SAKTHI COLLEGE OF ARTS AND SCIENCE FOR WOMEN, ODDANCHATRAM

(Recognized Under Section 2(f) and 12(B) of UGC Act 1956)

(Affiliated to Mother Teresa Women's University, Kodaikanal)

PG & RESEARCH DEPARTMENT OF PHYSICS

CURRICULUM FRAMEWORK AND SYLLABUS FOR

OUTCOME BASED EDUCATION IN

SYLLABUS FOR

M.Sc., Physics

FRAMED BY

MOTHER TERESA WOMEN'S UNIVERSITY,

KODAIKANAL

UNDER

CHOICE BASED CREDIT SYSTEM

2018-2021

Preamble:

Physics, a core discipline, is the fundamental and foremost to all natural sciences. It has been significant and influential through advances in its understanding that have translated in to new technologies. The Department of Physics has been launched in the academic year 2009, with the introduction of B.Sc., (Physics) Degree Programme. It has met with the vertical growth by the introduction of M.Sc., (Physics) in 2010 and M.Phil. (Physics) in 2014.

The Department has highly qualified faculty members and support staff and is committed towards the development of innovative and handy ways of teaching at graduate, post graduate and research level and carrying out cutting edge research in various research fields. The department strives to nurture the young minds towards embracing various scientific challenges. Project work and problem sessions are encouraged to develop innovative and analytical approach to physics learning.

Fixing the Learning Objectives:

Since the Academic year 2018 – 2019, the learning objectives and outcomes of the programmes B.Sc., (Physics), M.Sc., (Physics) and M.Phil. (Physics) have been set, following the Bloom's Taxonomy Cognitive Domain. Accordingly, it is broken into six levels of learning objectives of each course. They are

K1 / Knowledge = Remember

K2 / Comprehension = Understand

K3 / Application = Apply

K4 / Analysis = Analyze

K5 / Evaluation = Evaluate

K6 / Synthesis = Create

Mapping COs with POs:

For each programme, the Educational objectives and the Specific objectives are specified. The programme outcomes are designed according to the curriculum, teaching, learning and evaluation process. For each course, the definite outcomes are set, giving challenge to the cognitive domain. The course outcomes are mapped with the programme outcomes. The performance of the stakeholders is assessed and the attainment rate is fixed, by using the measurements 'high', 'medium' and 'low'. The restructuring of the curriculum is done based on the rate of attainment.

Institutional Objectives:

The institution has certain definite Institutional Objectives to be attained.

- Skill Development & Capacity Building
- Women Empowerment
- Self-reliance
- Gender Equity & Integrity

Programme Educational Objectives:

The Programmes B.Sc., M.Sc., and M.Phil. (Physics) are offered with certain Specific Objectives.

- To identify the fundamental laws for the study of various areas of physics and define and describe them with clarity.
- To know the application of principles and concepts of Physics with necessary practical background and assess their consequences
- To explain the basic foundation of the underlying principles and laws of Physics.
- To discuss, formulate and analyse problems in Physics and identify the key concepts and principles to solve them.
- To execute an experiment through careful observations, precise measurements, analyses, interpretation and effectively present the results.

Mapping PEOs with IOs:

Programme Educational Objectives	**Institutional Objectives**			
B.Sc. / M.Sc. / M.Phil., (Physics)	**1**	**2**	**3**	**4**
PEO1: To identify the fundamental laws for the study of various areas of physics and define and describe them with clarity.	*			
PEO2: To know the application of principles and concepts of Physics with necessary practical background and assess their consequences		*		
PEO3: To explain the basic foundation of the underlying principles and laws of Physics.			*	
PEO4: To discuss, formulate and analyze problems in Physics and identify the key concepts and principles to solve them.				*
PEO5: To execute an experiment through careful observations, precise measurements, analyses, interpretation and effectively present the results.			*	

Measuring: H – High; M – Medium; L – Low

Programme Outcomes: (POs):

On completion of the M.Sc., (Physics) Programme, certain outcomes are expected from the learners.

- **PO1:** Demonstrating an understanding of core knowledge in Physics.
- **PO2:** Acquiring laboratory skills to take measurements in a Physics laboratory and analysing the measurements to draw valid conclusions.
- **PO3:** Analysing the scientific problems and experiments creatively and critically for research problems
- **PO4:** Evaluating the basic foundation of the underlying principles and laws of Physics.
- **PO5:** Demonstrating written and oral communication skills in communicating Physics-related topics.
- **PO6:** Pursuing higher studies and undertaking research work.
- **PO7:** Taking up future academic career and establishing themselves in global scenario

ASSESSMENT PATTERN

CIA / QUESTION PATTERN & SCHEME

S. No	Section	Question Type	Marks Allotted
1	Part - A	Six questions in multiple choice pattern, testing K1 and K2 are to be given. Each question carries one mark.	03X01 = 03
2	Part - B	Two descriptive questions, with alternate options, testing K3 and K4, are to be given. Each question carries four marks.	02X02 = 04
3	Part - C	Two descriptive questions, testing K5 and K6, are to be given. Three questions are to be answered. Each question carries 15 marks.	02X04 = 08
4		Assignment	05
5		Seminar	05
Total Marks in CIA			25

CE / QUESTION PATTERN & SCHEME

S. No	Section	Question Type	Marks Allotted
1	Part - A	Ten questions in multiple choice pattern, testing K1 and K2 are to be given. From each unit, two questions must be taken. Each question carries one mark.	10X1 = 10
2	Part - B	Five descriptive questions, with alternate options, testing K3 and K4, are to be given. Each question carries four marks. Questions are taken in the given order. Qtn. No. 11 (a) or (b) from Unit I Qtn. No.12 (a) or (b) from Unit II Qtn. No.13 (a) or (b) from Unit III Qtn. No.14 (a) or (b) from Unit IV Qtn. No.15 (a) or (b) from Unit V	5X4 = 20
3	Part - C	Six descriptive questions, testing K5 and K6, are to be given. Three questions are to be answered. Each question carries 15 marks. Questions are taken in the given order. Qtn. No. 16 from Unit I Qtn. No. 17 from Unit II Qtn. No. 18 from Unit III Qtn. No. 19 from Unit IV Qtn. No. 20 from Unit V	3X15 = 45
Total Marks in CE			75

