completion of the practical, students should be able to:

- ✓ Understand the real concept of interfacing
- ✓ Work on different projects making use of the PIC microcontroller
- ✓ Able to solve some mathematical expressions using microcontroller
- ✓ Design of real time systems

SEMESTER	II	CC- VI MATHEMATICAL PHYSICS-I1	HOURS	6
COURSE CODE	19PP207		CREDIT	5

Objectives

- **To learn the concepts of Complex variables.**
- **To learn the concepts of Group theory and Matrix theory.**
- **To study the concepts of Tensor Analysis and Numerical Methods.**

UNIT – I PARTIAL DIFFERENTIAL EQUATION

Linear Partial Differential Equations - Wave and Laplace Equations (3D) by the method of separation of variables. Modeling: Vibrating String, Wave Equation Solution by Separating Variables. Modeling : Heat Flow from a Body in Space. Steady Two-Dimensional Heat Problems. Modeling : Membrane, Two-Dimensional Wave Equation Rectangular Membrane. Circular Membrane.

UNIT – II COMPLEX ANALYSIS

Functions of complex variables – Cauchy Riemann Conditions – Cauchy integral Theorem – Taylor's and Laurent's Series – Residues and Singularities – Evaluation of Residues – Cauchy Residue theorem – Residue at Infinity – Evaluation of Definite Integrals using Residues.

UNIT – III MATRIX THEORY

Matrix Theory - Review of basic concepts – Rank of matrix – Eigenvalue and Eigenvectors – Trace of a matrix – Cayley Hamilton Theorem – Inverse of a matrix – Reduction of a matrix to diagonal form - Jacobi method (2X2 matrices).

UNIT IV GROUP THEORY

Basic definitions – Sub groups – Cosets – Factor groups – Permutation groups – Cyclic groups – Homomorphism and Isomorphism – Classes of a group – Reducible and Irreducible representations - Symmetry elements and Symmetry operations – Schur's Lemmas - Great Orthogonality Theorem – Character representation – Construction of Character Table for C2v and C3v groups – SU(2) and O(3) groups.

UNIT V TENSOR ANALYSIS

Transformation of Co-ordinate – Summation Convention – Covariant and Contravariant, and Mixed Tensors – Rank of a Tensor – Symmetric and Antisymmetric Tensors – Contraction of a Tensor – Raising and Lowering of Suffixes – Metric Tensor.

Course Outcomes (CO):

- **Know the method of contour integration to evaluate definite integrals of varying complexity.**
- **Learn about special type of matrices that are relevant in physics and then learn about tensors.**
- **Have gained ability to apply group theory to physics problems, which is a pre-requisite for deeper understanding of crystallography, particle physics, quantum mechanics and energy bands in solids.**

Books for Study

1. Satya Prakash, "Mathematical Physics", Sultan Chand and Sons, New Delhi (2008), (Unit II, IV and V)
2. P.K.Chattopadhyay, Mathematical Physics, New Age International Pvt., Ltd., New Delhi, (2004) (Unit I,III)

Books for Reference

1. E. Kreyszig, "Advanced Engineering Mathematics" Wiley (8th Ed), New York (1999)
2. M. D. Greenbreg, "Advanced Engineering Mathematics" Pearson Education P. Ltd,(2nd Ed), Singapore (1999)
3. W. Joshi, "Elements of Group Theory for Physicists" New Age International P. Ltd., (3rd Ed) New Delhi (1995).
4. W. Joshi, "Matrice and Tensors in Phyiscs" New Age International P. Ltd., (3rd Ed) New Delhi (1995).

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4	PSO5	PS06	PSO7	**MEAN SCORE OF COS**
CO1	4	4	3	3	4	3	3	4	3	3	4	3	4	4	3	3	3.43
CO2	3	4	3	3	4	3	3	4	3	3	3	3	4	3	3	3	3.25
CO3	4	3	3	3	4	2	3	4	2	4	3	4	4	3	3	4	3.33
																	3.33

SEMESTER	II	CC- VII STATISTICAL MECHANICS	HOURS	6
COURSE CODE	19PP208		CREDIT	5

Objectives

- **To learn the properties of macroscopic systems using the knowledge of the properties of individual particles.**
- **To understand the nature of thermodynamics and Boltzmann Transport Equation.**
- **To study the Classical, Quantum Statistical Mechanics and its applications.**

UNIT – I REVIEW OF THERMODYNAMICS

Laws of thermodynamics- consequences-Entropy- changes in entropy in reversible processes –Principle of increase of entropy-Thermodynamic functions - Phase transitions- The Clausius Clayperon equation.

UNIT – II KINETIC THEORY

Boltzmann transport equation - Boltzmann's H theorem- Relation between H- function and entropy - Maxwell –Boltzmann distribution- Mean free path- Transport properties.

UNIT – III CLASSICAL STATISTICAL MECHANICS

Macroscopic and microscopic states- Phase space- statistical ensembles- Fluctuation - Liouville's theorem- Statistical density matrix – The phase space and Quantum states – Micro canonical distribution – canonical distribution – Equipartition theorem - Grand canonical distribution.

UNIT – IV QUANTUM STATISTICAL MECHANICS

Introduction – Ideal quantum gases- Maxwell – Boltzmann statistics – Bose Einstein statistics – Photon statistics – Fermi –Dirac statistics – validity of Maxwell – Boltzmann statistics- Sackur- Tetrode equation.

UNIT – V APPLICATIONS OF QUANTUM STATISTICAL MECHANICS

Ideal Bose gas – Bose Einstein Condensation – Black body radiation – The photon gas – liquid Helium – Ideal Fermi gas – Weakly degenerate – Strong degenerate – electron gas.

