FATIMA COLLEGE (AUTONOMOUS)

Re-Accredited with "A" Grade by NAAC (3rd Cycle)
74th Rank in India Ranking 2020 (NIRF) by MHRD
Maryland, Madurai- 625 018, Tamil Nadu, India

NAME OF THE DEPARTMENT: PHYSICS

NAME OF THE PROGRAMME : M.SC

PROGRAMME CODE : PAPH

ACADEMIC YEAR : 2020 - 21

FATIMA COLLEGE (AUTONOMOUS), MADURAI-18

DEPARTMENT OF PHYSICS

MAJOR CORE – 70 CREDITS

PROGRAMME CODE:

S. No	SEM.	COURSECODE	COURSE TITLE	HRS	CREDITS	CIA Mks	ESE Mks	TOT. MKs
1.	I	19PG1P1	Introduction to Mathematical Physics	6	4	40	60	100
2.		19PG1P2	Applied Electronics	6	4	40	60	100
3.		19PG1P3	Classical Mechanics	6	4	40	60	100
4.		19PG1P4	Practicals-I Non Electronics	4	2	40	60	100
5.		19PG1P5	Practicals-II Electronics	4	2	40	60	100
6.	II	19PG2P6	Principles in advanced Mathematical Physics	6	4	40	60	100
7.		19PG2P7	Quantum Mechanics	6	4	40	60	100
8.		19PG2P8	Electromagnetic Theory	6	4	40	60	100
9.		19PG2P9	Practicals-III Non Electronics	4	2	40	60	100
10.		19PG2P10	Practicals-IV Electronics	4	2	40	60	100

11.	**III**	19PG3P11	Condensed Matter Physics	6	5	50	60	100
12.		19PG3P12	Statistical Mechanics	6	5	40	60	100
13.		19PG3P13	Nuclear and Particle Physics	6	5	40	60	100
14.		19PG3P14	Practicals – V Advanced Non Electronics	4	2	40	60	100
15.		19PG4P15	Practicals – VI Advanced Electronics	4	2	40	60	100
16.	**IV**	19PG4P16	Advanced Condensed Matter Physics	6	5	40	60	100
17.		19PG4P17	Molecular Spectroscopy	6	5	40	60	100
18.		19PG4P18	Advanced Quantum Mechanics	6	5	40	60	100
		19PG4P19	Practicals –VII Advanced General Experiments	4	2	40	60	100
		19PG4P20	Practicals –VIII Programming in C++	4	2	40	60	100
			TOTAL	**104**	**70**		-	

MAJOR ELECTIVE / EXTRA DEPARTMENTAL COURSE / INTERNSHIP/ PROJECT -20 CREDITS

S. No	SEM.	COURSE CODE	COURSE TITLE	HRS	CREDITS	CIA Mks	ESE Mks	TOT. Mks
1.	I	19P1EDC	Modern Photography	3	3	40	60	100
2.	II	19P2EDC	Modern Photography	3	3	40	60	100
3.	III	19PG3PE1A/ 19PG3PE1B	Communication system/ Numerical methods and Programming in C++	4	4	40	60	100
4.		19PG3PSI	Summer Internship	-	3	40	60	100
5.	IV	19PG4PE2A/ 19PG4PE2B	Material Science / Astro Physics	4	4	40	60	100
6.		19PG4P21	Project*& Viva Voce	4	3	50	50	100
			TOTAL	**20**	**20**			

OFF-CLASS PROGRAMMES

ADD-ON COURSES

COURSES	HRS.	CREDITS	SEMESTER IN WHICH THE COURSE IS OFFERED	CIA MKS	ESE MKS	TOTAL MARKS
SOFT SKILLS	40	4	I	40	60	100
COMPUTER APPLICATIONS LATEX (Dept. Specific Course)	40	3	II	40	60	100
COMPREHENSIVE VIVA (Question bank to be prepared for all the courses by the respective course teachers)	-	2	IV	-	-	100
READING CULTURE	2	1	I- II	-	-	-
TOTAL		**10**				

EXTRA CREDIT COURSES

Course Code	Courses	Hrs.	Credits	Semester in which the course is offered	CIA Mks	ESE Mks	Total Marks
19PGSLP1	Adv.Learning Course Instrumentation & Experimental Methods	-	3	40	60	100	

I M.Sc., PHYSICS

SEMESTER –I

For those who joined in 2019 onwards

PROGRAMME CODE	COURSE CODE	COURSE TITLE	CATEGORY	HRS/ WEEK	CREDITS
PAPH	19PG1P1	INTRODUCTION TO MATHEMATICAL PHYSICS	Lecture	6Hrs.	4

COURSE DESCRIPTION

This course emphasises the basic concepts and applications of Mathematical Physics which involves vectors, matrices, integral transforms and special functions

COURSE OBJECTIVE/S

This course provides the mathematical foundation in vectors, matrices, special functions and Fourier and Laplace transforms required for the description of the physical phenomena.

UNIT –I VECTORS (18 HRS.)

Gauss's Divergence theorem –Deductions from Gauss's Divergence theorem- Stokes's theorem- orthogonal curvilinear coordinates- differential operators- spherical polar coordinates

UNIT –II MATRICES (18 HRS.)

Introduction-Review of algebraic operators on matrices-Sub matrices- Partitioning of matrices – Special types of Matrices – Vectors as Matrices and vector spaces- Linear transformations-The Eigen value problems

UNIT –III INTEGRAL TRANSFORMS (18 HRS.)

Introduction - Fourier transform- Few properties of Fourier transform (Shifting property, Convolution property, Parseval's theorem)- Fourier transform of derivatives -Development of the inverse Fourier transform – Laplace transforms- properties of Laplace transforms- Laplace transform of derivatives- Inverse Laplace transform – properties of Inverse Laplace transform

UNIT –IV SPECIAL FUNCTIONS I : (18 HRS.)

Definitions – The Beta function- Gamma function -The relation between the Beta function and the Gamma function.

Legendre's differential equation and Legendre functions, generating function –Rodrigue formula-orthogonal properties-recurrence formula

UNIT –V SPECIAL FUNCTIONS II : (18 HRS.)

Bessel differential equations-Bessel functions of the first kind – recurrence formula- generating function – Hermite polynomials – generating function-Rodrigue formula-orthogonal properties-recurrence formula

UNIT –VI DYNAMISM (Evaluation Pattern-CIA only)

Solving Problems on Fourier transforms and special functions

TEXT BOOKS:

Mathematical Physics with classical mechanics by Satya Prakash – Sultan chand and Sons, Fourth Revised and enlarged edition 2002

Unit I - Sec 1.7- 1.9,1.15

Unit II - Sec 2.1 –2.5, 2.9-2.19, 2.23, 2.26-2.34

Unit III- Sec 9.1-9.4, 9.9-9.11, 9.15, 9.17

Unit IV - sec 4.1-4.7,6.7-6.11

Unit V - Sec 6.17,6.21,6.22,6.29-6.33

REFERENCES:

1. The Mathematics of physics and chemistry by Margenau & Murphy

2. Fourier Transforms in Physics- D.C. Champeney wiley Eastern Ltd. July 1988.

3. Matrices and Tensors in Physics – A.W.Joshi-2nd edition

4. Applied Mathematics for engineers and Physicists by Louis . A. Pipes and Lawrence

R. Harvill III edn. McGraw – Hill International

5. Essential Mathematical methods for Physicists by Hans . J .Weber and George . B.Arfken - Academic Press

COURSE OUTCOMES

On the successful completion of the course, students will be able to:

NO.	COURSE OUTCOMES
CO 1	Define and deduce gauss divergence and stokes theorem and solving problems on gauss divergence and stokes theorem
CO 2	Discuss orthogonal curvilinear coordinates and spherical polar coordinates and solving problems using these coordinates
CO 3	Explain special type of matrices and its Eigen value problems and illustrate the properties of Fourier and Laplace transforms
CO 4	Define Beta and Gamma Functions and find its relations

I M.Sc., PHYSICS

SEMESTER –I

(*For those who joined in 2019 onwards*)

PROGRAMME CODE	COURSE CODE	COURSE TITLE	CATEGORY	HRS/WEEK	CREDITS
PAPH	19PG1P2	Applied Electronics	Lecture	6 Hrs.	4

COURSE DESCRIPTION

This course aims to introduce applied electronics to students, encompassing the concepts of semiconductor diode characteristics, Op-Amp characteristics, registers , counters, and analog to digital conversion techniques.

COURSE OBJECTIVES

The course curriculum is devised in a way to cover the theory giving a broader explanation on characteristics of Field Effect Transistors. It further includes basic circuitry involved for the linear and nonlinear analog systems comprising operational amplifier and its various applications. It also imparts knowledge on working principles of counters, registers and A/D conversion techniques.

UNIT I: FIELD EFFECT TRANSISTORS [18HRS]

The junction field effect transistor- the Pinch off voltage (Vp)-the JFET volt-ampere characteristics-the FET small signal model-the Metal-oxide semiconductor FET(MOSFET) Biasing the FET- the FET as a Voltage-Variable Resistor-the Common source Amplifier at High frequencies- Common Drain amplifier at High frequencies.

UNIT II: LINEAR ANALOG SYSTEMS [18 HRS]

The Basic operational amplifier- The differential amplifier- The Emitter Coupled Differential amplifier-Offset Error Voltages and Currents-Measurement of Operational amplifier Parameters. Basic Operational Amplifier applications-Differential DC amplifier-Stable AC-Coupled Amplifier-Analog Integration and Differentiation- Electronic Analog Computation .

UNIT III: NON LINEAR ANALOG SYSTEMS [18 HRS]

Comparators-Sample-and-hold Circuits- Logarithmic amplifiers-Anti log amplifier-Logarithmic Multiplier-Square wave generator-Pulse generator-Triangle wave generator- Saw tooth generator-Regenerative Comparator (Schmitt Trigger)- Square wave generator &Pulse generator using 555 Timer.

UNIT IV :REGISTERS AND COUNTERS [18 HRS]

The Shift Register- Clocking- Serial- Parallel data transfer- End around carry-Shift- Right-Shift- Left Register- Ripple counter-Methods to improve Counter Speed- Non binary counters- Mod-3 counters-Mod 5 counters- lockout- The up-down ripple counter- the up-down synchronous counter- ring counters-sequence generator.

UNIT V :ANALOG TO DIGITAL CONVERSIONS [18 HRS]

Sampling theorem- time-division- multiplexing- quantization - the weighted resistor D/A converter- The R-2R ladder D/A converter – Inverted ladder D/A converter- A/D converters- A parallel- comparator type- successive Approximation converters.

UNIT –VI DYNAMISM (Evaluation Pattern-CIA only)

Designing counters and sequence generators.

TEXT BOOK:

Jacob Millman, Cristos C. Halkias and Chetan D Parikh, (Second edition.
Seventh Reprint 2012) ***Milman's Integrated Electronics: Analog and Digital Circuits and systems***- **New Delhi: Tata McGraw Hill Publishing company Ltd**.

Unit I Chapter: 10.1-10.5,10.8-10.11.

Unit II Chapters: 15.1-15.3,15.6,15.8,16.1- 16.5.

Unit III Chapter: 16.12-16.13,16.15-16.17,16.20

Herbert Taub & Donald Schilling, ***Digital integrated electronics*** ,**McGraw Hill Book Company.**

Unit IV Chapters: 10.1-10.7, 10.8-10.11, 10.14-10.17

Unit V Chapters: 14.1-14.6, 14.9, 14.12-14.13

REFERENCES

1.Thomas L.Floyd-PEARSON, *Electronic devices*

2.Albert Paul Malvino ,*Digital Principles and Applications* ,Tata Mc Graw Hill

3.Garud, *Electronic devices and Linear circuits* –Tata McGraw Hill

4.Boylestad, *Electronic devices and circuit theory* New Delhi Prentice Hall of India

5.Jain Digital electronics and Microprocessors – Problems and Solutions Tata Mc Graw Hill

COURSE OUTCOMES

On the successful completion of the course, students will be able to:

NO.	COURSE OUTCOMES
CO 1	Distinguish between BJT and FET
CO 2	Explain the fundamental concepts of diode, BJT and transistor biasing to understand the small signal behaviour of FET for amplification applications
CO 3	Outline the basics of linear and nonlinear analog systems
CO 4	Describe the design concepts of counters and shift registers
CO 5	Apply the theory of OPAMP to design the linear and nonlinear applications of it.
CO6	Describe the design concepts of counters and shift registers. Demonstrate the various techniques to develop A/D and D/A converters

I M.Sc., PHYSICS

SEMESTER –I

(*For those who joined in 2019 onwards*)

PROGRAMME CODE	COURSE CODE	COURSE TITLE	CATEGORY	HRS/WEEK	CREDITS
PAPH	19PG1P3	Classical Mechanics	Lecture	6Hrs.	4

COURSE DESCRIPTION

This course imparts a thorough knowledge of Mechanics of single particle and a system of particles, applying various classical theories. This would help them to analyse any system using classical mechanics.