COMMON ACADEMIC STRUCTURE / M.Sc., PHYSICS / 2018 - 2021

Sem	Sub Code	Title of the Paper	Hrs.	Credits	Marks		
					CIA	CE	Total
I	PHY011C	Part III / Core I / Mathematical Physics I	5	5	25	75	100
	PHY012C	Part III / Core II / Classical Mechanics	5	5	25	75	100
	PHY013C	Part III / Core III / Applied Electronics	5	5	25	75	100
	PHY014C	Part III / Core Practical – I	5	5	25	75	100
	PHY015E	Part III / Elective-I / Numerical Methods	5	5	25	75	100
		SUB TOTAL	25	25	125	375	500
II	PHY021C	Part III / Core IV / Mathematical Physics II	5	5	25	75	100
	PHY022C	Part III / Core V / Quantum Mechanics I	5	5	25	75	100
	PHY023C	Part III / Core VI / Statistical Mechanics and Thermodynamics	5	5	25	75	100
	PHY024C	Part III / Core Practical – II	5	5	25	75	100
	PHY025E	Part III / Elective-II / Materials Characterization	5	5	25	75	100
		SUB TOTAL	25	25	125	375	500
III	PHY031C	Part III / Core VIII / Electromagnetic Theory and Plasma Physics	5	5	25	75	100
	PHY032C	Part III / Core VIII / Quantum Mechanics II	5	5	25	75	100
	PHY033C	Part III / Core IX / Solid State Physics	5	5	25	75	100
	PHY034C	Part III / Core Practical – III	5	5	25	75	100
	PHY035E	Part III / Elective-III / Materials Science	5	5	25	75	100
		SUB TOTAL	25	25	125	375	500
IV	PHY041C	Part III / Core X / Spectroscopy	5	5	25	75	100
	PHY042C	Part III / Core XI / Nuclear Physics and Particle Physics	5	50	25	75	100
	PHY043C	Project Viva -Voce	5	5	25	75	100
		SUB TOTAL	15	15	75	225	300
		TOTAL	90	90			1800

Programme: M.Sc., **Subject: Physics**

Semester: I **Course: Mathematical Physics I**

Course Type: Part – I/ Core Paper – I **Credits: 5**

Hours Required: 5 Hrs. / Week **CIA: 25 /CA: 75**

PHY011C MATHEMATICAL PHYSICS I

Course Outcomes:

After completion of the course, certain outcomes are expected from the learners.

Description	Bloom's Taxonomy level
Describing the first order ODEs and their application in physics problems.	Comprehension (Level 2)
Evaluating the concept of second and third order ODEs and their meaning.	Evaluation (Level 5)
Using Series Solutions of ODEs. Special Functions principles and problems can be solved	Application (Level 3)
Analyzing the mathematical concepts and tools such as Beta, Gama functions and partial differential functions to solve numerical problems of physics.	Analysis (Level 4)
Describing the usefulness of Laplace Transforms in solving problems associated	Synthesis (Level 6)

COURSE CONTENT

Unit I First- Order ODEs

Basic Concepts. Modelling - Geometric Meaning of y' = f(x, y). Direction Fields – Separable ODEs- Exact ODEs. Integrating Factors- Linear ODEs. Bernoulli Equation. Population Dynamics- Orthogonal Trajectories. Optional-Existence and Uniqueness of Solutions

Unit II Second- Order Linear ODEs

Homogeneous Linear ODEs of Second Order-Homogeneous Linear ODEs with Constant Coefficients – Differential Operators. Optional – Modelling: Free Oscillations. (Mass-Spring System)- Euler- Cauchy Equations- Existence and Uniqueness of Solutions. Wronskian-Non homogeneous ODEs – Modelling: Forced Oscillations. Resonance-Modelling: Electric Circuits- Solution by Variation of Parameters.

Unit III Higher Order Linear ODEs

Homogeneous Linear ODEs-Homogeneous Linear ODEs with Constant Coefficients-Non homogeneous Linear ODEs

Unit IV Series Solutions of ODEs. Special Functions

Power Series Method - Theory of the Power Series Method - Legendre's Equation .Legendre Polynomials - Frobenius Method - Bessel's Equation. Bessel Functions - Bessel Functions of the Second Kind - Sturm- Liouville Problems. Orthogonal Functions - Orthogonal Eigen function Expansions

Unit V Laplace Transforms

Laplace Transform, Inverse Transform. Linearity.-Shifting-Transforms of Derivatives and Integrals. ODEs -Unit Step Function's-Shifting - Short Impulses. Dirac's Delta Function. Partial Fractions - Convolution. Integral Equations - Differentiation and Integration of Transforms. –Systems of ODEs-Laplace Transform: General Formulas.

Book for Study:

1. Unit 1-5 - Chapter 1-3,5,6-Advanced Engineering Mathematics – Erwin Kreyszig, 9th Edition, John Wiley and Sons, Inc. 2006

Books for Reference:

1. Mathematical Methods for Physicist - George B.Arfken, Hans J.Weber, 6th Edition, Elsevier Academic Press, 2005
2. Mathematical Physics – P.K. Chattopadhyay– Wiley Easter,(1990)
3. Introduction to Mathematical Physics – Charlie Harper – Prentice Hall India (1987) New Delhi
4. Applied Mathematics for Engineers and Physicists, III Edn.–Pipes & Harveil l0 McGraw Hill (1971)

Online Resource

1. http://www.MathematicalPhysics si.edu/contents.html
2. http://www.physicstutorials.org/home/ mathematical physics

Programme: M.Sc. **Subject: Physics**

Semester: I **Course: Classical Mechanics**

Course Type: Part – I/ Core Paper – II **Credits: 5**

Hours Required: 5 Hrs. / Week **CIA: 25 /CA: 75**

PHY012C CLASSICAL MECHANICS

Course Outcomes:

After completion of the course, certain outcomes are expected from the learners.