Course Outcomes (CO):
The students should be able to

- **Explain statistical physics and thermodynamics as logical consequences of the postulates of statistical mechanics.**
- **Apply the principles of statistical mechanics to selected problems.**
- **Grasps the basis of ensemble approach in statistical mechanics to a range of situations.**
- **To learn the fundamental differences between classical and quantum statistics and learn about quantum statistical distribution laws.**
- **Study important examples of ideal Bose systems and Fermi systems.**

Books for Study

1. S.K.Sinha, Introduction to Statistical Mechanics, Narosa Publishing House, New Delhi (2007).

Books for Reference:

1. F. Mandl, Statistical Physics, John Wiley Eastern Ltd., New Delhi. (1983).
2. Singhal, Agarwal, Prakash, Thermodynamics and Statistical Physics,Prakashan, Meerut, (2003).
3. Donald, A.Mc Quarrie, Statistical Mechanics, Vikas Books Private Ltd, New Delhi, (2003).
4. B.K. Agarwal and M.Eisner, Statistical Mechanics, Wiley Eastern Ltd, New Delhi,(1994).

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	MEAN SCORE OF COS
CO1	4	4	4	4	4	5	4	5	4	3	3	3	4	4	3	4	**3.88**
CO2	4	4	4	4	5	3	4	4	4	4	3	2	4	4	3	4	**3.75**
CO3	4	4	4	4	5	4	5	5	4	3	3	3	3	3	4	3	**3.82**
CO4	4	3	4	4	5	5	4	4	4	3	3	3	4	4	3	4	**3.82**
C05	3	4	4	4	5	4	5	5	4	2	3	3	3	3	3	3	**3.63**
																	3.80

SEMESTER	II	CC- VIII QUANTUM MECHANICS	HOURS	6
COURSE CODE	19PP209		CREDIT	5

Objectives

- **The course is to introduce the quantum concepts and theory to simple physical systems.**
- **The real physical systems are also studied using time-independent and time-dependent perturbation theories.**
- **The basic relativistic quantum theory is also introduced.**

UNIT - I THE SCHRODINGER EQUATION AND OPERATOR FORMALISM

Time-dependent Schrodinger equation – Physical meaning and conditions on admissible wave function – Conservation of probability– Expectation value – Ehrenfest′ s theorem. Operator Formulation: Linear operator – Adjoint and self-adjoint operators – Completeness – Physical interpretation of eigenvalues and eigenfunctions – Commutator – Simultaneous eigenfunctions – Heisenberg uncertainty relation.

UNIT - II EXACTLY SOLVABLE BOUND STATE PROBLEMS

Eigenvalue Problems (using Schrodinger Equation): Particle in a box – Rectangular barrier potential – Rigid rotator - Hydrogen atom problem. Eigenvalue Problem (using Abstract Method): Linear Harmonic Oscillator.

UNIT - III PERTURBATION THEORY

Time independent perturbations: Non-degenerate case: First and second order perturbations Degenerate case: Zeeman effect – Stark effect – Variational method.

Time dependent perturbation: First order perturbation – Constant perturbation -Harmonic perturbation – Transition probability – Fermi's Golden rule – Adiabatic approximation – Sudden approximation.

UNIT - IV ANGULAR MOMENTUM

Components of orbital angular momentum **L** – Commutation relations among the components of **L,** $\mathbf{L}^2$ and $\mathbf{L_z}$– Ladder operators $\mathbf{L}\pm$ - Expectation values – Eigenspectra through commutation relations –Pauli spin matrices – Addition of angular momentum.

UNIT - V RELATIVISTIC QUANTUM MECHANICS

Klein-Gordon equation for a free particle – Dirac equation for a free particle – Dirac matrices and their properties – Probability and current densities– Plane wave solutions – Negative energy states – Zitterbewegung: jittery motion of a free particle – Spin of a Dirac particle.

Course Outcomes (CO) :

Upon completion of this course students will be able to

- **Familiarize with the postulates of quantum mechanics**
- **Understand the operator formalism and Solve the Schrodinger equation of simple systems**
- **Apply the theory of perturbation for the transition probability between states under different situations and the interaction with field**
- **Compute to systems of similar nature through solving them with appropriate techniques**
- **Acquire the required skill with necessary intricacies to attempt and compete in the Competitive Examinations**

Books for study

1. L. Schiff, Quantum Mechanics (Tata McGraw Hill, New Delhi, 1968)
2. P. M. Mathews and K. Venkatesan, A Text Book of Quantum Mechanics(Tata McGraw Hill, New Delhi, 1987)

Books for Reference

1. S. Rajasekar and R. Velusamy, Quantum Mechanics: The Fundamentals (CRC Press, BocaRaton, 2015).
2. M. S. Rogalski and B. Palmer, Quantum Mechanics (Gordon & Breach, Amsterdam, 1999)
3. S. Rajasekar and R. Velusamy, Quantum Mechanics: Advanced Topics (CRC Press, BocaRaton, 2015).

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	**MEAN SCORE OF COS**
CO1	4	5	3	3	4	2	2	3	2	3	3	3	1	2	3	2	**2.82**
CO2	4	5	3	3	4	2	3	3	2	4	3	2	1	2	3	2	**2.88**
CO3	4	5	3	3	4	2	3	3	2	3	3	3	1	3	3	4	**3.10**
CO4	5	5	5	5	5	5	3	3	3	3	3	3	1	3	3	3	**3.63**
C05	5	5	5	5	5	4	3	3	3	4	3	4	1	5	3	3	**3.82**
																	3.25

SEMESTER	II	CC- IX COMPUTATIONAL METHODS	HOURS	6
COURSE CODE	19PP210		CREDIT	4

Objectives

- The course consists of two parts.
- The first part aims developing C programming skills towards application to numerical methods.
- The second part concentrates on computational methods for curve fitting of data, interpolation, solutions of system of linear equations and one-dimensional nonlinear equations, numerical integration and differentiation of functions and solutions of ordinary differential equations.

Unit I : Programming in C

Constants and variables - I/O operators and statements -- Header files – Main function – Conditional statements - Switch statement - Void function – Function program – Loops: For, while and do while statements – Arrays - Break, continue and goto statements.

Unit II : Curve Fitting and Interpolation

Curve fitting: Method of least-squares – Normal equations – Straight-line fit – Exponential and power law fits.
Interpolation:
Newton interpolation polynomial – Linear interpolation – Higher-order polynomials – First-order divided differences – Gregory-Newton interpolation polynomials – Truncation error.