COURSE OBJECTIVES

To enable the student to learn different types of constraints, to derive Lagrange's equation from a variational principle, to understand the two body central force problem, to discuss scattering in central force field, to have knowledge about small oscillations, conservation laws and symmetry, canonical transformations and Poisson brackets.

UNIT –I Lagrangian Methods (18 HRS.)

Mechanics of a particle- Mechanics of a system of particles- constraints- D'Alembert's principle and Lagrange's equations- Velocity - dependent potentials and the dissipation function- simple application of the Lagrangian formulation.

UNIT –II Variational principles and Lagrange's equations (18 HRS.)

Hamilton's principle- some techniques of the calculus of variations- derivation of Lagrange's equations from Hamilton's Principle- Extension of Hamilton's principle to nonholonomic systems- conservation theorems and symmetry properties.

UNIT –III Two body central force problem (18 HRS.)

Reduction to the equivalent one-body problem- the equations of motion and first integrals-the equivalent one- dimensional problem and classification of orbits- the virial theorem- the differential equations for the orbit, and

integrable power- law potentials- conditions for closed orbits (Bertrand's theorem)- the Kepler problem: inverse square law of force- the motion in time in the Kepler problem- Scattering in a central force field- transformation of the scattering problem to laboratory coordinates.

UNIT –IV Small oscillations (18HRS.)

Formulation of the problem- Eigen value equation and the principle axis transformation- frequencies of free vibrations- normal coordinates- Free vibrations of a linear tri atomic molecule- Forced vibration and the effect of dissipative forces.

UNIT –V Hamilton equations of motion (18 HRS.)

Legendre transformations and the Hamilton equations of motion –Cyclic coordinates and conservation theorems- Routh's procedure- Derivation of Hamilton's equations from a variational principle- The principle of least action.

Canonical transformation

The equations of canonical transformations – Examples of canonical transformations- The symplectic approach to canonical transformations - equations of motion in the poisson bracket formulation.

UNIT –VI DYNAMISM (Evaluation Pattern-CIA only)

Discussion on the current Space Missions of ISRO.

REFERENCES

TEXT BOOK:

1. Herbert Goldstein, Classical Mechanics- Second Edition, Narosa Publishing House- New Delhi.

Unit1 - Chapter:1

Unit 2 - Chapter: 2.1-2.4,2.6,

Unit 3 - Chapter:3.1-3.8,3.10,3.11

Unit 4 - Chapter:6

Unit5 - Chapter:8.1(tillP343)8.2,8.3(till P352),8.5,8.6,9.1-9.3(tillP391)9.5(till P406)

REFERENCE BOOKS:

1. G.Arul Dhas, Classical Mechanics ,PHI

2., N.C. Rana & P.S. Joag,Classical Mechanics , TMH

3. Guta Kumar & Sharma, ,Classical Mechanics, Pragathi prakashan

COURSE OUTCOMES

On the successful completion of the course, students will be able to:

NO.	COURSE OUTCOMES
CO 1	To identify different types of constraints imposed on systems.
CO 2	To derive Lagrange's equation from Hamilton's variational principle and to write the equation of motion for any given system according to Lagrangian formulation.
CO 3	To explain the two body central force problem and classification of orbits and hence to discuss scattering in a central force field.
CO 4	To apply the theory of small oscillations to a linear triatomic moleculeand get the normal modes and normal frequencies of the same.
CO 5	To derive Hamilton's equations using Legendre transformation.
CO 6	a) To evaluate the connection between conservation theorems and symmetry properties of the system. b) To solve problems related to canonical transformations and Poisson brackets.

I M.Sc., PHYSICS

SEMESTER –I

For those who joined in 2019 onwards

PROGRAMME CODE	COURSE CODE	COURSE TITLE	CATEGORY	HRS/ WEEK	CREDITS
PAPH	19PG1P4	Practicals-I Non Electronics	Practical	4	2

COURSE DESCRIPTION

The course provides hands on training to work with fiber, Laser and determination of the young's modulus, mutual inductance.

COURSE OBJECTIVE/S

This course offers opportunity to handle the laboratory equipment's and develop lab skills in non-electronics experiments

LIST OF EXPERIMENTS

1. Determination of splice loss of the given fiber.
2. Determination of refractive Index of the liquid at various concentrations using laser.
3. Determination of bending loss of the given fiber.
4. Study of Fraunhofer diffraction pattern for various apertures
5. Determination of Young's modulus and Poisson's ratio of the given glass plate by employing elliptical fringes.
6. Determination of mutual inductance of the given pair of coils for various angles byAnderson's bridge.
7. Determination of absorption coefficient of transparent material of various thickness
8. Study of solar panel
9. Determination of Mass susceptibility of given solid using Guoy's Balance
10. Determination of resolving power of prism and grating
11. Study of specific rotation – Polarimeter
12. Dielectric constant of various liquids

I M.Sc., PHYSICS

SEMESTER –I

For those who joined in 2019 onwards

PROGRAMME CODE	COURSE CODE	COURSE TITLE	CATEGORY	HRS/ WEEK	CREDITS
PAPH	19PG1P5	Practicals-II Electronics	Practical	4	2

COURSE DESCRIPTION

The course provides hands on training to work with counters, multivibrators and OP-AMP circuits, flip flops and microprocessor.

COURSE OBJECTIVE/S

This course offers opportunity to handle the laboratory equipment's and develop lab skills in electronics experiments

LIST OF EXPERIMENTS

1. K-map simplification and implementation of logic gate using NAND and NOR gates.
2. Flip-Flops- RS , $\bar{R}S$ using IC 7400, IC 7402.(Construction and verification of Truth tables.)
3. J-K, D, T using IC 7410, IC 7404 (Construction and verification of truth tables)
4. Op-amp parameters using IC-741.(Closed loop gain, Output Resistance, CMRR, Input bias current)
5. OPAMP Applications
6. Binary counter using IC 7490 (Construction and verification of Truth tables.)
7. IC Regulated Dual power supply (Construction& Measurement of DC Output voltage.
8. Solving Boolean expressions to simplify the circuits.
9. MICROPROCESSOR -8086 Programs:

• To find the factorial of a given number
• Sum of a series of 16 bit data.
• Word move from REP instruction
• Block move using REP instruction.

10. Shift Register (Serial in -parallel out) using IC 7400, IC 7404, IC 74164.(Construction & study the working of Shift Register)

I M.Sc., PHYSICS

SEMESTER –I

For those who joined in 2019 onwards

PROGRAMME CODE	COURSE CODE	COURSE TITLE	CATEGORY	HRS/ WEEK	CREDITS
PAPH	19P1EDC	MODERN PHOTOGRAPHY	Lecture & Practical	3	3

COURSE DESCRIPTION

This course will familiarize the students with the fundamental techniques necessary for the creative use of photography by introducing them to the basic usage of SLR camera and Adobe Photoshop post processing.

COURSE OBJECTIVES

This course focuses on core photographic concepts like the basic parts of camera, its important control parameters and composition techniques of photography. The students will be introduced to basic exposure parameters namely F-number – Aperture – shutter speed – lighting-contrast-exposure-illumination etc., The course will include hands-on demonstrations with the SLR camera as well as basic digital image editing techniques comprising of the post production work like editing images, using retouching tools and filters by Adobe Photoshop. On completion of this course, students will have the opportunity to personally experience the creative potential of photography and the languages linked to it.

UNIT I: Camera and Lens [15 HRS]

Introduction to photography- writing with light - Camera- basic parts of camera-important controls of camera-types of camera-video camera-digital camera-focal length-speed of the lens-wide angle lens-telephoto lens-closeup lens- zoom lens – using a Digital camera –introducing the technical knowhow of using a SLR camera.

UNIT II: Focusing Aspects **[15 HRS]**

F-number – Aperture – shutter speed – lighting-contrast-exposure-illumination and use of flash light- composition of photography - Develop the skill of capturing technically good images - Practicing indoor subjects like Passport, Portrait, Article, Still life subjects and outdoor subjects like landscape and moving object photography.

UNIT III: Modern techniques **[15 HRS]**

use of "Photoshop"- Practicing post production work like editing images, using retouching tools and filters by Adobe Photoshop - Preparation of digital id cards – greeting cards –video making

TEXT BOOKS:

1. S.Thiagarajan (2007, IV edition), *The New Practical Photography*, SultanChand & Sons

REFERENCE BOOKS:

2. David Kilpatrick (1984), *Basic Photography*, Hamlyn London.
3. Michael Freeman(2005), *Mastering Colour Digital Photography*, Lark Books.

COURSE OUTCOMES

On the successful completion of the course, students will be able to:

NO.	COURSE OUTCOMES
CO 1	Students will be able to comprehend the basic parts of camera, its important control parameters and composition techniques of photography
CO 2	Students will be able to handle SLR camera and apply various composition techniques and shoot professional photographs
CO 3	Students will be able to understand the modern technique of photoshop and develop skills to manipulate, edit and enhance the real time photographs using photoshop.
CO 4	Students will be able to prepare their own digital ids and greeting cards with photoshop.

I M.Sc., PHYSICS

SEMESTER –II

For those who joined in 2019 onwards

PROGRAMME CODE	COURSE CODE	COURSE TITLE	CATEGORY	HRS/WEEK	CREDITS
PAPH	19PG2P6	PRINCIPLES IN ADVANCED MATHEMATICAL PHYSICS	Lecture	6Hrs.	4

COURSE DESCRIPTION

This course emphasise the basic concepts and applications of Mathematical Physics which involves complex variables, tensors, Dirac delta, Greens function and group theory

COURSE DESCRIPTION

This course provides the introduction of advanced mathematical tools such as complex variables, tensor analysis, Dirac delta and Green's functions and group theory

UNIT –I COMPLEX VARIABLES: (18 HRS.)

Complex numbers –review of Algebraic operations on complex numbers- Complex Conjugates-Modulus and argument of a complex numbers- definition- Cauchy-Riemann conditions - Cauchy-Riemann differential equations- cauchy's integral theorem- cauchy's integral formula- Laurent's series – singularities of an analytic function – Cauchy residue thoerem

UNIT –II TENSOR ANALYSIS (18 HRS.)

Introduction- Algebra of tensors- Quotient law-Fundamental tensor – Cartesian tensors- Four vectors in special relativity-Covariant formulation of electrodynamics. **(SELF STUDY)**

UNIT –III DIRAC DELTA FUNCTIONS & GREEN'S FUNCTION (18 HRS.)

Introduction-Green's function for the Sturn-Liouville operator- Series expansions for G (x /ε)- Concepts of theory of Distributions: Strongly peaked function and the Dirac- Delta sequences- The Calculus- Representation of Delta Functions-Application of the Calculus.

UNIT –IV ABSTRACT GROUP THEORY: (18 HRS.)

Defining properties of a group – some examples of groups – subgroups – classes – Molecular symmetry and the symmetry groups – symmetry elements and operations – symmetry planes and reflections – the inversion centre – proper axes and proper rotations – improper axes and improper rotations – products of symmetry operations – equivalent symmetry elements and equivalent atoms – general relations among symmetry elements and operations – symmetry elements and optical isomerism – the symmetry point groups – symmetries with multiple higher order axes – a systematic procedure for symmetry classification of molecules – illustrative examples – classes of symmetry operations

UNIT –V THEORY OF GROUP REPRESENTATION: (18 HRS.)