Description	Bloom's Taxonomy level
Understanding the concept of D'Alemberts principle and Lagrange principle.	Comprehension (Level 2)
Acquiring the knowledge about variation principles and two body central force problem.	Knowledge (Level 1)
Using an understanding of statistical physics and elementary mathematics along with physical principles	Application (Level 3)
Designing experiments and acquire data in order to explore physical principles, Euler angles, Euler's theorem and Eigen value equation and the principle axis transformation.	Analysis (Level 4)
Solving problems encountered in classical and statistical Mechanics.	Evaluation (Level 5)

COURSE CONTENT

Unit I: Survey of Elementary Principles

Mechanics of a particle and a system of particles, Constraints, D'Alembert's Principle and Lagrange's equation, Velocity dependent potential and dissipation function, Simple application of the lagrangian formulation, Variational principle and Lagrange's equation, Hamiltonian principle, Basic techniques of calculus of variations, Derivation of Lagrange's equations from Hamiltonian's Principle

Unit II: Symmetry Properties, Two Body Central Force Problem

Reduction to the equivalent one body problem, the equations of motion and first integrals, the equivalent one dimensional problem and classical of orbits, viral theorem, differential equation for the orbit and integral power law potentials, the Kepler problem

Unit III: The Kinematics of Rigid Body Motion

The independent coordinate of a rigid body, The Euler angles, Euler's theorem on the motion of rigid body, finite and infinitesimal rotation, rate of change of a vector, coriolis force, angular momentum and kinetic energy of motion about a fixed point, Moment of inertia tensor and its diagonalization, equation of torque –free motion, concepts of precession and nutation.

Unit IV: Small Oscillations

Formulation of the problem, Eigen value equation and the principle axis transformation, frequencies of free vibrations on normal coordinates, free vibrations of a linear triatomic molecule. Legendre transformation and Hamiltonian's equations of motion, cyclic coordinates and conservation theorems

Unit V: The Equations of Canonical Transformation

Examples, The simplistic approach to canonical transformation, Poisson brackets and other canonical invariants, equations of motion, Infinitesimal canonical transformation conservation theorem in the Poisson bracket formation, Hamiltonian Jacobi equation and its application to the harmonic oscillator problem

Books for Study:

1. H. Goldstein, Classical Mechanics, II Edition, Narosa Publishing House, New Delhi, Chennai, Mumbai and Kolkata, 2000. (Unit I-V, Chapter1-10).

References:

1. Naranya Chandra Rana, Classical Mechanics-Tata McGraw-Hill Publishing Company Limited, New Delhi, 1991.
2. TW.B.Kibble, Classical Mechanics- Longman,1985
3. J.L.Syngeand B.A.Griffith, Principles of Mechanics, McGraw-Hill, New York, 1942.

Online Resource:

1. http://www.classicalmechanics si.edu/contents.html
2. http://www.physicstutorials.org/home/ classical mechanics

Programme: M.Sc., **Subject: Physics**

Semester: I **Course: Applied Electronics**

Course Type: Part – I/ Core Paper – III **Credits: 5**

Hours Required: 5 Hrs. / Week **CIA: 25 /CA: 75**

PHY013C APPLIED ELECTRONICS

Course Outcomes:

After completion of the course, certain outcomes are expected from the learners.

Description	Blooms' Taxonomy Level
Providing the fundamental aspects regarding development of electronics in discrete components.	Knowledge (Level 2)
Understanding the Op- amps and its application	Comprehension (Level 2)
Using an understanding of oscillators and amplifiers with its physical principles by doing experiments	Application (Level 3)
Designing experiments using integrated chips by constructing of. D/A and A/D converters.	Analysis (Level 4)
Evaluating the function of amplifier, oscillators and counters, registers.	Evaluation (Level 5)

COURSE CONTENT

Unit I: Differential DC amplifiers

Differential DC amplifier–Stable AC Coupled amplifier–Analogue integration and differentiation – Solution to simultaneous and differential equations using Op Amps- Active Filters – Comparator-Zero crossing detector – Regenerative comparator – Clippers- Half wave Rectifier- peak detector – Clampers- Logarithmic amplifiers – Wave form generators - 555-timer IC and its applications

Unit II:

FlipFlops : SR Flipflop-D Flipflop-JKflip flop-T flipflop

Registers and Counters: Shift Registers–Ring Counter-Shift Counter-Asynchronous Counter-Synchronous counters – Designs of Mod -3, Mod- 16, Random sequence generator **Semiconductors Memories:** ROM, EPROM, EEPROM –Static and Dynamic Ram

Unit III: D/A and A/D Converters

Binary weighed resistor D/A converter- R-2R ladder D/A converter– Flash counter type, Successive approximation and dual slope A/D converters– Resolution and accuracy

Unit IV: Digital Integrated Circuits

Introduction – Bipolar transistor characteristics – RTL and DTL circuits – Integrated injection –logic- transistor- transistor logic – emitter – Coupled logic – Metal Oxide Semiconductor – Complementary MOS

Unit V: Optical Devices:

Optical absorption-Photon Absorption Coefficient-Electron–Hole Pair Generation rate-Solar Cells- PN junction solar cell-Conversion efficiency and solar concentration- no uniform absorption effects- hetero junction solar cells- amorphous silicon solar cell – Photo detectors-Photo conductor-photo diode-PIN photo diode- A valance photo diode-photo transistor-LED-Generation of lights-Internal Quantum efficiency-external quantum efficiency-LED devices-Laser diodes- Stimulated emission and population conversion-optical cavity-threshold current-device structures and characteristics.