Unit III : Solutions of Linear and Nonlinear Equations

Simultaneous linear equations: Gauss elimination method – Jordan′s modification – Inverse of a matrix by Gauss-Jordan method.
Roots of nonlinear equations: Newton-Raphson method – Termination criteria – Pitfalls – Order of convergence.

Unit IV : Numerical Integration and Differentiation

Numerical Integration: Newton-Cotes quadrature formula – Trapezoidal, Simpson's 1/3 and 3/8 rules – Errors in the formulas – Composite Trapezoidal and Simpson's rules – Errors in the formulas.
Numerical Differentiation: First-order derivative – Two and four point formulas – Second-order derivative – Three- and five-point formulas.

Unit V : Numerical Solution of Ordinary Differential Equations

First-order equations: First-order Euler method – Local and global truncation errors – Fourth order Runge-Kutta method – Geometric description of the formula – Error Versus step size.
Second-order equations: Euler methods and Fourth-order Runge-Kutta method

Course Outcomes (CO):
Upon completion of this course students should able to

- **develop C programs for numerically solving problems**
- **derive computational methods and error analysis for various mathematical operations and tasks**
- **make an appropriate curve fit for a given data set;**
- **apply appropriate algorithm for interpolating data and value of a function;**
- **understand and apply methods of constructing solutions of system of linear equations;**
- **familiar with numerical integration and differentiation of functions.**

Books for Study and Reference

1. J.H. Mathews, Numerical Methods for Mathematics, Science and Engineering (Prentice-Hall of India, New Delhi, 1998).
2. P.B. Patil and U.P. Verma, Numerical Computational Methods (Narosa, New Delhi, 2013).
3. E. Balagurusamy, Programming in ANSI C (McGraw Hill, New Delhi, 2017) 7th edition.
4. M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation (New Age International, New Delhi, 1993).
5. https://www.lce.hut.fi/teaching/S-114.1100/lect_9.pdf.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	**MEAN SCORE OF COS**
CO1	4	3	4	4	3	2	4	3	2	4	4	4	3	3	3	4	**3.37**
CO2	5	4	4	5	5	3	4	3	2	4	4	4	3	4	3	3	**3.7**
CO3	4	3	4	5	5	5	4	3	2	4	4	4	3	4	3	4	**3.81**
CO4	4	3	4	4	5	4	4	3	3	5	4	5	3	3	3	4	**3.81**
C05	4	3	4	5	5	4	4	3	3	5	4	4	3	5	3	4	**3.93**
CO6	4	4	4	4	5	4	4	3	3	4	4	4	3	4	3	4	**3.81**
																	3.75

SEMESTER	III	CC- VII ELECTROMAGNETIC THEORY	HOURS	6
COURSE CODE	19PP311		CREDIT	5

Objectives

- **To evaluate fields and forces in Electrodynamics and Magneto dynamics using basic scientific method.**
- **To provide concepts of relativistic electrodynamics and its applications in branches of Physical Sciences.**
- **To understand the Electrostatics, Magnetostatics and Electromagnetism.**
- **To study the concept of Electromagnetic Waves.**
- **To understand the concept of Radiating systems and Wave Guides.**

Unit – I ELECTROSTATICS

Coulombs law - The electric field - Continuous charge distributions - Field lines – flux - Gauss's law - The divegence of E - Application of Gauss's law - The curl of E - Electric potential - Poisson and Laplace equations - The potential of a localized charge distribution - Electrostatic boundary conditions – Laplace equation in one dimension - The classic image problem - The induce surface charge - Force and energy - Multipole expansion - Approximate potentials at large distances.

Unit – II MAGNETOSTATICS

Lorentz force law – Magetic fields - Magnetic forces - Currents – Continuity equation - Biot-Savart law – Steady current - Magnetic field of a steady current - Straight line current - Ampere's law - Application of Ampere's law - Comparison of magnetostatics and electrostatics - Magnetic vector potential - Magetostatic boundary conditions - Multipole expansion of vector potential - Ampere's law in magnetised material - Magnetic susceptibility and permeability.

Unit – III ELECTROMAGNETISM

Electromagnetic induction - Faraday's law of induction - Integral and differential forms - Displace current - Formulation of Maxwell's equations - Maxwell's equations in free space and in linear isotropic media - Boundary conditions on the fields at interfaces - Poynting's Theorem - Poynting vector - Conservation of energy - Scalar and vector potentials - Gauge transformations - Coulomb Gauge and Lorentz Gauge.

Unit – IV ELECTROMAGNETIC WAVES

Electromagnetic waves in vacuum – The wave equation for E and B - Monochromatic plane waves - Energy and momentum in electromagnetic waves - Electromagnteic waves in matter – Propagation in linear media - Reflection and transmission at normal incidence - Reflection and transmission at oblique incidence - Fresnel's equation - Electromagnetic waves in conductors - Reflecting at a conducting surface - The frequency dependence of permittivity.

Unit – V RADIATING SYSTEMS AND WAVE GUIDES

Retarded potential - Jefimneko's equations - Lienard-Wiechert potentials - The fields of moving point charge electric dipole radiation - Magnetic dipole radiation - Radiation from an arbitrary source - Guided waves: wave guides - TE & TM waves in rectangular wave guide - The coaxial transmission line.

Course Outcomes (CO) :

- **To explain and solve advanced problems based on classical electrodynamics using Maxwell's equation.**
- **The students will be able to analyze s radiation systems in which the electric dipole, magnetic dipole or electric quadruple dominate.**
- **The students will have an understanding of the covariant formulation of electrodynamics and the concept of retarded time for charges undergoing acceleration.**
- **Learn various concepts of electromagnetic waves.**

Books for study

1. David J. Griffiths, Introduction to Electrodynamics third edition, Prentice-Hall of India Private Limited, New Delhi (2014).