Representations of groups – the great Orthogonalitytheorem and its consequences - character tables – representations for cyclic groups – wave functions as bases for irreducible representation – the direct product

UNIT –VI DYNAMISM (Evaluation Pattern-CIA only)

Applications of Tensors for physical problems, molecular symmetry and operations of various molecules.

REFERENCES:

BOOKS FOR STUDY:

Unit 1:- Mathematical Physics with classical mechanics by Satya Prakash Sultanchand and Sons, Fourth Revised and enlarged edition 2002. Chapter: 5, Secs: 5.1-5.4, 5.9, 5.10, 5.14, 5.16, 5.21, 5.22, 5. 24

Unit 2:– Matrices and Tensors in Physics by A.W.Joshi - Wiley Eastern Ltd II – Tensor analysis :Chapters: 15-21

Unit 3:-Mathematical Physics - Butkov (Dirac Delta function and Green's function)

Chapters: 6 &12, Secs: 6.1-6.5,12.1-12.3

Unit 4 & Unit 5:- Chemical Applications of group theory by F. Albert Cotton – II ed. Wiley Eastern Ltd. Chapters:2,3,4& 5, Secs: 2.1- 2.4 , 3.1- 3.15, 4.2- 4.5 , 5.1,5.2

BOOKS FOR REFERENCE :

1. Applied Mathematics for Engineers and Physicists– A.Pipes&R. Harvil-IIIedition-

McGraw Hill international Book company- New Delhi.

2. Group theory and Quantum Mechanics- Michael Tinkham.

3. Essential Mathematical methods for Physicists- Hans J. Weber and George B.Arfken Academic Press.

4.Molecular Structure and Spectroscopy (Second Edition)-by G.Aruldhass –PHI Learning Private Limited

COURSE OUTCOMES

On the successful completion of the course, students will be able to:

NO.	COURSE OUTCOMES
CO 1	Perform algebra with complex numbers and to Identify and determine the differentiable functions and find its derivatives
CO 2	Identify the singularities of a function and determine whether they are removable poles are essential
CO 3	Perform algebra of tensors and apply four vectors in special relativity and the formulation of electrodynamics
CO 4	Discuss greens function for Sturn – Liouville operator and to compute dirac delta functions Green's functions and solving problems
CO 5	Represent delta function and apply delta calculus
CO 6	Describe group, cyclic group , sub group and multiplication tables
CO 7	Prove great orthogonality theorem and construct character tables of a group

I M.Sc., PHYSICS

SEMESTER –II

(*For those who joined in 2019 onwards*)

PROGRAMME CODE	COURSE CODE	COURSE TITLE	CATEGORY	HRS/WEEK	CREDITS
PAPH	19PG2P7	Quantum Mechanics	Lecture	6 Hrs.	4

COURSE DESCRIPTION

This course introduces Schrodinger equation, general formalism of quantum mechanics, exactly soluble Eigen value problems , representations and angular momentum.

COURSE OBJECTIVES

To enable the student to write the Schrodinger's equation and solve it for a free particle, a particle in a potential well and a simple harmonic oscillator; to have knowledge about self adjoint operators, degeneracy of eigen values, normalization and closure property of wave functions, to discuss the problems in Dirac notation, to know the matrix representation of angular momentum, addition of angular momenta and to find the Clebsh Gorden coefficients.

UNIT –I THE SCHRODINGER EQUATION & STATIONARY STATES:(15 HRS.)

The Schrodinger Equation:A free particle in one dimension- Generalisation to three dimension- the operator correspondence, and the Schrodinger equation for a particle subject to forces.

Physical Interpretation and conditions on: Normalization and probability interpretation- non-normalizable probability – expectation values; Ehrenfest's theorem- Admissibility conditions on the wave functions

Stationary states and Energy Spectra: The time-independent schrodinger equation-A particle in a square well potential- Bound states in a square well : (E < O)

Admissible solutions of wave equation (b) the energy eigen values- discrete spectrum (c) the energy eigen functions : parity (d) penetrations into classically forbidden regions- **The square well: non localized states (E > O) – square**

potential barrier: (a) Quantum mechanical tunnelling (b) Reflection at potential barriers and wells (Self Study).

UNIT –II GENERAL FORMALISM OF WAVE MACHANICS: (15 HRS.)

The fundamental postulates of wave mechanics: (a) Representation of states (b) Representation of Dynamical variables: Expectation values, Observables- The adjoint of an operator and self- Adjointness- the eigenvalue problem: Degeneracy- Eigenvalues and eigenfunctions of self- adjoint operators- the Dirac Delta function- observables: Completeness and normalization of eigenfunction- closure- physical interpretation of eigenvalues, eigenfunction,amd expansion coefficients- Momentum eigenfunctions : wave functions in momentum space: (a) self-adjointness and reality of eigen values (b) normalization and closure (c) the wave function and operations in momentum space – the uncertainty principle- states with minimum value for uncertainty product- commuting observables : removal of Degeneracy- Evolution of system with time: Constants of the motion – **Non-interacting and interacting systems- symmetric and antisymmetric wave functions (b) relation between type of symmetry and statistics: the exclusion principle (Self study).**

UNIT –III EXACTLY SOLUBLE EIGEN VALUE PROBLEMS: (15HRS.)

The simple Harmonic Oscillator:

The Schrodinger equation and energy eigenvalues – the energy eigenfunctions: (a) Series solution: Asymptotic Behaviour (b) Orthonormality- properties of stationary states- **The abstract operator method:** (a) The ladder (or Raising and lowering) Operators (b) the eigen value spectrum (c) the energy eigen functions – coherent states.

Angular momentum and parity:

The angular momentum operators- the eigen value equations for L: separation of variables- admissibility conditions on solutions: eigen values- the eigen functions spherical harmonics- physical interpretation parity angular momentum in stationary states of systems with spherical symmetry: **(a) The rigid rotator (b) A particle in a central potential: The Radial equation (c) the radial wave function (Self study).**

UNIT–IV REPRESENTATIONS, TRANSFORMATIONS & SYMMETRIES

(15HRS.)

State vectors and wave function – the 23ilbert space of state vectors: Dirac Notation: (a) state vectors and their conjugates (b) norm and scalar

product (c) Basis in Hilbert space- Dynamical variables and linear operators: (a) Abstract operators: the Quantum condition (b) the adjoint of an operator, self adjointness 9c) eigen values and eigenvector (d) expansion of the identity (Self study): Projection operators (e) Unitary Operators – Representations: (a) Representation of state vectors : the wave function (b) Dynamical variables as Matrix operators (c) products of operators : the quantum condition (d) self adjointness and hermiticity (e) Diagonalization- Continuous Basis – the Schrodinger representation – Degeneracy : Labelling by commuting observables- change of Basis : Unitary transformations- unitary transformations induced by change of co-ordinate system- algebra of Rotation generators- transformation of Dynamical Variables – **Symmetries and conservation laws-space inversion : (a) intrinsic parity (b) the unitary Operator of space inversion (c) parity non conservation – time reversal (Self study).**

UNIT –V ANGULAR MOMENTUM (15HRS.)

The eigenvalue spectrum- Matrix representation of J in the jm basis – spin angular momentum☹a) spin-1/2 (b) spin-1 (c) total wave function-nonrelativistic Hamiltonian including spin- **addition of angular momenta-clebsch-Gordon coefficients: determination of $< j_1; j- j_1 | j\ j >$ (Self study).**

UNIT –VI DYNAMISM (Evaluation Pattern-CIA only)

Quantum Mechanics in daily life including application of Quantum mechanics to innovations made in the field of Fiber Optics, Solar Cells, Telecommunication, GPS, Microscopy, Medical diagnosis and treatment, etc.

TEXT BOOK:

P.M. Mathews and K.Venkatesan, A textbook of Quantum Mechanics, Tata Mc Graw Hill publishing Company Ltd.- New Delhi. 2012

Unit1: 2.1-2.13

Unit 2: 3.2-3.16

Unit 3: 4.1-4.12 upto radial wave equation only.

Unit 4: 7

Unit 5: 8.1-8.5, 8.6(d) only,

REFERENCES:

1.L.I.Schiff ,Quantum Mechanics , McGraw Hill

2.B.Craseman and J.D.Powell,Quantum Mechanics (Addison Wesley)

3. Devanathan, Quantum Mechanics.

COURSE OUTCOMES

On the successful completion of the course, students will be able to:

NO.	COURSE OUTCOMES
CO 1	To analyze the inadequacy of Classical mechanics to explain black body radiation, photoelectric effect, specific heat of solids and Compton effect.
CO 2	To discuss the basic postulates of Quantum mechanics.
CO 3	To explain the general formalism of wave function and to write the Schrodinger's equation and obtain the Eigen values and Eigen functions of a particle in a square potential well; To discuss the problem of barrier penetration.
CO 4	To solve the problem of Simple harmonic oscillator by Schrodinger's method and also by abstract operator method.
CO 5	a) To compare Shrodinger's notation with Dirac notation and to discuss the representation of state vectors and operators. b) To outline the matrix representation of orbital and spin angular momenta and to calculate Clebsch -Gordon coefficients.

I M.Sc., PHYSICS

SEMESTER –II

For those who joined in 2019 onwards

PROGRAMME CODE	COURSE CODE	COURSE TITLE	CATEGORY	HRS/ WEEK	CREDITS
PAPH	19PG2P8	Electromagnetic theory	Lecture	6	4

COURSE DESCRIPTION

The purpose of this course is to provide the methods to analyse and understand the static electric field, the static magnetic field, and electromagnetic wave propagation. The course provides a basic knowledge of fundamental principles behind Electromagnetic Theories and Phenomena.

COURSE OBJECTIVES

This course helps to recall the basis of Electric and Magnetic fields. This course will improve the elemental concepts and enhance the intellectual, experimental, analytical and Mathematical skills of the students in Electricity, Magnetism, and Optics.

UNIT I: THE STATIC ELECTRIC FIELD: [18 HRS]

The electric field of several point charges and the superposition of fields- charge distributions- the electric scalar potential – the electric scalar-potential as a line integral of electric field- electric potential of charge distribution and the principle of superposition of potentials.

CHARGED PARTICLES MOVING IN ELECTRIC FIELDS:

Moving charge in electric fields- inkjet printers- electrostatic precipitators- electrostatic printing- sand papers and carpets made electrostatically- electrostatic separators.

UNITII: THE STATIC ELECTRICFIELD IN DIELECTRICS: [18 HRS]

Introduction- homogeneity, linearity and isotropy- dielectrics and permittivity - electric field in a dielectric- the electric dipole and dipole moment- polarization- boundary conditions- capacitors with dielectrics- dielectric strength- energy in a capacitor and energy density.

Divergence of flux density-Maxwell's divergence equation from Gauss law- divergence theorem- divergence of D and P in a capacitor – Poisson's and Laplace's equations.

Divergence of J and continuity relations for current- current and field at a conductor insulator boundary- current and field at a conductor – conductor boundary- Laplace's equations for conduction media- lightning, grounding and atmospheric conductivity

UNITIII: STATIC MAGNETIC FIELDS OF STEADY CURRENTS [18 HRS]

Magnetic flux and magnetic flux density – Magnetic flux over a closed surface- a comparison of divergence and curl- The vector potential.

CONDUCTORS AND CHARGED PARTICLES MOVING IN A STATIC MAGNETIC FIELD:

Introduction – charged particles moving in a static magnetic field- magnetic mirrors and bottles- magnetic levitation- moving conductors in a static magnetic field- magnetic brake.

PHYSICS OF PLASMA:

Electrical neutrality in a plasma- particle orbits and drift motion in a plasma- magnetic mirrors – the hydromagnetic equations- the pinch effect- magnetic confinement systems for controlled thermonuclear fusion- plasma oscillations and wave motion.

UNIT IV:TIME CHANGING ELECTRIC&MAGNETIC FILEDS: [18 HRS]

Moving conductor in a magnetic field – General case of induction- Examples of induction- Displacement current- Maxwell's equations from Ampere's law- General field relations.