Book for Study:

1. G.K.Mithal, Electronic devices and Circuits(22nd Edition), Khanna Publishers, Delhi, 1999 (Unit I)
2. V. Vijayendran, Introduction to Integrated Electronics, Viswanathan Printers, 2007. (Unit - II,III,IV)
3. Donald A. Neamen, Semiconductor Physics and devices (3rdedition), Tata Mc.Graw, 2003.(Unit V)

Books for reference:

1. F. Coughlin and F. F. Driscol, Opamp and linear integrated circuits (6th Edition), Pearson, 2001
2. A. Ghatak and K.Thyagarajan, Optical electronics, Cambridge Press, 1989.
3. M.S.Tyagi,IntroductiontoSemiconductorDevicesWiley,NY,1991
4. S.M.Sze, Physics of Semiconductor Devices(2nd Edition),Wiley,NY,1981
5. M.Sayerand A.Mansingh, Measurement, Instrumentation and Experimental Design in Physics and Engineering, Prentice-Hall India, New Delhi, 2000.

Online Reference:

1. https://en.wikipedia.org/wiki/Electronic_oscillator
2. https://www.electronics-tutorials.ws/opamp/opamp_1.html
3. https://byjus.com › Physics › Physics Article

Programme: M.Sc., **Subject: Physics**

Semester: I **Course: Practical I**

Course Type: Part – III/ Practical I **Credits: 5**

Hours Required: 5 Hrs. / Week **CIA: 25 /CA: 75**

Course Outcomes:

After completion of the course, certain outcomes are expected from the learners.

Description	Blooms' Taxonomy Level
Understanding the OP-amp experiment.	Knowledge (Level 1)
Identifying the link between theory and experiment on various experiments like Phase – Shift Oscillator, wein bridge, Square wave generator experiments.	Comprehension (Level 2)
Using an understanding of Timer IC NE 555 7400and7413experiments voltage regulation principles in electrical equipment's can be known.	Application (Level 3)
Designing experiments and acquire data in order to study about the various working configuration of OP-Amp. And ICs.	Analysis (Level 4)
Applying the knowledge of OP-Amp IC NE 555 7400and7413and students are able to correlate theory and experiments and make useful conclusions.	Synthesis (Level 6)

COURSE CONTENT

This paper aims at providing an in-depth knowledge of the operational amplifier.

The students will also get the opportunity to practically work out during the lab sessions.

1. Operational Amplifier–Design–Phase–Shift Oscillator,
2. Operational Amplifier– Design–Wein Bridge Oscillator
3. Operational Amplifier– Square wave generator
4. Operational Amplifier–sawtooth wave generator
5. Operational Amplifier–Triangular wave generator
6. Operational Amplifier– Design of Schmitt Trigger
7. Operational Amplifier–Construction of Monostable Multivibrator
8. Timer IC NE555SchmittTrigger
9. ClockGeneratorsusing7400and7413Ics
10. Up-Down Counters–Design of modulus counters
11. ArithmeticoperationsusingIC7483
12. 7490 as modulus counters and displayusing7447
13. Study of Multiplexer and Demultiplexer
14. ActiveFiltersusingIC74

Suggested Books

1. C.C Ouseph, G.Rangarajan- A Text Book of Practical Physics- S. Viswanathan Publisher-Part I(1990).

2. C. C Ouseph, C. Rangarajan, R. Balakrishnan-A Text Book of Practical Physics-S. Viswanathan Publisher-Part II (1996)

3. S. L Gupta and V. Kumar-Practical Physics - Pragati Prakashan –25th, Edition (2002)

Online References:

1. https://www.youtube.com/watch?v=N0lxwqANsd4
2. https://www.youtube.com/watch?v=WwexoU-gUoc
3. https://www.youtube.com/watch?v=OGHpiUMSRwg
4. https://www.cmi.ac.in/~debangshu/lab1/zener.pdf

Programme: M.Sc., **Subject: Physics**

Semester: I **Course: Numerical Methods**

Course Type: Part – II/ Elective Paper – I **Credits: 5**

Hours Required: 5 Hrs. / Week **CIA: 25 /CA: 75**

PHY015E NUMERICAL METHODS

Course Outcomes:

After completion of the course, certain outcomes are expected from the learners.

Description	Bloom's Taxonomy level
Describing Curve fitting problems	Comprehension (Level 2)
Evaluating the concept of Algebraic and Transcendental theorem, formulas and their meaning.	Evaluation (Level 5)
Using Simultaneous Equations and problems can be solved	Application (Level 3)
Analysing Newton's Interpolation Formulae to solve numerical problems of physics.	Analysis(Level 4)
Describing the usefulness of Laplace Transforms in solving problems associated	Synthesis (Level 6)

COURSE CONTENT

Unit I: Curve Fitting

Introduction-Linear Law-Method of Group Averages-Method of Moments-Method of Least Squares.

Unit II: Algebraic and Transcendental Equations

Introduction-Errors in Numerical Computation-Iteration Method-Bisection Method-Regular Falsi Method-Newton-Raphson Method-Horner's Method.

Unit III: Simultaneous Equations

Introduction-SimultaneousEquations-BackSubstitution-GaussElimination Method-Gauss-Jordan Elimination Method-Calculation of Inverse of a Matrix-Crout's Method-Iterative Methods-Gauss Jacobi Iteration Method-Gauss-Seidel Iteration Method-Relaxation Method-Newton-Raphson method for Simultaneous Equations.

Unit IV: Interpolation

Introduction-Newton's Interpolation Formulae-Central Difference Interpolation Formulae-Lagrange's Interpolation Formula-Divided Differences-Newton's Divided Differences Formula-Inverse Interpolation-Hermits Interpolating Polynomial.

Unit V: Numerical Differentiation and Integration

Introduction-Derivatives using Newton's Forward Difference Formula Derivatives Using Newton's Backward Difference Formula, Derivatives Using Central Difference Formulae-Maxima and Minima of the Interpolating Polynomial-Numerical Integration-Gaussian Quadrature Formula-Numerical Evaluation of Double Integrals

Book for Study:

1. S.Arumugam, A.Thangapandi Issac, A.Somasundaram, Numerical Methods, Scitech (2000)

Book for References:

1. R.L. Burden, J.D.Faires, Numerical Analysis, Thomson Asia,2002
2. P.B.Patil, U.P.Verma, Numerical Computational Methods, Narosa, 2006

Online Resource

1. https:// www.teacheron.com. Numerical method.tutors//
2. https://www. Numerical method.com

Programme: M.Sc., **Subject: Physics**

Semester: II **Course: Mathematical Physics II**

Course Type: Part – I/ Core Paper – I **Credits: 5**

Hours Required: 5 Hrs. / Week **CIA: 25 /CA: 75**

PPHT21 MATHEMATICAL PHYSICSII

Course Outcomes:

After completion of the course, certain outcomes are expected from the learners.