Books for Reference

1. J. D. Jackson, Classical Electrodynamics, Willey India (P) Ltd., New Delhi (2010)
2. Edward C.Jordan, Keith G.Balmin, Electromagnetic Waves and Radiating Systems, Prentice –Hall of India Ltd, New Delhi (2003)
3. J.R. Reitz, F.J.Milford, R.W.Christy, Foundations of Electromagnetic theory, Norosa Publishing House,New Delhi ,(1998).
4. Walter Greiner, Classical ElectrodynamicsSpringer-Verlag, Newyork,(1998).

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	**MEAN SCORE OF COS**
CO1	4	3	4	4	3	2	4	3	2	4	4	4	3	3	3	4	**3.38**
CO2	5	4	4	5	5	3	4	3	2	4	4	4	3	4	3	3	**3.75**
CO3	4	3	4	5	5	5	4	3	2	4	4	4	3	4	3	4	**3.81**
CO4	4	3	4	4	5	4	4	3	3	5	4	5	3	3	3	4	**3.81**
C05	4	3	4	5	5	4	4	3	3	5	4	4	3	5	3	4	**3.93**
CO6	4	4	4	4	5	4	4	3	3	4	4	4	3	4	3	4	**3.81**
																	3.75

SEMESTER	III	CC- X – SOLID STATE PHYSICS	HOURS	6
COURSE CODE	19PP312		CREDIT	5

Objectives

- **To provide extended knowledge of principles and techniques of solid state physics**
- **To provide an understanding of structure, thermal and electrical properties of matter**
- **To study the concept of Crystal classes, Crystal structure, Crystal vibration and Diffraction Methods.**
- **To understand the free electron theory and Dielectrics & Ferroelectrics.**
- **To study the concept of Super conductivity.**

UNIT –I CRYSTALLOGRAPHY

Crystal classes and systems: 2D & 3D lattices - Bravais lattice - Point groups - Space groups -Bonding in crystals – Crystal structure of NaCl, CsCl, ZnS and Diamond - Miller indices - Diffraction methods: Laue, rotating crystal and powder crystal method - Reciprocal lattice of BCC and FCC crystals - Structure factor for BCC and FCC - Systematic absences.

UNIT II CRYSTAL VIBRATION

Crystal vibration: Crystal with monoatomic basis – Crystal with diatomic basis – Quantization of elastic waves – Phonon momentum. Phonon heat capacity: Density of states in 1D – Density of states in 3D – Debye model – Einstein model. Thermal conductivity: Thermal resistivity of Phonon gas – Umklapp processes.

UNIT – III THEORY OF SOLIDS

Free electron theory: Energy levels in 1D and 3D - Density of orbitals – Effect of temperature on the Femi Dirac distribution – Heat capacity of electron gas - Electrical conductivity and Ohm's law –Motion in magnetic fields – Hall effect. Nearly free electron model: Origin and magnitude of energy gap - Bloch Theorem and function – Kronig-Penny model – Wave equation of electron in periodic potential - Crystal momentum of an election – Number of orbitals in a band - Band structure ins metals and Insulators - Effective mass of the free electron.

UNIT-IV DIELECTRICS AND FERRO ELECTRICS

Macroscopic electric field – Local electric field in an atom - Dielectric constant and polarizability - Clausius–Mossotti equation – Dielectric loss - Ferroelectric crystals – polarization catastrophe - ferroelectric domains – Antiferro electricity – Quantum Theory of Dia and Para magnetisms – Rare earth ions - Crystal field splitting - Quenching of the orbital angular momentum – Cooling by isentropic demagnetization – Paramagnetic susceptibility of conduction electrons. Ferromagnetic order – Spin waves - Magnons - Thermal excitations - Antiferromagnetic order.

UNIT - V SUPER CONDUCTIVITY

Super Conductivity: Occurrence of Super conductivity – Meissner effect -- Thermodynamics of super conducting Transition – London equation – BCS theory of superconductivity - Type I and II superconductors – Flux quantization – Coherence length – Josephson Tunneling – High temperature super conducting materials – Application – SQUID - Cryo electronics.

Course Outcomes (CO) :

Students will have understanding of

- **Structures in solids and their determination using XRD.**
- **Behavior of electrons in solids including the concept of energy bands and effect of the same on material properties.**
- **Electrical, thermal, magnetic and dielectric properties of solids.**
- **The students will be able to formulate basic models for electrons and lattice vibrations for describing the physics of crystalline materials; and develop an understanding of relation between band structure and the electrical/optical properties of a material.**

Books for study

1. C. Kittel, Introduction to Solid State Physics, 7th Ed, Wiley Eastern., New Delhi (1996).
2. R. L. Singhal, Solid State Physics, 3rd Ed. , Kedarnath and Ramnath & Co. Meerut, New Delhi (1987)
3. S. O. Pillai, Solid State Physics, 3rd Ed., New Age International Publishers, New Delhi (1999).

Book for Reference

1. N. W. Ashcroft and N. D. Mermin ,Solid State Physics, Harcourt Asia Pvt Ltd, Singapore, (2001).
2. M. M. Woolf man, An Introduction to X-ray Crystallography, Cambridge University Press, Cambridge (1991).
3. J. S. Blakemore, Solid State Physics, 2nd Ed., Cambridge University Press Cambridge, London (1974).

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	MEAN SCORE OF COS
CO1	4	4	4	4	4	4	3	4	2	5	3	4	1	4	3	3	**3.5**
CO2	4	4	4	4	4	3	3	4	2	4	4	4	1	4	3	3	**3.44**
CO3	4	4	4	4	4	4	3	4	2	3	4	4	4	3	3	3	**3.56**
CO4	4	4	3	3	4	3	3	3	3	4	3	3	4	3	3	5	**3.44**
																	3.50

<table>
<tr><td>SEMESTER</td><td>IV</td><td rowspan="2">CC- XII – PRACTICAL– III ADVANCED GENERAL PHYSICS AND INSTRUMENTATION LAB</td><td>HOURS</td><td>6</td></tr>
<tr><td>COURSE CODE</td><td>19PP313L</td><td>CREDIT</td><td>4</td></tr>
</table>

Advanced General Physics experiments (Any 10 experiments)

1. B.H. Loop- Energy loss of a magnetic material –Anchor ring.
2. Determination of wavelength and thickness of a film by using Michelson Interferometer using laser /Sodium lamp.
3. Determination of wavelength of monochromatic source using Bi-Prism.
4. Determination of refractive index of liquids using Bi-Prism.
5. Determination of specific rotatory power of a liquid using Polarimeter.
6. Forbe's method of determining thermal conductivity.
7. Determination of Magnetic susceptibility using Quinke's method.
8. Ultrasonic velocity of liquids- ultrasonic Interferometer.
9. Energy band gap of a semiconductor by Four Probe method.
10. Determination of Planck's constant using LED.
11. Determination of carrier concentration and Hall coefficients in semiconductors.