Maxwell's equations as generalization of circuit equations- Maxwell's equations in free space- Maxwell's equations in harmonically varying fields.

PROPOGATION OF ELECTRO MAGNETIC WAVES

Plane monochromatic waves in non -conducting media- Energy density and flux- Plane monochromatic waves in conducting media.

UNIT V: WAVE GUIDES AND TRASMISSION LINES [18 HRS]

Introduction- circuits, Lines and guides- a comparison- The hollow rectangular wave guide Coaxial transmission line- Two lines of charge- Two wire transmission line- Single wire transmission line - Heart dipole field

ANTENNAS AND RADIATIONS:

Retarded potentials- the short dipole antenna and its radiation resistance – pattern and radiation resistance of $\lambda/2$ and $3\lambda/2$ dipoles.

UNIT –VI DYNAMISM (Evaluation Pattern-CIA only)

New developments in electromagnetic theory - magnetic monopoles - unification of electromagnetism and gravitation.

REFERENCES:

1. J.D. Krauss (IVedition),*Electromagnetics*,International Edition, McGraw Hill, Inc.

Unit I: Ch 2: 2.6-2.9, 2.12, 3.1, 3.2, 3.4-3.9

Unit II: Ch 4: 4.1-4.11, 4.18-4.22, 5.13-5.15, 5.17, 5.18

Unit III: Ch 6: 6.5, 6.6, 6.18, 6.19, 7.1, 7.2, 7.6, 7.10, 7.12, 7.14

Unit IV: Ch 10: 10.3-10.5, 10.11, 10.12, 10.17, 11.4-11.6

Unit V: Ch 14: 14.1, 14.2, 14.4, 4.12-4.15, 4.17, 15.4-15.6

2. Reitz & others(III Edition),*Foundations of Electromagnetic theory*, New Delhi:Narosa Publishing House, New Delhi.

Unit III: Ch 14: 14.1-14.7

Unit IV:Ch 17: 17.1,17.3, 17.4

REFERENCE BOOKS:

1.B.K.Bhat(1986),*Fundamentals of electromagnetic theory*,New Delhi:C.B.S. Publishers

COURSE OUTCOMES

On the successful completion of the course, students will be able to:

NO.	COURSE OUTCOMES
CO 1	Gain insight about the electric field and their charge distribution at various condition such as in static and moving fields
CO 2	Cultivate knowledge in dealing with the static electric field in dielectric media and their elaborated parameter study.
CO 3	Develop thorough knowledge of static and moving magnetic fields of steady current and charged particles.
CO 4	Detailed understanding of time dependent electric and magnetic fields and their wave propagation properties.
CO 5	Acquire essential knowledge in circuitry in transmission lines and wave guides and a detailed study about antenna.

I M.Sc., PHYSICS

SEMESTER –I

For those who joined in 2019 onwards

PROGRAMME CODE	COURSE CODE	COURSE TITLE	CATEGORY	HRS/ WEEK	CREDITS
PAPH	19PG2P9	Practicals-III Non Electronics	Practical	4	2

COURSE DESCRIPTION

The course provides hands on training to work with counters, multivibrators and OP-AMP circuits, flip flops and microprocessor

COURSE OBJECTIVE/S

This course offers opportunity to handle the laboratory equipment's and develop lab skills in electronics experiments

LIST OF EXPERIMENTS

1) 3 bit Digital to Analog converter using IC 741 (Construct & Study its operation)
2) Multiplexer &Demultiplexer using IC74151, IC 74155 (Study the function of Multiplexer &Demultiplexer)
3) Analog to Digital converter (Construct & Study its operation)
4) Monostablemultivibrator using IC-555
5) Non Binary counter (Construction and verification of Truth tables) .
6) JK Master Slave Flip Flop (Construction and verification of Truth tables)
7) Sequence generator (To Implement a sequence generator using D-Flip-flop)
8) Astablemultivibrator using IC-741
9) Superconductivity using LC circuit.
10) MICROCONTROLLER-8051
    - Program to add two 8-bit data.
    - Program to multiply two 8-bit data.
    - Program to subtract 8 bit data from another 8 bit data.
    - Program to find the 1's complement of a binary number.
    - Program to find the 2'complement of a binary number.

I M.Sc., PHYSICS

SEMESTER –I

For those who joined in 2019 onwards

PROGRAMME CODE	COURSE CODE	COURSE TITLE	CATEGORY	HRS/ WEEK	CREDITS
PAPH	19PG2P10	Practicals-IV Electronics	Practical	4	2

COURSE DESCRIPTION

The course provides hands on training to work with Four Probe method, Prism, Grating and Quinke's method.

COURSE OBJECTIVE/S

This course offers opportunity to handle the laboratory equipment's and develop lab skills innon-electronics experiments

LIST OF EXPERIMENTS

1) Determination of the Resistivity of semiconductor by Four Probe method at different
temperatures.
2) Determination of susceptibility of the given liquid by Quinke's method.
3)Determination of Young's modulus and Poisson's ratio of the given glass plate by
employing hyperbolic fringes.
4) Copper Arc Spectrum- Determination of wavelength.
5).Study of absorption of LASER light on various filters
6.Determination of the refractive index of a transparent bar using diode laser.
7) Determination of mutual inductance of the given pair of coils for various angles by
Anderson's bridge.
8.Error analysis.
9.Determination of the numerical aperture of the given fiber
10.Characteristic study of Photo Detectors.
11.A.C. Bridges
12..Determination of Grating element using LASER

I M.Sc., PHYSICS

SEMESTER –II

For those who joined in 2019 onwards

PROGRAMME CODE	COURSE CODE	COURSE TITLE	CATEGORY	HRS/ WEEK	CREDITS
PAPH	19P2EDC	MODERN PHOTOGRAPHY	Lecture & Practical	3	3

COURSE DESCRIPTION

This course will familiarize the students with the fundamental techniques necessary for the creative use of photography by introducing them to the basic usage of SLR camera and Adobe Photoshop post processing.

COURSE OBJECTIVES

This course focuses on core photographic concepts like the basic parts of camera, its important control parameters and composition techniques of photography. The students will be introduced to basic exposure parameters namely F-number – Aperture – shutter speed – lighting-contrast-exposure-illumination etc., The course will include hands-on demonstrations with the SLR camera as well as basic digital image editing techniques comprising of the post production work like editing images, using retouching tools and filters by Adobe Photoshop. On completion of this course, students will have the opportunity to personally experience the creative potential of photography and the languages linked to it.

UNIT I: Camera and Lens [15 HRS]

Introduction to photography- writing with light - Camera- basic parts of camera-important controls of camera-types of camera-video camera-digital camera-focal length-speed of the lens-wide angle lens-telephoto lens-closeup lens- zoom lens – using a Digital camera –introducing the technical knowhow of using a SLR camera.

UNIT II: Focusing Aspects **[15 HRS]**

F-number – Aperture – shutter speed – lighting-contrast-exposure-illumination and use of flash light- composition of photography - Develop the skill of capturing technically good images - Practicing indoor subjects like Passport, Portrait, Article, Still life subjects and outdoor subjects like landscape and moving object photography.

UNIT III: Modern techniques **[15 HRS]**

use of "Photoshop"- Practicing post production work like editing images, using retouching tools and filters by Adobe Photoshop - Preparation of digital id cards – greeting cards –video making

TEXT BOOKS:

1. S.Thiagarajan (2007, IV edition), *The New Practical Photography*, SultanChand & Sons

REFERENCE BOOKS:

2. David Kilpatrick (1984), *Basic Photography*, Hamlyn London.
3. Michael Freeman(2005), *Mastering Colour Digital Photography*, Lark Books.

COURSE OUTCOMES

On the successful completion of the course, students will be able to:

NO.	COURSE OUTCOMES
CO 1	comprehend the basic parts of camera, its important control parameters and composition techniques of photography
CO 2	handle SLR camera and apply various composition techniques and shoot professional photographs
CO 3	understand the modern technique of photoshop and develop skills to manipulate, edit and enhance the real time photographs using photoshop.
CO 4	prepare their own digital ids and greeting cards with photoshop.

II M.Sc., PHYSICS

SEMESTER –III

***For those who joined in 2019 onwards* (*Bookman Old Style 1*)**

PROGRAMME CODE	COURSE CODE	COURSE TITLE	CATEGORY	HRS/WEEK	CREDITS
PAPH	19PG3P11	CONDENSED MATTER PHYSICS	Lecture	6Hrs.	5

COURSE DESCRIPTION

The objective of this course is to understand the structure and properties of solid state materials

COURSE OBJECTIVES

The course enables the student :

- To understand the structure of different types of crystals
- To study the types of binding of crystals
- To gain knowledge about lattice vibrations and properties like specific heat , thermal conductivity
- To discuss metallic and semiconductor crystals and their properties

UNIT I **15 hrs**

CRYSTAL STRUCTURE : Periodic arrays of atoms- lattice translational vectors- Basis and crystal structure- Primitive lattice cell. Fundamental types of lattices : Two dimensional and three dimensional lattice types. Index system for crystal planes – Simple crystal structures: Sodium chloride structure-Caesium chloride structure- Hexagonal close packed structure- Diamond structure-cubic zinc sulphide structure. Direct imaging of atomic structure- Non-ideal crystal structures. (self-study)

RECIPROCAL LATTICE:

Diffraction of waves by crystals: Bragg's law. Scattered wave amplitude: Fourier Analysis- Reciprocal lattice vectors –Diffraction condition – Laue

Equations(self-study). Brillouin zones: Reciprocal lattice to sc, bcc and fcc. Fourier analysis of the basis : Structure factor of the bcc and fcc lattice-Atomic Form factor.

UNIT II 13 hrs

CRYSTAL BINDING

Crystals of inert gases **:** Van der Waals-London Interaction – Repulsive Interaction – equilibrium Lattice Constants – Cohesive energy.Ionic crystals**:** Electrostatic or Madelung Energy – evaluation of Madelung constant. Covalent crystals - Metals- Hydrogen bonds**-** Atomic radii **–** Ionic Crystal radii.

UNIT III **15 hrs**

PHONONS-CRYSTAL VIBRATIONS

Vibrations of crystals with monatomic basis**:** First Brillouin zone- group velocity- long wavelength limit.Two atoms per primitive basis - Quantization of elastic waves.

phonons-thermal properties

Phonon heat capacity**:** Planck Distribution- Normal mode enumeration-Density of states in 1D and 3D-Debye Model for density of states- Debye T^3 law- Einstein model of the density of states.

UNIT IV **16 hrs**

FREE ELECTRON FERMI GAS

Energy levels in one dimension - Effect of temperature on the Fermi – Dirac distribution- Free electron gas in 3D.Heat capacity of the electron gas**:** Experimental heat capacity of metals.Electrical conductivity and ohm's law**:** Experimental electrical resistivity of metals (Umklapp scattering not included).Motion in magnetic fields: Hall effect. Thermal conductivity of metals: Wiedemann- Franz law.

energy bands :Nearly free electron model **- (**only descriptive – exclude origin and magnitude of energy gap) Bloch functions - Kronig - Penney model .

UNIT V **16 hrs**

SEMICONDUCTOR CRYSTALS:

Band gap- Equations of motion (exclude physical derivation) -Holes-Effective Mass- Intrinsic carrier concentration **:**Intrinsic mobility.

fermi surfaces and metals .

Reduced zone scheme, periodic zone scheme (explanation only) - Construction of Fermi surfaces(orbits not included).

Experimental methods in Fermi surface studies**:** Quantization of orbits in a magnetic field – De Haas-van Alphen effect.

UNIT –VI DYNAMISM (Evaluation Pattern-CIA only)

Recent developed crystals in semiconductors, metals , ionic crystals – study of any two crystals for each – their structure, properties and applications. (From published research papers).