Description	Bloom's Taxonomy level
Describing the Fourier Series, Integrals, and Transforms and their application in problems and theory's.	Comprehension (Level 2)
Evaluating the concept of Partial Differential Equations (PDEs) and their functions	Evaluation (Level 5)
Using Complex Numbers. Complex Plane and Special Functions principles and problems can be solved	Application (Level 3)
Analysing the mathematical concepts and tools such as Line Integral in the Complex Plane - Cauchy's Integral Theorem to solve problems of physics.	Analysis(Level 4)
Describing the usefulness of Laplace Transforms in solving problems associated with power series.	Synthesis (Level 6)

COURSE CONTENT

Unit I Fourier series, Integrals, and Transforms

Fourier series- Functions of Any Period P=2L-Evenand Odd Functions-Half-Range Expansions, Complex Fourier Series. - Forced Oscillations - Approximation by TrigonometricPolynomials-FourierIntegral-FourierCosineandSineTransforms-Fourier Transform, Discrete and Fast Fourier Transforms

Unit II Partial Differential Equations (PDEs)

Basic Concepts -Modelling: Vibrating String, Wave Equation -Solution by Separating Variables. Use of Fourier series - D' Alembert's Solution of the Wave Equation. Characteristics – Heat Equation: Solution by Fourier Series-Heat Equation: Solution by Fourier Integrals and Transforms -Modelling: Membrane, Two-Dimensional Wave Equation.

Unit III Complex Numbers and Functions

Complex Numbers, Complex Plane-Polar Form of Complex Numbers. Powers and Roots-Derivative. Analytic Function-Cauchy-Riemann Equations. Laplace's Equation-Exponential Function-Trigonometric and Hyperbolic Functions-Logarithm. General Power.

Unit IV Complex Integration

Line Integral in the Complex Plane - Cauchy's Integral Theorem - Cauchy's Integral Formula –Derivatives of Analytic Functions.

Unit V Power Series, Taylor Series, Laurent Series. Residue Integration

Sequences, Series, Convergence Tests-Power Series-Functions Given by Power Series-Taylor and McLaurin Series-Laurent Series-Singularities and Zeroes. Infinity-Residue Integration Method –Residue Integration of Real Integrals.

Book for Study:

1. Unit I - V Chapter 11-16 –Advanced Engineering Mathematics–Erwin Kreyszig, 9th Edition, John Wiley and Sons, Inc. 2006

Books for Reference:

1. Mathematical Methods for Physicist George B. Arfken, Hans J. Weber, 6th Edition, Elsevier Academic Press, 2005.
2. Mathematical Physics–P.K. Chattopadhyay– Wiley Easter, (1990)
3. Introduction to Mathematical Physics – Charlie Harper – Prentice Hall India (1987) New Delhi Applied Mathematics for Engineers and Physicists, III Edn.–Pipes & Harveill McGrawHill (1971)

Online Resource:

1. https:// www.teacheron.com./mathematicalphysicstutors//
2. https://www.mathematicalphysics.com

Programme: M.Sc., **Subject: Physics**

Semester: II **Course: Quantum Mechanics-I**

Course Type: Part – I/ Core Paper – II **Credits: 5**

Hours Required: 5 Hrs. / Week **CIA: 25 /CA: 75**

PPHT22 QUANTUM MECHANICSI

Course Outcomes:

After completion of the course, certain outcomes are expected from the learners.

Description	Blooms' Taxonomy Level
Understanding the basic concepts of Quantum Mechanics to explain natural physical processes and related technological advances.	Comprehension (Level2)
Acquiring the Knowledge about General Formalism of Quantum Mechanics of quantum physics.	Knowledge (Level 1)
Using the the One Dimensional Problems concepts , Alpha Emission, Bloch Waves in a Periodic Potential concepts are known	Application (Level 3)
Acquiring knowledge about Two Interacting Particles, Three Dimensional Square-Well Potential, Deuteron. And evaluation of related scientific studies.	Evaluation (Level 5)
Solving problems encountered in angular momentum and Eigen values, Eigen function problems free particle and square well potential.	Synthesis (Level 6)

COURSE CONTENT

Unit I: Wave Mechanical Concepts

Wave Nature of Particle – The Uncertainty Principle - The Principle of Superposition – Wave Packet–time dependent Schrodinger Equation–Interpretation of the Wave Function–Ehrenfest's Theorem–Time independent Schrodinger Equation–Stationary States–Admissibility Condition on the Wave function

Unit II: General Formalism of Quantum Mechanics

Linear Vector Space – Linear Operator – Eigen function and Eigenvalue – Hermitian Operator –Postulates of Quantum Mechanics–Simultaneous Measurability of Observables–General Uncertainty Relation–Dirac's Notation– Equation of Motion – Momentum Representation.

Unit III: One Dimensional Problems

Square Well Potential with Rigid Walls-Square Well Potential with Finite Walls-Square Potential Barrier-Alpha Emission-Bloch Waves in a Periodic Potential-Kronig Penney Square Well Periodic Potential-Linear Harmonic Oscillator: Schrodinger Method-Linear Harmonic Oscillator: Operator Method.

Unit IV: Three Dimensional Problems

Particle Moving in a Spherically Symmetric Potential-System of Two Interacting Particles-Rigid Rotator-Hydrogen Atom-Hydrogenise Orbitals-The Free Particle-Three Dimensional Square-Well Potential-The Deuteron.