Instrumentation experiments (Any 5 experiments)

1. Characteristics of LVDT.
2. Calibration of Pressure gauge.
3. Calibration of thermistor using Bridge amplifier.
4. Calibration of thermocouple.
5. Study the characteristics of strain gauge.
6. Study the characteristics of load cell.
7. Study the characteristics of torque Transducer.
8. Study the characteristics of Piezo electric transducer.
9. Study the characteristics of Hall Effect Transducer.

SEMESTER	III	CC- XII – PRACTICAL – IV ADVANCED DIGITAL ELECTRONICS AND COMPUTER PROGRAMMING	HOURS	6
COURSE CODE	19PP313L		CREDIT	4

Digital electronics experiments (Any 10 experiments)

1. Half adder and full adder.
2. Half subtractor and Full subtractor.
3. Study of Flip flops. (D, JK, RS)
4. Multiplexer using ICs
5. Demultiplexer using ICs.
6. Shift register.
7. BCD to seven segment Display.
8. Decade counter –MOD 3.5,7,9. (Using IC 7490)
9. K-maps
10. Reduction of Boolean expression.
11. D/A converter Binary weighted and R-2R method.
12. A/D converter using IC 0804.
13. Decoder using ICs.
14. Encoder using ICs.

Computer Programming (Any 5 Programme)

1. Solving algebraic equation by Newton- Raphson Method.
2. Gauss Elimination Method.
3. Gauss-Seidal Method.
4. Trapezoidal Rule.
5. Simpson Rule.
6. Euler's Method.
7. Runge-Kutta IV order Method.
8. Least square Curve fitting.

Semester	III	EC-I ATOMIC AND MOLECULAR PHYSICS	Hours	6
Course Code	19PP315		Credit	4

Objectives

- **To provide an understanding of the fundamental aspects of atomic and molecular physics**
- **To study spectroscopy of the multi-electron atoms and diatomic molecules**
- **To learn structure of atom, atomic spectra and other phenomena.**
- **To study the Microwave, IR and Raman Spectroscopy.**
- **To study the concept of LASER and MASER.**

UNIT – I ATOMIC SPECTRA

Quantum states of Electron in atoms- Hydrogen atom spectrum- Electron spin- Stern Gerlach Experiment- Spin Orbit interaction- Lande interval rule- Two electron systems- LS –JJ coupling Schemes-Fine structure- Spectroscopic terms and selection rules-Hyperfine structure - Exchange symmetry of wave function- Pauli's exclusion principle- periodic table- Alkali type spectra-Equivalent electrons.

UNIT – II ATOMS IN EXTERNAL FIELDS AND RESONANCE SPECTROSCOPY

Zeeman and Paschen Back Effect of one and two electron systems- Selection Rules- Stark effect-Inner Shell vacancy- X-ray- Auger transitions- Compton Effect. NMR – Basic principles – Classical and Quantum mechanical description – Spin-spin and Spin-lattice relaxation times – Magnetic dipole coupling – Chemical shift – Knight shift.

ESR – Basic principles – Nuclear interaction and Hyperfine Structure – g-factor – Zero field splitting

UNIT – III MICROWAVE SPECTROSCOPY AND IR SPECTROSCOPY

Rotational spectra of diatomic molecules – Rigid rotator – Effect of isotropic substitution – Non rigid rotator – Rotation spectra of polyatomic molecules – Linear, symmetric top and asymmetric top molecules – Experimental Techniques. Diatomic vibrating rotator – Linear, Symmetric top molecule –Analysis by infrared techniques - Characteristic and group frequencies

UNIT – IV RAMAN AND ELECTRONIC SPECTROSCOPY

Raman effect – Quantum theory of Raman effect – Rotational Raman spectra – Vibrational Raman Spectra - Raman spectra of polyatomic molecules. Electronic spectra of diatomic molecules – Frank-Condon principle – Dissociation energy and dissociation products – Rotational fine structure of electronic vibration transitions – Fortrat Diagram – Predissociation.

UNIT – V LASERS AND MASERS

Spontaneous and stimulated emission – Interaction of radiation with atomic systems - Einstein Coefficients - Population inversion - Laser threshold condition- Rate equation for 3 and 4 level lasers- Laser resonators- Ruby laser- He-Ne Laser- CO 2 Laser- Semiconductor Lasers – Laser Applications - Ammonia Maser.

Course Outcomes (CO):
Students will have understanding of

- **Atomic spectroscopy of one and two valance electron atoms.**
- **The change in behavior of atoms in external applied electric and magnetic field.**
- **Rotational, vibrational, electronic and Raman spectra of molecules.**
- **Electron spin and nuclear magnetic resonance spectroscopy.**
- **Quantum behavior of atoms in external electric and magnetic fields; and become familiar with the working principle of laser.**

Books for Study

1. J.B.Rajam, Atomic Physics, S.Chand & Company Ltd., New Delhi, 1950. (Unit I,II)
2. C.N. Banwell, Fundamentals of Molecular Spectroscopy, Fourth edition, Mc Graw Hill, New York (2004).(Unit-III, IV)
3. Sathya Prakash, Laser Systems and Applications, Pragati Prakasan Publishers, First edition, (2010), (Unit V)

Books for Reference

1. Suresh Chandra, Physics of atoms and Molecules, Narosa Publishing House, New Delhi, (2010).
2. G.M Barrow, Introduction to Molecular Spectroscopy, McGraw Hill Ltd., Singapore (1986).
3. Manas chanda, Atomic Structure and Chemical Bond, Tata McGraw Hill, New Delhi (2003).
4. Arthur Beiser, Concepts of Modern Physics, Tata McGraw Hill, New Delhi (2003).