BOOKS FOR STUDY:

Charles Kittel - Introduction to Solid State Physics - VIII Edition -

Unit 1: Ch -1, 2
Unit 2: Ch -3(page 48 to page 72 only)
Unit 3: Ch- 4 (page 91 to page 99 only) 5 (page 107 to page 118 only)
Unit 4: Ch- 6(exclude page 151), 7 (page 163 to page 169 only, (exclude 165,166)
Unit 5: Ch- 8(exclude pages 193, 199,200 to 205, 209 to 217). Ch - 9 (page 223 to 228 only and pages 242 to 249only)

BOOKS FOR REFERENCE

1. Omar ,M.A. - Elementary Solid State Physics: Principles and applications- Addison Wesley- First Indian Reprint, 2000.
2. Srivastava ,J.P. - Elements of Solid State Physics –Prentice Hall of India Private Ltd. II Edition.
3. Pillai , S.O. -Solid State Physics- Revised and enlarged edition- Wiley Eastern Ltd. New Age International Ltd.

COURSE OUTCOMES

On the successful completion of the course, students will be able to:

NO.	COURSE OUTCOMES
CO 1	Explain Fourier analysis of crystals and compute the structure factor - Discuss the various types of crystal binding
CO 2	Discuss quantization of elastic waves in lattice vibrations
CO 3	Analyze the thermal properties of solids by applying different models
CO 4	Discuss the Kronig-Penney model and its implications
CO 5	Explain Fermi surfaces and determine the same by De Haas van Alphen effect

II M.Sc., PHYSICS

SEMESTER –III

For those who joined in 2019 onwards

PROGRAMME CODE	COURSE CODE	COURSE TITLE	CATEGORY	HRS/WEEK	CREDITS
PAPH	19PG3P12	STATISTICAL MECHANICS	Lecture	6	4

COURSE DESCRIPTION

This course develops concepts in Classical statistical mechanics, Quantum statistics, fluctuations and one dimensional random walk.

COURSE OBJECTIVES

The course provides a conceptually based exposure to some advanced topics in the field of equilibrium statistical physics. The course links thermodynamics to the micro description used in classical Statistical Mechanics. The course enables the students to understand the concepts of M-B, B-E and F-D statistics and to apply them to the real systems.

UNIT –I INTRODUCTION (18 HRS.)

Phase Space-Ensemble-Ensemble average-Liouville Theorem-Equation of motion-Equal-apriori-probability-Statistical equilibrium-Micro canonical ensemble-Entropy of an ideal Boltzmann gas using micro canonical ensemble-Gibb's paradox. Quantisation of phase space-basic postulates-classical limit-Symmetry of wave functions-effect of symmetry on counting-MB, BE and FD statistics-various distributions using micro canonical ensemble.

UNIT –II CANONICAL AND GRAND CANONICAL ENSEMBLES (18 HRS.)

Entropy of a system in contact with a heat reservoir-Ideal gas in canonical ensemble-Maxwell velocity distribution-Equipartition of energy. Grand canonical ensemble-Ideal gas in grand canonical ensemble-Canonical partition function Translational partition function-Rotational partition function-Vibrational partition function-Electronic partition function.

UNIT –III BOSE-EINSTEIN STATISTICS (18 HRS.)

Bose-Einstein distribution-Bose-Einstein condensation **Thermodynamic properties of an ideal BE gas**-Liquid Helium-Landau spectrum of Phonons and Protons Helium 4 and Helium 3 mixtures-Superfluid phases of Helium

UNIT –IV FERMI-DIRAC STATISTICS (18 HRS.)

Fermi-Dirac distribution-degeneracy-Thermionic emission-white dwarfs-**Nuclear matter**-Quantum Hall effect.

UNIT –V FLUCTUATIONS (18 HRS.)

Introduction-mean square deviation-Fluctuations in ensembles-Concentration fluctuations in quantum statistics-One dimensional random walk-Brownian motion-Fourier analysis of a random function-Electrical noise-Nyquist theorem.

UNIT –VI DYNAMISM (Evaluation Pattern-CIA only) (4 HRS.)

The Fractional Quantum Hall Effect

REFERENCES:

1. Agarwal.B.K. and Melvin Eisner, S***tatistical Mechanics*** ,New Age International Limited, New Delhi (2003) 2nd edition.
2. Donald A. McQuarrie, S***tatistical Mechanics*** Viva Books Private limited,(2003).
3. Silvio R A Salinas, I***ntroduction to Statistical Physics*** Springer,(2004)
4. Bhattacharjee, S***tatistical Mechanics*** Allied Publishers limited,(1996).
5. Kerson Huang, S***tatistical Mechanics*** Wiley Eastern(1988) third reprint

WEB REFERNCES :

1. https://www.cmi.ac.in/~kpnmurthy/StatisticalMechanics2017/book.pdf
2. https://www.britannica.com/science/degenerate-gas
3. https://www.space.com/23756-white-dwarf-stars.html
4. http://www.damtp.cam.ac.uk/user/tong/qhe.html
5. http://www.damtp.cam.ac.uk/user/tong/qhe/three.pdf)

COURSE OUTCOMES

On the successful completion of the course, students will be able to:

NO.	COURSE OUTCOMES
CO 1	Analyse classical equilibrium thermodynamics to make physical predictions, describe the effects of quantum mechanics on statistical mechanics.
CO 2	Acquire knowledge on Canonical and Grand canonical ensembles.
CO 3	Understand the concepts of Bose Einstein condensation.
CO 4	Apply statistical mechanics to condensed matter systems such as Fermi gases, white dwarfs and nuclear matter.
CO 5	Compute fluctuations in the systems of canonical, micro canonical and grand canonical ensembles and comprehend random process using Fourier analysis

II M.Sc., PHYSICS

SEMESTER –III

For those who joined in 2019 onwards

PROGRAMME CODE	COURSE CODE	COURSE TITLE	CATEGORY	HRS/WEEK	CREDITS
PAPH	19PG3P13	NUCLEAR AND PARTICLE PHYSICS	Lecture	6	5

COURSE DESCRIPTION

The aim of this course is to provide an overview of the fields of nuclear and particle physics.

COURSE OBJECTIVES

This course provides the knowledge about alpha and beta particles in nuclear physics. And it explains about nuclear fission and fusion reactions and its application in nuclear reactor. Expels knowledge in nuclear force and elementary particles.

UNIT –I ALPHA PARTICLES (18HRS.)

Introduction- range of alpha particles-range-velocity-energy-life relations-alpha energy- -mass number- alpha particle spectra- Gamow's Theory of alpha decay, (decay probability, hindrance factors, spontaneous nuclear disintegration).

BETA-DECAY: Introduction- Beta-Spectroscopy. The neutrino hypothesis-energy- half life relationships-Fermi theory of Beta Decay, (Kurie plots, Mass of neutrino, Life time of beta decay, selection rules for allowed and forbidden transitions)-Parity violation- Helicity.

UNIT –II NUCLEAR FISSION (18 HRS.)

The discovery of nuclear fission- fission cross sections and thresholds- the fission products-the mass and energy distributions of the fission products-Neutron emission in fission-the energy distribution of the neutrons emitted in fission-the energy release in fission- the theory of the fission process.

NUCLEAR ENERGY SOURCES: Nuclear fission as a source of energy- the chain-reacting system of nuclear reactor- Thermal nuclear reactors- The neutron cycle- the calculation of the multiplication factor for a homogeneous thermal reactor- the heterogeneous thermal reactor- power and breeding- energy production in stars- thermonuclear reactions-controlled thermo nuclear reactions.(self study)

UNIT –III NUCLEAR FORCE & MODELS (18 HRS.)

NUCLEAR FORCES: The Deuteron- Ground State of the Deuteron- Triplet and Singlet states- Meson theory of Nuclear forces.

NUCLEAR MODELS: Introduction- Degenerate Fermi gas model- The Semi-empirical mass formula- the liquid drop model- the shell model- the collective model.

UNIT –IV NUCLEAR REACTIONS (18 HRS.)

Types of nuclear reactions, conservation laws, Nuclear Reaction Kinematics- Solution to Q-equation; Nuclear cross- section, Partial wave analysis of Reaction cross-section, Requirements for a reaction- Reaction mechanism.

UNIT –V ELEMENTARY PARTICLES (18 HRS.)

Introduction- Classification of Elementary particles- Particle Interactions (Gravitational, Electromagnetic, Strong, Weak) Conservation laws- Invariance under charge, parity ,C.P ,time reversal and C.P.T- Electrons and positrons- **protons and antiprotons- neutrons and antineutrons-neutrinos and Antineutrinos – Photons,** Mesons -Hyperons- Elementary particle symmetries, Quark theory.

UNIT –VI DYNAMISM (Evaluation Pattern-CIA only) (3 HRS.)

Application of nuclear fission and nuclear fusion. Application of nuclear energy in constructive purposes.

REFERENCES

1. D.C. TAYAL " Nuclear Physics" Umesh Prakashan- Khurja
2. Irving Kaplan, Nuclear Physics, Addison-Wesley Publishing Company.
3. Arthur Beiser, Perspectives of Modern Physics, Mcgraw Hill Book company
4. SATHYA PRAKASH, Nuclear Physics and Particle Physics, Sultan Chand

5. Devanathan.V, Nuclear physics, Narosa publishers.
6. Harald Enge Addison, Introduction to Nuclear Physics, Wesley
    a. Publishing Company.

COURSE OUTCOMES

On the successful completion of the course, students will be able to:

NO.	COURSE OUTCOMES
CO 1	Define nuclear fission and fusion process and beta decay
CO 2	Describe nuclear energy sources
CO 3	Explain various nuclear models
CO 4	Describe nuclear reactions and solve some problems related to cross section
CO 5	Classify the elementary particles and explain their various properties

II M.Sc., PHYSICS

SEMESTER –III

(*For those who joined in 2019 onwards*)

PROGRAMME CODE	COURSE CODE	COURSE TITLE	CATEGORY	HRS/WEEK	CREDITS
PAPH	19PG3PE1A	Communication Systems	Lecture	4 Hrs.	4

COURSE DESCRIPTION

This is a strong foundation course covering the principles of analog and digital communication systems involving different modulation and coding schemes. Also it encompasses the fundamental concepts of satellite, fiberoptic communications and microwave generation**.**

COURSE OBJECTIVES

This course introduces the types of analog and digital modulation- AM, FM and PM , its various spectra,bandwidth requirements, Generation & detection and power relations. Further it also gives the basics of satellite communication laws and a description of source and detectors of fiber optic communication. Also principles of basic, high frequency, microwave , wideband and special purpose antennas and microwave generation are dealt here.

UNIT I : AMPLITUDE MODULATION (12Hrs)

Introduction-Amplitude modulation- Amplitude modulation index-Modulation index for sinusoidal AM-Frequency spectrum for sinusoidal AM-Average power for sinusoidal AM - Effective voltage and current for sinusoidal AM – Double sideband suppressed carrier (DSBSC) modulation- Amplitude modulator circuits-Amplitude demodulator circuits. Single sideband principles- Balanced modulators- **SSB generation-SSB reception**- **Modified SSB systems- Signal to noise ratio for SSB- Companded SSB.(selfstudy)**

UNIT II : ANGLE MODULATION (12Hrs)

Introduction – Frequency modulation – Sinusoidal FM- Frequency spectrum for sinusoidal FM-Average power for sinusoidal FM- Modulation index for sinusoidal FM- Phase modulation- **Equivalence between PM and FM – Sinusoidal PM- Digital PM (selfstudy)**- Angle modulator circuits- FM Transmitters- Angle modulation detectors.

UNIT III: PULSE AND DIGITAL MODULATION (12Hrs)

Pulse amplitude modulation (PAM)- Pulse code modulation(PCM)- Pulse frequency modulation(PFM)- Pulse time modulation (PTM)- Pulse position

modulation (PPM)-Pulse width modulation(PWM) Digital communication- Introduction- Synchronization -Asynchronous transmission- **Probability of Bit error in baseband transmission –Digital carrier systems**.
(selfstudy)

UNIT IV: SATELLITE AND FIBER OPTIC COMMUNICATIOINS (12Hrs)

Kepler's first law- Kepler's second law- Orbits- Geostationary orbits- Power systems- Altitude control- Satellite station keeping- Antenna look angles- Limits of visibility- **Frequency plans and polarization-** Transponders –**Multiple access methods. (selfstudy) FIBER OPTIC COMMUNICATIONS:** Introduction- Light sources for fiber optics- Photodetectors- Connectors and Splices- Fiber optic communication link.