Unit V: Angular Momentum

The Angular Momentum Operators-Angular Momentum Commutation Relations-Eigen Values and Eigen Functions of L^2 and L_Z-General Angular Momentum-Eigenvalues of $J^2$and J_Z-Angular Momentum Matrices-Spin Angular Momentum-Spin Vectors for Spin-(1/2) System-Addition of Angular Momentum

Book for Study

1. Chapter 2-5, 8, G. Aruldhas, Quantum Mechanics, 2nd edition, Prentice Hall of India, New Delhi, 2008.

Book for Reference

1. P.M .Mathews and K.Venkatesan, A Textbook of Quantum Mechanics, Tata McGraw-Hill, New Delhi.2ndEdn,2017
2. I.L.Schiff, Quantum Mechanics, 3rd Edition, 2017, McGraw Hill, New York.
3. B.K.Agarwal, H.Prakash, Quantum Mechanics, 2004, Prentice Hall of India, New Delhi.

Online Reference:

1. web.mst.edu/~parris/QuantumTwo/Class_Notes/GeneralFormulation.pdf
2. www.damtp.cam.ac.uk/user/tong/aqm/aqmsix.pdf
3. https://en.wikipedia.org/wiki/Matrix_mechanics

Programme: M.Sc., **Subject: Physics**

Semester: II **Course: Statistical Mechanics and Thermodynamics**

Course Type: Part – I/ Core Paper – III **Credits: 5**

Hours Required: 5 Hrs. / Week **CIA: 25 /CA: 75**

PPHT23 STATISTICAL MECHANICS AND THERMODYNAMICS

Course Outcomes:

After completion of the course, certain outcomes are expected from the learners.

Description	Blooms' Taxonomy Level
Understanding the concept Phase Space, Concept of ensembles and Canonical ensembles.	Comprehension (Level 2)
Acquiring the knowledge about Maxwell's distribution of velocities and Problems	Knowledge (Level 1)
Using an understanding of Bose-Einstein and Fermi-Dirac Statistics along with Black Body radiation, Photons.	Application (Level 3)
Designing experiments Mean free path, Viscosity of gases and the principle axis transformation.	Analysis (Level 4)
Solving problems Kubo relations fluctuations dissipation theorem. Derivation of the Onsager relations.	Evaluation (Level 5)

COURSE CONTENT

Unit: I Phase Space, Concept of ensembles

Canonical ensembles–Thermo dynamical relation in a canonical ensemble, Micro canonical ensemble and Grand Canonical ensemble–Information theory and statistical mechanics problems

Unit II: Properties of gases

Partition function for the system and for the particles Translation partition function -Gibb's paradox: Sackur Tetrode Equation, Boltzmann equi partition Theorem, Rotational partition function, Vibrational contributions to thermodynamic quantities, Electronic partition function, Maxwell's distribution of velocities– Problems

Unit III: Bose-Einstein and Fermi-Dirac Statistics

Symmetric and anti-symmetric wave function Bose Einstein and Fermi Dirac distributions-Weak and strong degeneracy of perfect gases, Bose–Einstein condensation–Black Body radiation, Photons

Unit IV: Kinetic Theory of gases

Mean free path–Viscosity of gases-Heat conduction in gases–Effusion Phenomena Energy fluctuations in a canonical ensemble – Fluctuations in a grand canonical ensemble, Brownian motion, Langevin equation for random motions – Random walk problem – Diffusion, Einstein relation for mobility

Unit V: Time dependence of fluctuations

Power spectrum of fluctuations – Persistence and correlation of fluctuations – Wiener-Khinchin theorem – Johnson noise: Nyquist theorem, Shot noise problem- Irreversible Thermodynamics: Onsager reciprocity relations-Derivation of the Onsager relations- Thermo electric phenomena –Linear response theory–Kubo relations fluctuations dissipation theorem.

Books for Study:

1. E.S.R.Gopal, Statistical Mechanics and properties of Matter (Theory and Applications) Ellis Horwood Ltd, 1974. (Unit I-V, Chapter 1-6)
2. R.K.Srivastaand J.Ashok, Statistical Mechanics, Prentice-Hall of India Private Limited, New Delhi, 2006. (Unit III, IV Chapter 6, 12).

Books for Reference:

1. B.K.Agarwal and M.Eisner, Statistical mechanics, Second Edition, New Age international Private Limited, Delhi, 2016.
2. R.K.Pathtria, Statistical Mechanics-Second Edition, Butterworth-Heinemann, 1972.
3. L.D.Landau and E.M.Lifshitz, Statistical Mechanics-Third Edition, Publisher by Robert Maxwell M.C, 1959.
4. J.K.Bhattacharjee, Statistical Mechanics:An Introductory Text, Allied Publsihers Pvt. Ltd, ISBN: 4567149629

Online Resource:

1. http://www.Statistical Mechanics .edu/contents.html
2. http://www.physicstutorials.org/home/ StatisticalMechanicsAndThermodynamics

Programme: M.Sc., **Subject: Physics**

Semester: II **Course: Practical II**

Course Type: Part – III/ Practical II **Credits: 5**

Hours Required: 5 Hrs / Week **CIA: 25 /CA: 75**

PPHP22 GENERAL PRACTICAL II

Course Outcomes:

After completion of the course, certain outcomes are expected from the learners.

Description	Blooms' Taxonomy Level
Understanding the General physics experiments	Knowledge (Level 1)
Identifying the link between theory and experiment on various experiments like Solar Spectrum, Laser Experiments., Zeeman effect, .Band Gap of Thermistor experiments.	Comprehension (Level 2)
Using an understanding of Band Gap of Thermistor, Determination of Solar Constant, Michelson Interferometer, Wavelength and separation of wavelengths equipment's can be known.	Application (Level 3)
Designing experiments Hall Effect and Spectral analysis of a salt.	Analysis (Level 4)
Applying the knowledge Ultrasonic and B-H curve and correlating theory and experiments and make useful conclusions.	Synthesis (Level 6)

COURSE CONTENT

1. Solar Spectrum –Hartmann's Interpolation formula
2. Critical resistance of a metal/analogy by four probe method–as a function of temperature
3. Measure of numerical aperture(NA) of a telecommunication- grade Optic fibre
4. Fibre attenuation of a given optical fibre
5. Laser Experiments
6. Zeeman effect
7. Band Gap of Thermistor
8. Determination of Solar Constant
9. Michelson Interferometer–Wavelength and separation of wavelengths
10. Michelson Interferometer-Thickness of a mica sheet /thin film
11. Susceptibility–Quinke's or Gouy's method
12. Hall Effect
13. Spectral analysis of a salt