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4	PSO5	PS06	PSO7	MEAN
C01	5	5	4	5	4	4	5	5	4	5	4	4	5	4	5	5	4.56
C02	4	5	5	4	4	4	4	5	4	5	4	4	5	4	4	5	4.37
C03	4	5	5	4	5	4	4	5	4	5	4	4	5	4	5	5	4.5
C04	4	5	5	5	5	4	4	5	4	5	5	4	5	4	4	4	4.5
CO5	4	4	4	5	4	5	4	4	4	5	5	5	4	4	4	5	4.37
																	4.45

Semester	**III**	**EC-II**	**Hours**	**6**
Course code	**19PP316**	**CRYSTAL GROWTH AND THIN FILMS**	**credit**	**4**

Objectives

- **The aim of this course is to provide you an extended knowledge on advanced condensed matter topic like crystal growth methods.The course covers the understanding of theories involves in crystal growth nucleation process and solution, melt and vapour growth techniques and Characterization tools.**
- **To learn the concept of Thin Film techniques.**
- **Analytic techniques involved in the measurement and characterization of Crystal and thin films.**

UNIT – I NUCLEATION THEORY

Importance of crystal growth – Classification of crystal growth methods – Nucleation Theory -Kinds of nucleation – Homogeneous nucleation - Heterogeneous nucleation – secondary nucleation -Classical theory of nucleation: Gibbs Thomson equations for vapour and solution –Kinetic theory of nucleation –BCF Theory.

UNIT – II SOLUTION AND GEL GROWTH TECHNIQUE

Low temperature solution growth: Solution – Solubility and super solubility – Expression of super saturation –Miers T-C diagram – Constant temperature bath and crystallizer – Seed preparation and mounting – Slow cooling and slow evaporation methods.**High temperature solution growth**: Flux growth – Hydrothermal growth method.

Gel growth techniques : Principle – various types – Structure of gel – Importance of gel – Experimental procedure – Chemical reaction method – single and double diffusion method – Chemical reduction method – Complex and de-complexion method – Advantages of gel method.

UNIT – III OTHER GROWTH TECHNIQUES

Melt technique: Bridgman technique: Basic process – Various crucible design – Thermal consideration – Vertical Bridgman technique – Czochralski technique: Experimental arrangement

Vapour Technique : chemical vapour deposition CVD - Physical vapour deposition PVD

UNIT – IV THIN FILMS

Definition-Importance of thin films - types of thin films – growth techniques (MBE, PLD and Sputtering) -Thickness measurements – different types of thickness measurement techniques- optical techniques(Photometric, Multiple beam interferometer)– Applications of thin films (LED, Laser and Solar Cell).

UNIT – V CHARACTERIZATION TECHNIQUES

X- ray Diffraction (XRD): Powder and single crystal – Fourier transform infrared analysis – Elemental analysis – Scanning Electron Microscopy (SEM) –transmission electron microscopy- UV-VIS Spectrometer and Photo luminescence – Vickers Micro hardness tester

Course Outcomes (CO) :
Students will learn about the fundamentals of

1. **Nucleation mechanisms and different kinds of nucleation**
2. **Important crystal growth techniques like (Bridgman, Czochralski (Pulling method),solution growth, gel ,flux and hydrothermal methods)**
3. **Gain in depth knowledge on thin films growth methods of Physical and chemical.**
4. **Understanding of various characterization techniques of a) Powder and Single crystal XRD b) FTIR, c) UV-Visible and PL, d) micro hardness e) SEM and TEM**

Books for Study

1. P.Shanthana Ragavan and P.Ramasamy, **Crystal Growth Processes and Methods**, KRU Publications, Kumbakonam (2001).
2. A. Goswami, **Thin Film Fundamentals**, New Age International (P) Limited, New Delhi (1996).

Books for Reference

1. J.C. Brice, Crystal Growth Processes, John Wiley and
2. http://nptel.ac.in/courses/104104011/14.
3. https://nptel.ac.in/courses/113104075/40

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4	PSO5	PS06	PSO7	MEAN
C01	4	4	3	4	3	4	3	3	2	3	3	4	3	3	3	3	3.25
C02	3	4	4	4	4	3	3	4	2	3	3	4	3	4	3	3	3.375
C03	3	4	2.5	3	3	4	3	3	2	3	3	4	2	4	2	2	2.96
C04	3	3	4	3	3	3	3	4	2	4	4	4	1	4	3	2	3.125
																	3.20

Semester	III	CC- XIV	Hours	6
Course Code	19PP417	NUCLEAR AND PARTICLE PHYSICS	Credit	5

Objectives

- **To study the properties of nucleus, radioactivity and Detectors.**
- **To understand the nuclear reactions and elementary particles.**
- **To study the Accelerators, Nuclear Fission and Fusion Processes.**

- **To provide an understanding of static properties of nuclei, nuclear decay modes, nuclear force and nuclear models**
- **To provide broad understanding of basic experimental nuclear-detection techniques**

UNIT – I BASIC NUCLEAR FORCES

Basic nuclear properties – size by Masonic X- ray method – shape, charge distribution – spin and parity – determination of nuclear Mass by mass synchrometer method. Binding Energy – Semi – empirical mass formula - Nuclear Stability Nuclear, Shell model, its validity & limitation – Liquid drop Model. Nuclear Forces : Nature of Nuclear forces – Elements of two body problem – Ground state of deuteron – Phass shift analysis – Scattering length – Scattering amplitude-low energy n-p Scattering – Non – central forces (Tensor forces)- Yukawa's meson theory.

UNIT – II RADIOACTIVE DECAYS, DETECTORS

Gamow's theory of decay – Fermi theory of □ decay – Selection rules – Non conservation of parity in beta decay – Gamma decay – Selection – rules – international conversion – Nuclear isomerism. **Nuclear radiation Detectors :** interaction of charged particles & energy with matter – Basic principles of Particle detectors – ionization chamber – gas proportional counter and GM counter – scintillation counter – Semiconductor detector.