UNIT V: ANTENNAS AND MICROWAVE TUBES (12Hrs)

Basic considerations – Wire radiators in space- Terms and definitions- **Effects of ground on antennas- antenna coupling at medium frequencies (selfstudy)**- Directional high frequency antennas- Microwave antennas- Wideband and special - purpose antennas.Multicavity Klytstron- Reflex Klystron- Magnetron- Travelling wave tube.

TEXT BOOKS:

1. Electronic Communication by Dennis Roddy &John Coolen (IV Edition)

UNIT I : Chapters (8.1- 8.11) & (9.1-9.8)

UNIT II : Chapter (10.1 –10.14)

UNIT III: Chapter (11.1-11.7) &(12.1 –12.4 &12.9)

UNIT IV: Chapters (19.1- 19.13 &19.18) & (20.5 – 20.8)

2. Electronic Communication systems by George Kennedy (IIIEdition)

UNIT V : Chapters (9.1- 9.9) & (11.1- 11.5)

REFERENCE BOOKS:

1. Communication systems by B.P.Lathi
2. Communication systems by Simon Haykin
3. Satellite communication by P.M.Gagliardi

COURSE OUTCOMES

On the successful completion of the course, students will be able to:

NO.	COURSE OUTCOMES
CO 1	explain amplitude modulation techniques and sideband principles
CO 2	describe the concepts of angle modulation and compare frequency and phase modulation
CO 3	describe the key modules of digital *communication systems* with emphasis on…PAM, Pulse code modulation (PCM), DM
CO 4	deduce the fundamental laws of of satellite communication and explain the principle of optical fiber communication
CO5	Describe about basic, high frequency, microwave , wideband and special purpose antennas and principles of microwave generation.

II M.Sc., PHYSICS

SEMESTER –III

(*For those who joined in 2019 onwards*)

PROGRAMME CODE	COURSE CODE	COURSE TITLE	CATEGORY	HRS/WEEK	CREDITS
PAPH	19PG3PE1B	Numerical Methods & Programming in C++	Lecture	4 Hrs.	4

COURSE DESCRIPTION

This course provides object oriented techniques to write programs in C++ especially for numerical methods

COURSE OBJECTIVES

The objective of this course is to enable the students to learn the various numerical methods to solve algebraic & transcendental equations and also numerical differentiation and integration. Also it provides object oriented techniques to write programs in C++ especially for all the numerical methods.

UNITS

UNIT I: Numerical solutions of Algebraic and Transcendental Equation [12HRS]

Method of False position (Regula Falsi method)-Newton-Raphson Method-Solution of Simultaneous Linear Algebraic Equations: Gauss Elimination Method-Interpolation with equal intervals: Gregory-Newton's forward interpolation formula for Equal Intervals- Gregory-Newton's Backward interpolation formula for Equal Intervals-Interpolation with unequal Intervals: **Lagrange's Interpolation Formula for unequal Intervals**

UNIT II: Numerical Differentiation and Integration [12 HRS]

Values of the derivatives of y, based on Newton's Forward Interpolation formula- Values of the derivatives of y, based on Newton's Backward Interpolation formula-Numerical integration: **Newton-Cote's Quadrature**

Formula- Trapezoidal rule- Numerical solutions of ordinary differential equations: Euler's method- Runge-Kutta formulas of first and second order.

UNIT III: Object Oriented programming [12 HRS]

Introduction to OOP- Function Prototypes-Comments- Flexible Declarations-*structure, union* and *enum* Syntax- Typecasting-void Pointers- The :: Operator-References- **The const Qualifier**- Constructor for Intrinsic Data Types- The bool Data Type -Function Overloading –Operator overloading

UNIT IV : Classes in C++ [12 HRS]

Classes and Constructors- Destructors- A complex Class – **Overloaded operators Revisited**- *this* Pointer- Overloading Unary Operators- Postfix Notation- **Function Definition Outside the class**-new and delete Operators-*malloc*( )/*free*( ) versus new/delete-The Matrix Class-Classes, Objects and Memory

UNIT V : Inheritance and Polymorphism [12 HRS]

Inheritance-Constructors in multiple inheritance- Private inheritance-Protected inheritance- Functions that are not inherited- Pure virtual functions- Classes within classes- Friend functions.

UNIT –VI DYNAMISM (Evaluation Pattern-CIA only)

Advanced features in friend functions, classes within classes, smart pointers.

BOOKS FOR STUDY:

1. **Veerarajan. T, Rmachandran T, Numerical Methods with programs in C and C++, Tata Mc Graw Hill Publishing company Ltd, New Delh**
   Unit I- Pages 3.5-3.5, 4.1-4.2, 6.1-6.4,7.6-7.7
   Unit II-Pages: 8.1-8.3,8.28-8.32, 10.16-10.18

2. **P. Kanetkar Yashavant, Let us C++, BPB publications, First Edition.**

Unit III Chapters: 1,2,3
Unit IV Chapter : 4
Unit V Chapters: 8,9,11(Relevant sections)

BOOKS FOR REFERENCE

1.Balagurusamy. E, Computer Oriented Numerical Methods, Prentice-Hall of India

2.Ravi Chandran. D, Programming with C++, Tata Mc Graw Hill Publishing company Ltd.

COURSE OUTCOMES

On the successful completion of the course, students will be able to:

NO.	COURSE OUTCOMES
CO 1	solve Algebraic and Transcendental equations numerically using Regula Falsi and Newton Raphson method
CO 2	apply newton's forward and backward interpolation formulae to equal and unequal intervals
CO 3	evaluate numerical differentiation and integration
CO 4	compose C++ program using structures and classes and apply inheritance and polymorphism features in C++ programming.
CO5	Describe the design concepts of counters and shift registers.Demonstrate the various techniques to develop A/D and D/A converters

II M.Sc., PHYSICS

SEMESTER –III

For those who joined in 2019 onwards

PROGRAMME CODE	COURSE CODE	COURSE TITLE	CATEGORY	HRS/WEEK	CREDITS
PAPH	**19PG3P14**	**Practicals V Advanced Non Electronics**	**Practicals**	**3**	**3**

COURSE DESCRIPTION

The lab course deals with **Advanced General Experiments** in Physics.

COURSE OBJECTIVE/S

The course gives a conceptual understanding of electrical, magnetic, optical and magneto-opticproperties of materials, propagation of Ultrasonic waves through liquids, lattice parameters of crystals, principle and efficiency of solar water heater, properties of polarized light.

LIST OF EXPERIMENTS

1. Hall Effect-Determination of hall voltage, carrier density and carrier mobility of the given Ge crystal.
2. Solar water heater-Evaluation of thermal performance of domestic solar water heater.
3. Diode Laser- Investigation of (i) transmission of polarized beam, (ii)Irradiance of divergent beam
4. Faradayeffect-Determination of angle of rotation and to calculate theVerdette Constant.
5. Ultrasonic Interferometer-Determination of ultrasonic velocity through distilledwater and compressibility of water at different temperatures.
6. Thermistor characteristics-Determination of temperature coefficient of thermistor
7. Determination of Miller indices and lattice parameter of an unknown powder material by Xray diffraction.
8. Laser-Determination of thickness of wire.
9. Determination of dielectric constant of a liquid by RF oscillator method.

II M.Sc., PHYSICS

SEMESTER –III

For those who joined in 2019 onwards

PROGRAMME CODE	COURSE CODE	COURSE TITLE	CATEGORY	HRS/WEEK	CREDITS
PAPH	19PG3P15	Practicals VI Advanced Electronics	Practicals	3	2

COURSE DESCRIPTION

This course gives an opportunity to understand the characteristics and applications of Electronic devises like Op- Amp, Photo diode, FET, UJT, SCR, Klystron, Micro controller and Transmission line.

COURSE OBJECTIVE/S

With the knowledge gained, the student should be in a position to use the various electronic devises mentioned here for various applications. Also the student is exposed to Mathematica –Wolfram language and Wolfram cloud to plot simple functions.

LIST OF EXPERIMENTS

1. Solving simultaneous linear equations-using OP-AMP
2. Transmission line- Determination of Input Impedance, Attenuation of line, Phase displacement of line.
3. SCR characteristics
4. UJT characteristics
5. UJT-Relaxation Oscillator
6. Microcontroller- Interfacing with electrical switches and LEDs.
7. FET characteristics
8. Photodiode characteristics.
9. Op-amp - Design of square wave, saw tooth wave, and Triangular wave generators.
10. Plotting simple functions using Mathematica (i) plot a polynomial (ii) plot a quadratic function

II M.Sc., PHYSICS

SEMESTER –III

***For those who joined in 2019 onwards* (*Bookman Old Style 1*)**

PROGRAMME CODE	COURSE CODE	COURSE TITLE	CATEGORY	HRS/WEEK	CREDITS
PAPH	19PG4P16	ADVANCED CONDENSED MATTER PHYSICS	Lecture	6Hrs.	5

COURSE DESCRIPTION

The objective of this course is to understand in depth the physics of the properties of metals, superconductors, dielectrics and magnetic solids

COURSE OBJECTIVES

The course enables the student :

- To understand the transmission and reflection properties of plasmons
- To study the types of lattice defects
- To gain knowledge about the superconducting property of solids
- To understand the polarisation and magnetisation properties of solids

UNIT I **15 hrs**

Plasmons, polaritons, polarons and excitons

Dielectric function of the electron gas **:** Dispersion relation for electromagnetic waves- Transverse optical modes in a plasma – transparency of alkali in the ultraviolet- longitudinal plasma oscillations. Plasmons - Electrostatic screening**:** Mott-Metal transition- screening and phonons in metals. Polaritons **:** LST relation. Polarons- Excitons(types of excitons explanation only. No derivation).

UNIT 2 **16 hrs**

Point defects - Lattice vacancies: Schottky defect, Frenkel defect- Diffusion: Metals- Color centers: F Centers, Other centers in alkali halides.

Super conductivity

Experimental survey: Occurrence of super conductivity-Destruction of superconductivity by magnetic fields – Meissner effect – Heat capacity – Energy gap – Microwave and infrared properties – Isotope effect.

Theoretical survey**:** Thermodynamics of the superconducting transition – London equation – Coherence length – BCS theory of superconductivity – BCS ground state.

UNIT 3 **16 hrs**

Flux quantization in a superconducting ring – Type II superconductors – Vortex state – Estimation of H_{C1} and H_{C2}- Single particle tunneling – Josephson superconductor tunneling – DC Josephson effect – AC Josephson effect – Macroscopic quantum interference – High Temperature superconductors.

UNIT 4 **13 hrs**

Dielectrics and ferroelectrics - Macroscopic electric field**:** Depolarization field. Local electric field at an atom **:** Lorentz field. Dielectric constant and polarizability- electronic polarizability –classical theory of electronic polarizability. Structural phase transitions. Ferroelectric crystals **:** Classification of ferroelectric crystals. Displacive transitions**:** Soft Optical Phonons – Landau theory of the phase transition – second order transition – first transition – antiferroelectricity – ferroelectric domains – piezoelectricity.

UNIT 5 **15 hrs**

Diamagnetism and paramagnetism - Langevin diamagnetism equation. Quantum theory of diamagnetism of mononuclear systems. Paramagnetism- Quantum theory of Para magnetism: Rare earth ions, Hund rules. Paramagnetic susceptibility of conduction electrons

Ferromagnetism and Antiferromagnetism- Ferromagnetic order: Curie point and the exchange integral **–** Magnons **:** Dispersion relation of magnons.

Ferrimagnetic order **:** Curie temperature and susceptibility of ferrimagnets. Antiferromagnetic order **:** susceptibility below Neel temperature. Ferromagnetic domains**:** Anisotropy energy, Transition region between domains

UNIT –VI DYNAMISM (Evaluation Pattern-CIA only)

Recent developed crystals in superconductors, dielectrics, ferroelectrics, Ferromagnetic, antiferromagnetic, ferrimagnets - study of any two crystals for each – their structure, properties and applications. Explain spintronics and their applications. (From published research papers).