14. Absorption spectra
15. Ultrasonic– Compressibility of a liquid
16. Ultrasonic– Compressibility of a solid
17. .B-H curve using CRO
18. Calibration of Gamma ray spectrometer and determination of the energy of unknown source

Reference Books

1. C.C Ouseph, G.Rangarajan- A Text Book of Practical Physics- S. Viswanathan Publisher-Part I (1990).
2. C.C Ouseph, C.Rangarajan, R.Balakrishnan – A Text Book of Practical Physics - S.Viswanathan Publisher – Part II (1996)
3. 3.S.LGupta and V.Kumar – Practical Physics - Pragati Prakashan – 25th, Edition (2002)

Online References:

1. https://www.youtube.com/watch?v=N0lxwqANsd4
2. https://www.youtube.com/watch?v=WwexoU-gUoc
3. https://www.youtube.com/watch?v=OGHpiUMSRwg
4. https://www.cmi.ac.in/~debangshu/lab1/zener.pdf

Programme: M.Sc., **Subject: Physics**

Semester: II **Course: Materials Characterization**

Course Type: Part – II/ Elective Paper – I **Credits: 5**

Hours Required: 5 Hrs. / Week **CIA: 25 /CA: 75**

PPHE22 MATERIALS CHARACTERIZATION

Course Outcomes:

After completion of the course, certain outcomes are expected from the learners.

Description	Blooms' Taxonomy Level
Understanding the concept thermo gravimetric analysis and differentiate thermal analysis-basic techniques.	Comprehension (Level 2)
Acquiring the knowledge about X-Ray Analysis and Optical Methods	Knowledge (Level 1)
Using an understanding of Principles of SEM, TEM, EDAX, AFM, EPMA and its instrumentation.	Application (Level 3)
Designing the experiments Electrical Methods Hall effect, Carrier density, resistively and two probe and four probe methods.	Analysis (Level 4)
Solving the solution methods of finding Magnetic and Mechanical properties	Evaluation (Level 5)

COURSE CONTENT

Unit I: Thermal Analysis

Introduction- thermo gravimetric analysis- instrumentation – determination of weight loss and decomposition products – Differential scanning Calorimetry-instrumentation-specific heat capacity measurements – determination of thermochemical parameters-Differential thermal analysis-basic techniques.

Unit II: X-Ray Analysis and Optical Methods

Single and powder diffraction-Diffract meters-interpretation of diffraction patterns-indexing-phase identification-thin film characterization-X-ray fluorescence spectroscopy-uses. FTIR-UV-Visible spectroscopy – Photoluminescence – light matter interaction-fundamental transitions – excitations – instrumentation – electro luminescence-instrumentation-photo reflectance.

Unit III: Electron Microscopy

Principles of SEM, TEM, EDAX, AFM, EPMA-instrumentation-sample preparation and analysis of materials-study of dislocations-ion implantation-uses.

Unit I V: Electrical Methods

Hall Effect-Carrier density – resistively – two probe and four probe methods – scattering mechanism- Vander paw method – CV characteristics- schottky barrier capacitance- impurity concentration– electrochemical CV profiling–Limitations.

Unit V: Magnetic and Mechanical properties

Magnetic measurements using vibrating sample magnetometer(VSM)-magnetic force microscopy (MFM) - Electron Paramagnetic Resonance (EPR)-Nuclear Magnetic Resonance(NMR) spectroscopy – Mechanical properties-micro hardness - nano indentation-elastic and plastic deformation-fracture toughness– Super plasticity.

Books for Study:

1. Willard, Merritt, Dean, Settle, Instrumental Methods and Analysis- Seventh Edition, CBS Publishers, New Delhi, 1986.(Unit I-III, V, Chapter - 6,11,13, 25)
2. Jasprit Singh, Semiconductor Devices- Basic Principles, John Wiley & Sons (ASIA) Pvt.3.mited, 2001. (Unit IV, Chapter -3, 4, 6)
3. V.Raghavan, Materials Science and Engineering-Fourth Edition, Prentice-Hall of India Private Limited, New Delhi, 2001. (Unit - III, IV, Chapter 6, 10, 11)
4. G.Aruldhas, Molecular Structure and Spectroscopy-Second Edition, PHIL earning Private Limited, New Delhi, 2017. (Unit-V, Chapter-11)
5. William D.Callister, Jr.Materials Science and Engineering an Introduction-Sixth Edition, Wiley International Edition, 2003. (Unit-IV,Chapter-8)
6. Douglas A. Skoog, F. James Holler, Timothy A. Nieman, Principles of Instrumental Analysis- Fifth Edition, Thomson Business Information India Private Limited, India,2006.(Unit-III, Chapter21-Section-C)

Reference Books:

1. J.A.Belk, Electron Microscopy and microanalysis of crystalline materials, Applied Science Publishers, London, 1979.
2. J.W.Gardner, H.T.Hingle, From Instrumentation to Nanotechnology, Gordon and Breach Science Publishers, 1990.

Online Resource:

1. http://www.Materials Characterization.edu/contents.html
2. http://www.physicstutorials.org/home/ Materials Characterization

Programme: M.Sc., **Subject: Physics**

Semester: III **Course: Electromagnetic Theory**

Course Type: Part – I/ Core Paper – I **Credits: 5**

Hours Required: 5 Hrs. / Week **CIA: 25 /CA: 75**

PPHT31 ELECTROMAGNETIC THEORY

Course Outcomes:

After completion of the course, certain outcomes are expected from the learners.