UNIT – III ACCELERATORS, FUSION, FISSION

Cyclotron – Synchrocyclotron – Betatron – Synchrotron – Linear accelerators.

Nuclear Fission : Characteristics of fission – Mass & energy distribution to nuclear fragments –

Energy in fission – nuclear chain reaction. Four – factor formula – Bohr wheelers theory of nuclear fission – Fission reactors – Power & Breeder type reactor.

Nuclear Fusion: Basic fusion processes – Solar fusion – Cold fusion – Controlled thermonuclear reactions – Pinch effect.

UNIT IV NUCLEAR REACTIONS

Energetic of reactions –Q equation – Level widths in unclear reaction – Nuclear reaction cross – section – Partial wave analysis – Compound nucleus model – Resonance scattering – Breit –
Wigner one level formula – Direct reactions – stripping and Pick up reactions.

UNIT V ELEMENTARY PARTICLES

Four types of interactions and classifications of elementary particles – Isospin – quantum numbers – Strangeness- & hyper charge – Hadrons – Baryons – Leptons – Invariance principles and symmetries – Invariance under charge – parity (CP). Time (T) and CPT – CP violation in neutral K meson decay – Quark model- SU (3) symmetry –Gell Mann Nishijma formula –Charm, bottom and top Quarks.

Course Outcomes (CO) :

The students will have an understanding of the structure of the nucleus, radioactive decay, nuclear reactions and the interaction of nuclear radiation with matter; and develop an insight into the building block of matter along with the fundamental interactions of nature.

After successful completion of the course, the student is expected to

- **Have a basic knowledge of nuclear size, shape, bindingenergy.etc and also the characteristics of nuclear force in detail.**
- **be able to gain knowledge about various nuclear models and potentials associated.**
- **Acquire knowledge about nuclear decay processes and their outcomes. Have a wide**
- **understanding regarding beta and gamma decay.**
- **Grasp knowledge about Nuclear reactions, Fission and Fusion and their**
- **characteristics. Understand the basic forces in nature and classification of particles**
- **and study in detail conservations laws and quark models in detail**
- **Weak interaction between quarks and how that this is responsible for β decay. .**
- **Leptons and how the (electron) neutrinos and (electron) antineutrinos are produced**
- **during β+ and β- decays respectively.**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4	PSO5	PS06	PSO7	MEAN
C01	5	5	4	5	4	4	5	5	4	5	4	4	5	4	5	5	4.56
C02	4	5	5	4	4	4	4	5	4	5	4	4	5	4	4	5	4.37
C03	4	5	5	4	5	4	4	5	4	5	4	4	5	4	5	5	4.5
C04	4	5	5	5	5	4	4	5	4	5	5	4	5	4	4	4	4.5
CO5	4	4	4	5	4	5	4	4	4	5	5	5	4	4	4	5	4.3
C06	5	5	5	4	4	4	5	4	4	5	4	5	4	4	5	4	4.43
C07	4	5	5	5	4	4	4	5	4	5	4	4	5	4	4	4	4.37
C08	5	4	5	5	4	4	4	4	4	5	4	4	4	4	4	5	4.31
C09	4	4	5	5	4	4	5	5	4	4	4	5	4	4	5	5	4.43
C010	5	4	5	5	4	4	4	5	4	4	4	4	5	4	5	4	4.37
																	4.43

Semester	IV	EC-III ELECTRONIC COMMUNICATION SYSTEMS	Hours	6
Course Code	19PP418		Credit	4

Objectives:

- **To study the concept of Modulation, Demodulation.**
- **To understand the Digital and Optical Fiber Communication.**
- **To study the Satellite and Mobile Communication.**

UNIT-I INTRODUCTION TO COMMUNICATION SYSTEM

Modulation and Demodulation: Theory Amplitude modulation-Frequency modulation- Phase modulation-modulator and demodulator circuits. Noise: Internal Noise-External Noise-noise calculation-noise figure-noise temperature-noise in communication systems.

UNIT –II DIGITAL COMMUNICATION

Pulse modulation: Pulse amplitude modulation-Pulse frequency modulation-Pulse time modulation-Pulse position modulation-Pulse width modulation. Digital data Carrier systems: Amplitude shift keying (ASK)-Frequency shift keying (FSK) –Phase shift Keying (PSK)-Differential PSK-Quatrapolar Phase shift Keying (QPSK)-Pulse code modulation-Delta modulation-error control coding.-Multiplex transmission-frequency and time division multiplexing.

UNIT –III OPTIC FIBER COMMUNICATION

Fiber optics-Different types of fiber-step index and graded index fibers-signal degradation fibers-Absorption, attenuation, Scattering losses and dispersion-Optical sources and detectors (qualitative only)-Power launching and coupling-Sources to power launching –fiber joints-Splicing techniques-general optical communication systems.

UNIT –IV SATELLITE COMMUNICATION

Satellite links-Orbits and inclination-satellite construction-satellite communication frequencies-Different domestic satellites –Intelsat system-MARISAT satellites-telemetry.

UNIT –V MOBILE COMMU NICATION

Cellular concept-Multiple Access Cellular systems-Cellular system Operation and planning-General Principles-analog cellular systems-Digital cellular mobile systems-GSM-cellular standards.

Course Outcomes (CO):

Students will have understanding of

- **The principle and structure of optical fibers.**
- **The working principle of fiber optical sources and couplers and apply it in the optical communication systems.**
- **Explore concepts of designing and operating principles of Satellite communication and mobile communication.**

Books for study

1. Alok Singh and A.K.Chhabra, Principles of Communication Engineering S.Chand group,New Delhi,(2007).(Unit I and II)

2. K.Sam Shanmugam, Digital and Analog Communication system, John.wiley &sons, Singapore (2009).(Unit II)

3. R.Allen Shotwell, An Introduction to fiber optics, PHI Learning Pvt.Ltd,(2010).(Unit –III)

4. N.D.Deshpande, P.K.Rangole, Communication Electronics, Tata McGraw Hill Pvt.Ltd.(Unit –IV)

5. Raj Pandya, Mobile and Personal Communication Services and systems Prentice Hall of India Private ltd., New Delhi,(2003).(Unit V)

Books for Reference

1. Dennis Reddy and john Coolen, Electronic Communication, fourth edition PHI Private Ltd,(1999).

2. G.Kennady and Davis, Electronic Communication systems, TMH, New Delhi,(1999).

3. Gerd Keiser, Optical Fiber Communication, Third Edition, McGraw-Hill, Singapore,(2000)
4. Sanjeev Gupta ,electronic Communication systems, Khanna publications, New Delhi(1995).