BOOKS FOR STUDY:

1. Introduction to Solid State Physics VIII Edition – Charles Kittel-

Unit 1: Ch-14 (page 394 to page 416 only and pages 420 to 421 only),

Ch-15 (pages 435 to 441 only)

Unit 2: Ch-10(page 259 to page 279 only), Ch-20 .

Unit 3: Ch-10 (from page 279 to page 293 only)

Unit 4: Ch- 16

Unit 5: Ch-11 (page 299 to page 306 only and pages 315 to 317 only) ,

Ch - 12 (page 323 to page 325 only and pages 330 to 333, 336 to 338 excluding antiferromagnetic magnons, then include pages 340 to 343 only, 346 to 350 only)

BOOKS FOR REFERENCE

1. Omar, M.A.- Elementary Solid State Physics: Principles and applications- Addison Wesley- First Indian Reprint, 2000.
2. Srivastava, J.P. - Elements of Solid State Physics –Prentice Hall of India Private Ltd.

II Edition.

3. Pillai, S.O. - Solid State Physics- S.O.Pillai Revised and enlarged edition- Wiley Eastern Ltd. New Age International Ltd.

COURSE OUTCOMES

On the successful completion of the course, students will be able to:

NO.	COURSE OUTCOMES
CO 1	Analyse the dispersion of electromagnetic waves in a non-magnetic solid
CO 2	Identify lattice vacancies and defects and explain the color centers in crystals Compare the behaviour of normal conductor and superconductor Explain superconductivity based on various models and theories
CO 3	Identify dielectric medium and analyze their polarization properties
CO 4	Identify magnetic solids and their properties Apply quantum theory and analyze the magnetisation and susceptibility properties
CO 5	Discuss the formation of plasmons, polaritons, polarons and excitons and their interactions with the solids

II M.Sc., PHYSICS

SEMESTER –IV

For those who joined in 2019 onwards

PROGRAMME CODE	COURSE CODE	COURSE TITLE	CATEGORY	HRS/WEEK	CREDITS
PAPH	PG4PI7	MOLECULAR SPECTROSCOPY	Lecture	6HRS	5

COURSE DESCRIPTION

This course imparts a thorough knowledge of spectroscopic methods of the different regions of the electromagnetic spectrum and the techniques available for the understanding of molecular structure, nature of bonding, molecular symmetry and inter and intra molecular interactions. This would help them to analyse any substance from the informations obtained through various spectroscopic techniques.

COURSE OBJECTIVES

To enable the student to learn different types of molecular spectroscopy such as Microwave, Spin Resonance , Infra Red, Raman, Electronic and Nuclear Magnetic Resonance spectroscopy.

UNIT –I MICROWAVE SPECTROSCOPY: **(16 HRS)**

The Rotation of molecules- Rotational spectra- Diatomic molecules- Poly atomic molecules-**Techniques and Instrumentation (Self study)** - Chemical analysis by Microwave Spectroscopy

UNIT –II - INFRA-RED SPECTROSCOPY: (16 HRS.)

The Vibrating Diatomic molecule- The diatomic vibrating rotator- The vibration- rotation spectrum of Carbon Monoxide- breakdown of the Born-Oppenheimer Approximation: the interaction of rotation and vibrations-The vibrations of Polyatomic molecule- **Techniques and Instrumentation. (Self study)**

UNIT –III RAMAN SPECROSCOPY: (15HRS.)

Introduction- Pure rotational Raman Spectra- Vibrational Raman Spectra- Polarization of Light and the Raman Effect- **Structure Determination from Raman and Infra-red spectroscopy- Techniques and Instrumentation(Self study).**

UNIT –IV ELECTRONIC SPECTROSCOPY OF MOLECULES:

(10 HRS.)

The Born-Oppenheimer Approximation- Vibrational Coarse Structure: Progressions- Intensity of vibrational electronic Spectra: The Frank- Condon Principle- Dissociation Energy and Dissociation Products- Rotational fine structure of Electronic-vibration transitions- The Fortrat Diagram- Predissociation- **Diatomic Molecules: summary(Self study).**

UNIT –V SPIN RESONANCE SPECTROSCOPY: **(18HRS.)**

The nature of spinning particles- Interaction between spin and magnetic field- Population energy levels- Larmor precession -Relaxation times

NUCLEAR MAGNETIC RESONANCE:

Magnetic properties of Nuclei- Resonance Condition- **NMR Instrumentation(Self study)** - Relaxation Process- Bloch Equation- Chemical Shift-Indirect Spin- spin interaction- Hindered rotation- NMR Imaging- **Interpretation of certain NMR spectra (Self study).**

REFERENCES:

1. ColinN. Banwell and Elaine M. McCash - Fundamentals of Molecular Spectroscopy (Fourth Edition)-Tata McGraw Hill -New Delhi.

Unit I - Chapters: 2.1-2.6, 7.1-7.1.5

Unit II - Chapters: 3.1-3.5,3.8.1,3.8.3.

Unit III - Chapters: 4.1- 4.6

Unit IV - Chapters: 6.1- 6.1.8

2. G. Aruldhas - Molecular Structure and Spectroscopy (Second edition) - Prentice Hall Private Ltd

Chapters: 10.1-10.5,10.7- .9,10.17-10.19 - Unit V

COURSE OUTCOMES

On the successful completion of the course, students will be able to:

NO.	COURSE OUTCOMES
CO 1	To identify the various interactions of radiation with matter and the corresponding regions in the electromagnetic spectrum.
CO 2	To derive the relationship between molecular spectra and molecular properties
CO 3	To explain Microwave , Spin Resonance, Infra Red, Raman , Electronic and NMR spectra and the associated techniques and instrumentation.
CO 4	To apply the theory to understand molecular spectra
CO 5	To derive Bloch equations
CO6	To analyze the results of measurements using molecular spectroscopic methods and to solve problems related to spectroscopic studies of molecules

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SEMESTER –IV

For those who joined in 2019 onwards

PROGRAMME CODE	COURSE CODE	COURSE TITLE	CATEGORY	HRS/WEEK	CREDITS
PAPH	**19PG4P18**	**Advanced Quantum Mechanics**	**Lecture**	**6**	**5**

COURSE DESCRIPTION

This course deals with the approximation methods for stationary states, evolution of time concepts, scattering theory and relativistic quantum mechanics.

COURSE OBJECTIVES

- Gain knowledge of time independent perturbation theory and application of charge particle in a electromagnetic field
- Solve quantum mechanical problems using variation method and solve one dimension Schrödinger equation using WKB approximation method
- Insight of dipole approximation, harmonic perturbation, Fermi's Golden rule
- Derive Relativistic wave equations using Klien Gordan and Dirac formulations

UNIT –I APPROXIMATION METHODS FOR STATIONARY STATES

(14 HRS.)

Perturbation theory for discrete levels: Equations in various order of perturbation theory – The Non degenerate case.-The first order - The second order – The degenerate case- Removal of degeneracy – **The effect of an electric field on the energy levels of an atom (Stark effect):** (a) The ground state of the hydrogen atom (b) The first excited level of the hydrogen atom

UNIT –II TITLE (15 HRS.)

The variation method: Upper bound on ground state energy application to excited states- Trial function linear in variational parameters – **The hydrogen molecules.**

The WKB Approximation-The one dimensional Schrödinger equation: a) the asymptotic solution b) solution near a turning point c) matching at a linear turning point d) Asymptotic connection formula-**The Bohr – Sommerfield Quantum condition.**

UNIT –III SCATTERINGTHEORY (16 HRS.)

The scattering cross section : General considerations- Kinematics of the scattering process : Differential and total cross- section- wave mechanical picture of scattering : the scattering amplitude- Green's functions: formal expression for scattering amplitude- the Born approximation -validity of the Born- approximation – the Born series.

Partial wave Analysis – Asymptotic Behavior of Partial waves: Phase shifts: a) Partial waves b) Asymptotic form of radial function c) Phase shifts **– the scattering amplitude in terms of phase shifts** – the differential and total cross sections: optical theorem. .

UNIT –IV EVOLUTIONWITHTIME (16 HRS.)

Perturbation theory for time evolution problems: Perturbative solution for transition amplitude – Selection rules – First order transitions : Constant perturbation a) Transition probability b)closed spaced levels: constant transition rate- Harmonic perturbations a) amplitude for transition with change of energy b) Transitions induced by incoherent spectrum of perturbing frequencies – Interaction of an atom with electromagnetic radiation – The dipole approximation: selection rules – **the Einstein coefficient: Spontaneous Emission**

UNIT –V RELATIVISTIC WAVE EQUATIONS (19 HRS.)

Generalization of the Schrodinger Equation: The Klein-Gordon equation: Plane wave solution; charge and current densities- Interaction with electromagnetic fields; Hydrogen like atom. The Dirac Equation: Dirac's relativistic Hamiltonian- Position probability density: expectation values- Dirac matrices- Plane wave solutions of the Dirac equation : energy spectrum- The spin of the Dirac particle – Significance of negative energy states; **Dirac particle in Electromagnetic fields -Spin magnetic moment- The spin orbit energy.**

UNIT –VI DYNAMISM (Evaluation Pattern-CIA only)

Application of quantum mechanics in the current field

REFERENCES

1 . P.M. Mathews and K. Venkatesan, A Text book of Quantum Mechanics, Second Edition– Tata Mc Graw- Hill Publishing Company Limited New Delhi.

Chapters:5,6,9&10

Unit I : 5.1-5.4,

Unit II : 5.6-5.9, 5.11-5.13

Unit III : 6.1-6.6, 6.8-6.11(a)

Unit IV : 9.7, 9.12-9.15

Unit V : 10.1-10.10, 10.15(b),10.16

WEB REFERNCES :(OPTIONAL):

NPTEL online courses – Relevant videos for Quantum mechanics.

COURSE OUTCOMES

On the successful completion of the course, students will be able to:

NO.	COURSE OUTCOMES
CO 1	Understand perturbation theory
CO 2	Solve quantum mechanical problems using variation method and solve one dimension Schrödinger equation using WKB approximation method
CO 3	Explain about dipole approximation, harmonic perturbation, Fermi's Golden rule
CO 4	Understand partial wave analysis techniques
CO 5	Solve the problems using relativistic equations

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SEMESTER –IV

For those who joined in 2019 onwards

PROGRAMME CODE	COURSE CODE	COURSE TITLE	CATEGORY	HRS/WEEK	CREDITS
PAPH	19PG4PE2A	MATERIALS SCIENCE	Lecture	4	4

COURSE DESCRIPTION

Materials science occupies the centre of the innovative research area. This course deals with the various crystal growth techniques, characterization methods, thin films, nano materials and other types of materials such as polymers and ceramics and glass.

COURSE OBJECTIVES

The course enables the student to study various crystal growth techniques and understand the characterizations techniques like TEM, SEM, TGA, XRD.Also to analyse the mechanisms of Ceramics, Polymers and composites and discuss and explain various preparatory and measurements of thin film and distinguish carbon nanotubes & carbon nanomaterials and their preparatory techniques.

UNIT –I CRYSTAL GROWTH TECHNIQUES (12 HRS.)

Aqueous solution growth-nucleation-heterogeneous nucleation- crystal growth from melt-Bridgeman technique- Czochralski technique-zone melting technique-**liquid phase epitaxy(self study)**.

UNIT –II CERAMICS, POLYMERS AND COMPOSITES (12 HRS)

Ceramics- Classification of ceramics-general properties of ceramics-general properties and applications of selected engineering ceramics.

Polymers-Types of polymer-polymerization-thermosets-additives-structure of polymers-mechanism of molecular movement in polymers-**general properties and applications of thermo plastics(self study)**

UNIT –III THIN FILMS (12 HRS)

Preparation of thin films- Thermal evaporation-**flash evaporation(self study)**- electron gun beam method-cathodic sputtering –chemical vapour deposition.Thickness measurements-Ellipsometry –interferometry-multiple beam interferometer-Fizeau technique-fringes of equal chromatic order (FECO) method.

UNIT –IV NANO POWDERS AND NANO MATERIALS (12 HRS)

What are nano materials? – preparation-plasma arcing-chemical vapour deposition -Sol-gels – electrodeposition – ball milling – using natural nanoparticles-**applications of nanomaterials**.