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4	PSO5	PS06	PSO7	mean
C01	4	4	4	4	4	4	3	4	4	4	4	3	4	3	3	3	3.68
C02	4	3	4	3	4	4	3	4	4	4	3	3	4	3	3	4	3.56
C03	4	4	4	3	4	5	4	4	4	4	3	3	4	3	3	3	3.68
																	3.65

SEMESTER	IV	EC-IV NANOSCIENCE	Hours	6
COURSE CODE	19PP419		CREDIT	4

Objectives:

- **To study the basic concept of Nanoscience and its application.**
- **To understand the Nanomaterials, Nanopowders and its applications.**
- **To study the Nanoelectronics, AFM and STM.**

UNIT - I INTRODUCTION OF NANOSCIENCE

Nanoscience and Nanotechnology: Basics – Concept of nanotechnology, classification of Nanomaterials – applications of nanotechnology in nanoscience – information & Communication- heavy industry.

UNIT – II NANOPOWDERS AND NANOMATERIALS

Nanomaterials – Preparation - Topdown – bottom up approaches. – Plasma arcing – Chemical vapour deposition – Sol-gels – Eletro deposition – Ball milling – Using natural Nano particles – Application of Nano materials.

UNIT – III CARBON AGE AND QUANTUM DOTS

Carbon age – New form of Carbon – Types of Nano tubes – Formation of Nano tubes-assembiles – Purification of carbon tubes – Properties – uses. Q-dot – description – QCE in semi Conductors – fabrication – applications.

UNIT – IV NANOELECTRONICS

Nano electronics – Birth of electronics – Micro and Nano fabrication – Quantum electronic devices – Quantum information and Quantum computers – Experimental implementation of quantum computers – MEMS, NEMS.

UNIT – V INSTRUMENTS AND METHODOLOGY

XRD - Atomic Force microscope – description Imaging modes – advantages – disadvantages – Scanning tunneling microscope – components of STM – FESEM – TEM.

Course Outcomes (CO):

Students will have understanding of

- **different synthesis techniques of Nano materials**
- **Preparation of carbon nanotubes and its applications.**
- **Preparation of Quantum computers and its applications,**
- **Acquire knowledge about MEMS and NEMS.**
- **Understanding of various characterization techniques like AFM,ST M,SEM,TEM**

Books for Study

1. M. Wilson, K.K.G. Smith, M. Simmons, B.Ragase, Nanotechnology, Overseas press India Pvt., Ltd., New Delhi, First Edition, 2005. (Unit II, III)
2. S. Shanmugam, Nano Technology, MJP publishers, 2010. (Unit I,III,IV,V)

Books for reference

1. Mark Ratner, Daniel Ratner, Nanotechnology, Pearson Education, 2003.
2. Charles P.Poole Jr. Frank J.Owens, Introduction to Nanotechnology, John Wiley & Sons Inc, Publications, 2006.
3. T.Pradeep, Nano: The essentials, McGraw Hill Education, 2007.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PSO1	PSO2	PSO3	PSO4	PSO5	PS06	PSO7	Mean score of CO'S
C01	4	4	4	4	4	4	4	4	3	4	4	3	4	3	3	3	3.68
C02	4	3	4	3	4	4	4	4	3	4	3	3	4	3	3	4	3.56
CO3	4	4	4	4	3	5	4	5	3	4	3	3	4	3	3	4	3.75
CO4	4	4	4	4	4	5	4	4	3	4	3	3	4	3	3	3	3.68
CO5	3	3	4	3	3	3	3	4	3	4	4	4	1	4	3	2	3.18
																	3.57

Mapping

Course Code	Title of Course	Inst. Hours/Week	Credits	Mean overall score of COs	Quality
19PP101	CC-I Mathematical Physics – I	6	5	3.60	High
19PP102	CC-II Classical Dynamics and Special Relativity	6	5	3.30	High
19PP103	CC-III Electronics and Instrumentation	6	5	4.30	Very high
19PP104	OEC- PIC Microcontroller and Its Applications	6	5	4.65	Very high
19PP207	CC- VI Mathematical Physics – II	6	5	3.33	High
19PP208	CC-VII Statistical Mechanics	6	5	3.80	High
19PP209	CC-VIII Quantum Mechanics	6	5	3.25	High
19PP210	CC-IX Computational Methods	6	4	3.25	High
19PP311	CC-X Electromagnetic Theory	6	5	3.75	High
19PP312	CC-XI Solid State Physics	6	5	3.50	High
19PP315	EC-I atomics and molecular Physics	6	4	4.45	Very high
19PP316	EC-II – Crystal Growth and thin flim	6	4	3.20	High
19PP417	CC- XIV Nuclear and Particle Physics	6	4	4.43	Very high
19PP418	EC-III – Electronics and communications	6	4	3.65	High
19PP419	EC- IV – Nanoscience	6	4	3.57	High

MAPPING (%)	1-20	21-40	41-60	61-80	81-100
SCALE	1	2	3	4	5
RELATION	0-1	1.1-2	2.1-3	3.1-4	4.1-5
QULAITY	VERY LOW	LOW	MODERATE	HIGH	VERY HIGH

MEAN SCORE OF CO'S = $\frac{TOTAL\ VALUES}{TOTAL\ NO\ OF\ POs\ \&\ PSOs}$	MEAN OVERALL SCORE FOR Cos = $\frac{TOTAL\ MEAN\ SCORES\ OF\ COs}{TOTAL\ NIMBER\ OF\ COs}$