The Carbon age

New forms of carbon – types of nanotubes- formation of nanotubes

assemblies-purification of carbon nanotubes – the properties of carbon nano tubes - **uses of nanotubes (self study)**

UNIT –V CHARACTERIZATION METHODS (12HRS)

Diffraction analysis- X-Ray diffraction-interpretation of diffraction pattern-cell parameter determination.

Thermal analysis- Thermo gravimetric analysis-**differential thermal analysis**-**differential scanning calorimetry(self study)**.

Electron microscopy-TEM, SEM –mode of operation-instrumental details-elemental analysis.

UNIT –VI DYNAMISM (Evaluation Pattern-CIA only) (4 HRS.)

Sensors, solar cell, opto electronic devices

REFERENCES:

Unit I&V (Relevant sections)

1. Crystal growth processes and methods, by P.Santhana Raghavan, P. Ramasamy.

2. Antony R.West,Solid state chemistry and its applications

3. V.Raghavan, Materials science and engineering-A first course.

4. C.Richard Brundle, Charles A.Evans and Shaun Wilson

Encyclopidia of materials characterization

Unit II- William.D. Callister, Jr. Materials science and Engineering – an introduction (V edition)

Unit III- A.Goswami, Thin Film fundamentals by (New age International (P) Ltd.)

Unit IV- Mick Wilson, K.K.G.Smith, M.Simmons, & B.Raguse, Nanotechnology by (Overseas Press)

WEB REFERNCES :

https://www.elsevier.com/physical-sciences-and-engineering/materials-science

https://www.sciencedirect.com/referencework/9780128035818/materials-science-and-materials-engineering

http://www.istl.org/02-spring/internet.html

http://igorivanov.tripod.com/physics/materials.html

COURSE OUTCOMES

On the successful completion of the course, students will be able to:

NO.	COURSE OUTCOMES
CO 1	Deduce the expressions of Nucleation phenomena and explain various Crystal growth techniques
CO 2	explain the mechanism of molecular movements in Ceramics, Polymers and Composites
CO 3	Analyse various methods of preparing thin films and its measurement techniches
CO 4	Explore novel methods of preparing carbon nanomaterials and carbon nanotubes.
CO 5	understand the concepts of Diffraction analysis, Thermal analysis and Electron microscopy used in crystal characterisation

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SEMESTER –IV

(*For those who joined in 2019 onwards*)

PROGRAMME CODE	COURSE CODE	COURSE TITLE	CATEGORY	HRS/WEEK	CREDITS
PAPH	19PG4PE2B	ASTRO PHYSICS	Lecture	4 Hrs.	4

COURSE DESCRIPTION

This course intends to give an insight into versatile concepts of astronomy namely origin and evolution of universe, observation techniques, stellar evolution, fate of stars and various mechanisms of stellar energy generation.

COURSE DESCRIPTION

This course gives an overview of the universe and imparts knowledge on the sense of size and time for astronomical observation techniques. It gives a complete description of the fate of stars comprising of its birth, evolutionary stages and its ultimate fate. Also the origin , evolution and future course of the universe is detailed out.

UNIT I: LIGHT AND TELESCOPE [12 HRS]

Light and Telescopes-The spectrum-the spectral lines-what a telescope is-refracting telescopes-reflecting telescopes-spectrscopy-recording the data-electronic imaging devices-observing at short wavelengths-ultraviolet and X-ray astronomy-X-ray telescopes-observing at long wavelength-infrared astronomy-radio astronomy

UNIT II: STELLAR EVOLUTION [12 HRS]

Stellar evolution-stars in formation-stellar energy generation-atoms-stellar energy cycles-the stellar prime of life-(the neutrino experiment)-dying star-red giant-planetary nebula-white dwarfs-white dwarfs and the theory of relativity-**novae-(evolution of binary stars).(selfstudy)**

UNIT III: PULSERS [12 HRS]

Red super giants-supernovae -(cosmic rays)-neutron stars-discovery of pulsars-what are pulsars-(gravitational waves.)-The formation of stellar black hole-the photon sphere-the event horizon-rotating black hole – **detecting a black hole-non-stellar black holes (self study)**

UNIT IV: SUN [12 HRS]

The sun-basic features of the sun-the photosphere-the chromosphere-the corona-space observations of the chromosphere and the corona-sunspots and other solar activity-solar-terrestrial relations-**solar wind-solar constant. (self study)**

UNIT V: GALAXY [12 HRS]

Comets-meteoroids-astroids-chiron. Structure of Milky way galaxy-nebluae-center of our galaxy-**high-energy sources in our galaxy. (self study)** Quasars-discovery-red shift in Quasars-importance of Quasars. Big Bang theory-General relativity theory and cosmology-steady state theory.

UNIT – 6 DYNAMISM [1 HR]

Impact of black holes on earth atmosphere

TEXT BOOKS:

CONTEMPORARY ASTRONOMY-JAY M. PASCHOFF

UNIT I : Chapter1-1.1-1.3, 2.1-2.5,2.10-2.13.
UNIT II : Chapter8-8.1-8.7, 9.1-9.3,9.4,9.5,9.6.9.8
UNIT III : Chapter10-10.1,10.2,(10.3),10.4,10.5,10.7,(10.12),11.1-11.6
UNIT IV : Chapter7 – 7.1-7.10
UNIT V : Chapter 20-20.1-20.4, 22.1-22.3, 27.2-27.4, 26.1- 26.3.

REFERENCE BOOKS:

1. An introduction to astrophysics by Baidhyanath Basu
2. An introduction to Modern Astrophysics by Bradley W. Caroll and Dale A.Ostlie.

COURSE OUTCOMES

On the successful completion of the course, students will be able to:

NO.	COURSE OUTCOMES
CO 1	outline variety of objects in the Universe with a sense of scale for size and time and different types of observing techniques, instruments used in Astronomy.
CO 2	acquire knowledge about the stellar evolution and mechanism of stellar energy generation
CO 3	gain an idea of fate of massive stars exploding as dazzling supernovae and medium mass stars condensing as neutron stars
CO 4	explain the surface features and regions of the nearest star Sun and the impacts of the solar activities on earth.
CO5	obtain knowledge about the origin and evolution of the Universe and comprehend its future course..

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SEMESTER –IV

For those who joined in 2019 onwards

PROGRAMME CODE	COURSE CODE	COURSE TITLE	CATEGORY	HRS/WEEK	CREDITS
PAPH	19PG4P19	Practicals VII	Lecture	3	2

COURSE DESCRIPTION

The lab course provides hands on experience in **Advanced General Experiments** in Physics.

COURSE OBJECTIVE/S

The course deals with electric, magnetic, optic and electromagnetic behaviour of materials,propagation of Ultrasonic waves through liquids, microwave characteristics.

LIST OF EXPERIMENTS

1. Determination of curie temperature, energy loss, and to trace the hysteresis (B-H) loop of a ferromagnetic specimen.

2. Ultrasonic Interferometer-Determination of ultrasonic velocity through KCl solution and its compressibility at different concentrations.

3. Determination of Dielectric constants of solids and liquids using capacitance method.

4.Impedance measurementusing LCR meter.

5.Determination of particle size using laser.

6. Microwave characteristics of reflex klystron-Determination of its frequency.

7. Determination of wavelength of a laser source using diffraction grating.

8. To study the magneto-striction of a given material.

9. G.M. counter-Characteristics, inverse square law.

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SEMESTER –IV

For those who joined in 2019 onwards

PROGRAMME CODE	COURSE CODE	COURSE TITLE	CATEGORY	HRS/WEEK	CREDITS
PAPH	19PG4P20	Practicals VIII	Practicals	3	2

COURSE DESCRIPTION

The course deals with Computational Programming skills.

COURSE OBJECTIVE/S

The course familiarizes the students to apply numerical methods in modern scientific computing.

Computational Programming Lab

(C++ and Scilab programmes)

1. Evaluating a root of non-linear equation by Newton-Raphson method using external function
2. Program to solve system of linear equations using simple Gaussian elimination method
3. Program for straight line fit using the method of least squares for a table of data points
4. Program for polynomial curve fitting
5. Program to integrate any function or tabulated data using trapezoidal rule
6. Program to integrate any function or tabulated data using Simpson's rule
7. Program to compute the solution of a first order differential equation of type y'=f(x,y) using the fourth order Runge-Kutta method
8. Program to compute the interpolation value at a specified point, given a set of data points using Lagrangian interpolation representation
9. Program to compute the interpolation value at a specified point, given a set of data points using Newton's interpolation representation
10. Ascending and descending order of numbers and characters
11. Matrix addition, subtraction and multiplication
12. Transpose of a matrix
13. Program to calculate and print the mean, variance and standard deviation of set of N numbers
14. Program to solve the quadratic equation

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SEMESTER –III

For those who joined in 2019 onwards

PROGRAMME CODE	COURSE CODE	COURSE TITLE	CATEGORY	HRS/WEEK	CREDITS
PAPH	19PGSLP1	INSTRUMENTATION AND EXPERIMENTAL METHODS	Tutorial	-	2

COURSE DESCRIPTION

This course enables the students to understand, analyze and implement the fundamental instrumentation and experimental methods of Physics.

COURSE OBJECTIVES

This course introduces the various instrumentation and experimentation methods encompassing data interpretation and analysis, sensors and transducers, vacuum and thin film techniques, ac and dc measurements, signal conditioning and noise

UNIT I:DATA INTERPRETATION AND ANALYSIS

Measurement, result of a measurement, sources of uncertainty and experimental error, Systematic error, random error, Reliability- chi square test, Analysis of repeated measurement, Precision and accuracy, Elementary data fitting.

UNIT II: SENSORS AND TRANSDUCERS

Transducers, Transducer characteristics, selection of a instrumentation transducer, Transducer as an electrical element, modelling external circuit components, circuit calculations, Sensors and Transducers: Temperature, Pressure, Vibration, Magnetic Field, Force and Torque, Optical.

UNIT III: VACUUM AND THIN FILM TECHNIQUES

Units of pressure measurement, characteristics of vacuum, applications of vacuum, Vacuum pumps: Rotary, oil diffusion, turbo molecular pumps, Ion pumps. Vacuum gauges: Pirani and Penning gauges. Pumping speed of a

vacuum pump. Thin film techniques(overview), film thickness monitors, film thickness measurement.

UNIT IV: MEASUREMENTS

Resistance: DC and AC Measurements , Inductance Measurement: The Maxwell Bridge, Parallel Inductance bridge, Anderson bridge. Voltage Measurement: AC and DC, Current Measurement: AC and DC. Resistivity Measurement: 2-probe, 4-probe and Van-der-Paw measurements.

UNIT V: SIGNAL CONDITIONING AND NOISE

Operational amplifiers, Instrumentational amplifiers, precision absolute value circuits, True RMS to DC converters. Phase sensitive detection: Lock in amplifier, Box-car integrator, Spectrum analyzer. Noise in Circuits: Probability Density Functions, The Power Density Spectrum, Sources of noise, Introduction to Digital signal conditioning

REFERENCES

1. Measurement, Instrumentation and Experimental desigh in Physics and
   EngineeringMichael Sayer and Abhai Mansingh, Prentice Hall of India 2005
2. Data Reduction and Error Analysis for the Physical Sciences, P.R. Bevington and K.D Robinson, McGraw Hill, 2003
3. Electronic Instrumentation- H.S. Kalsi, TMH Publishing Co. Ltd. 1997
4. Instrumentation Devices and Systems-C.S. Rangan, G.R. Sharma, V.S.V.
   Mani, 2nd Edition, Tata McGraw Hill, New Delhi, 1997
5. Instrumentation Measurement Analysis-B.C. Nakra, K.K. Chaudhary.

COURSE OUTCOMES

On the successful completion of the course, students will be able to:

NO.	COURSE OUTCOMES
CO 1	Explain the field of nanoscience to analyze and fit the experimental data with different kind of errors
CO 2	explain principle, theory and application of various sensors and transducers
CO 3	describe the various methods of vacuum and thin film measurements
CO 4	Discuss the basic principle and importance of the different AC and DC measurement techniques.
CO 5	Explain the developing instruments and their uses