Description	Blooms' Taxonomy Level
Understanding the concept of electrostatics and electrical susceptibility	Comprehension (Level 2)
Learning the knowledge about Magneto statics, Bound Currents Auxiliary field H-Ampere's law	Knowledge (Level 1)
Using an understanding Maxwell Equations and its Boundary conditions.	Application (Level 3)
Designing the experiments EM waves and Propagation of EM waves between parallel and perfectly conducting planes	Analysis (Level 4)
Types of Electromagnetic Radiation waves condition through electric field waves.	Evaluation (Level 5)

COURSE CONTENT

Unit I: Electro Statics

Introduction to Electrostatics-Gauss law-electro static potential-Poisson's and Laplace's equation–Green's theorem–Green's functions–Potential with Dirichlet and Neumann boundary conditions–Solution of Laplace's equation in rectangular box–Solution by separation in spherical polar coordinates – Multiple expansion, electrostatic field in matter –Dielectrics – Polarization – Polarization vector – Field outside polarized dielectric – Bound charges- Electric displacement vector – Gauss law in presence in dielectrics – linear dielectrics –Boundary conditions in dielectric media–Electrostatic energy in presence of dielectrics-Alignment of polar molecules–Dielectric sphere in uniform electric field–Molecular polarizability and electrical susceptibility

Unit II: Magneto Statics

Introduction to Magneto statics – Conservation of charge and equation of continuity – Biot – Savart's law- Magnetic field due to a localized current distribution – Ampere's law – Magnetic vector potential – Magnetic scalar potential – Magnetic moment, force and torque on a current distribution in an external field– Magnetization–Field of a magnetized object– Bound Currents Auxiliary field H-Amperes law–linear media–Magneto static theory–Uniformly magnetized sphere– Multipole expansion

Unit III: Maxwell Equations

Equation of continuity in electro dynamics- Faraday's law of induction – Maxwell equation – Maxwell displacement current–Maxwell's equation in free space and matter–Physical significance–Boundary conditions

Unit IV: Wave Propagation

Plane wave in non-conducting media – Poynting Vector, electromagnetic waves in conducting media – Reflection and refraction of EM waves at a plane interface – laws of reflection and refraction for EM waves – Fresnel formulae – Polarization of EM waves – Brewster's angle and degree of polarization – Total internal reflection –Propagation of EM waves between parallel and perfectly conducting planes– Rectangular wave guide.

Unit V: Electromagnetic Radiation

Inhomogeneous wave equation and retarded potentials -Oscillating electric dipole –Energy radiated by an oscillating electric dipole- Jefimenko's Equation, Lienard- Wiechert Potentials- The fields of a moving point Charge.

Books for Study:

1. B.B.Laud, Electromagnetic 2nd Edition- New age international publishes, 1987. (Unit I-V, Chapter1-7).
2. David J. Griffiths Introduction to Electrodynamics, Third edition, Prentice- Hall of India Private Limited, New Delhi, 2002. (Unit-V, Chapter10).

References:

1. W.Panofsky M.Phillips, Classical Electricity and Magnetism-Second Edition, Addition Wesley Publishing Company, Inc. 1962.
2. J.D.Jackson,Classical Electrodynamics-2nd edition–John Wiley & Sons, Inc. New Delhi, 1962.

Online Resource:

1. http://www. Electromagnetic theory .edu/contents.html
2. http://www.physicstutorials.org/home/ Electromagnetic theory

Programme: M.Sc., **Subject: Physics**

Semester: III **Course: Quantum Mechanics-II**

Course Type: Part – I/ Core Paper – II **Credits: 5**

Hours Required: 5 Hrs. / Week **CIA: 25 /CA: 75**

PPHT32 QUANTUM MECHANICS-II

Course Outcomes:

After completion of the course, certain outcomes are expected from the learners.

Description	Blooms' Taxonomy Level
Understanding the Time Independent Perturbation Theory and its derivations	Comprehension (Level2)
Acquiring the Knowledge about General Formalism of Variation Method for Excited States in hydrogen atoms	Knowledge (Level 1)
Using the WKB Approximation to solve the Bound States in a Potential Well.	Application (Level 3)
Learning the knowledge about Time Dependent Perturbation Theory and its formulas	Evaluation (Level 5)
Solving the Scattering function equation using scattering theory and Laboratory and Centre of Mass Coordinate Systems.	Synthesis (Level 6)

COURSE CONTENT

Unit I Time Independent Perturbation Theory

Basic concepts – Non degenerate Energy Levels – An harmonic Oscillator: First Order Correction-The Ground State of Helium-Effect of Electric Field on the Ground State of Hydrogen–Degenerate Energy Levels – effect of electric Field on the n=2 State of Hydrogen – Spin-Orbit Interaction.

Unit II The Variation Method

The Variation Method – Rayleigh Ritz Method – Variation Method for Excited States – The Hellmann Feynman Theorem – the Ground State of Helium – The Hydrogen Molecule Ion – the Ground State of Deuteron.

Unit III WKB Approximation

The WKB Method–The Connection Formula–Validity of WKB Method–Barrier Penetration Alpha Emission– Bound States in a Potential Well.

Unit IV Time Dependent Perturbation Theory

Introduction–FirstorderPerturbation–HarmoicPerturbation–Transition to Continuum States Absorption and Emission of Radiation–Einstein's A and B Coefficients-Selection Rules

Unit V Scattering

Scattering Cross-section – Scattering Amplitude – Partial Waves-Scattering by Central Potentials Partial Wave Analysis–Significant Number of Partial Waves– Scattering by an Attractive Square Well Potential-Breit-Wigner Formula – Scattering Length – Expression for Phase shifts-Integral equation–the Born Approximation–Scattering by Screened Coulomb Potential-Validity of Born Approximation–Laboratory and Centre of Mass Coordinate Systems.

Book for Study

1. Unit I-V; Chapter 9 12, 14, G.Aruldhas, Quantum Mechanics, 2nd edition, Prentice Hall of India, New Delhi 2008.

Book for Reference

1. P.M.Mathews and K.Venkatesan, A Textbook of Quantum Mechanics, Tata McGraw-Hill, New Delhi 2nd Edn, 2017.
2. I.L.Schiff, Quantum Mechanics, 3rd Edition, 2017, McGraw Hill, New York.
3. B.K.Agarwal, H.Prakash, Quantum Mechanics, 2004, Prentice Hall of India, New Delhi.

Online Resource

1. https:// www.teacheron.com. Quantum physics/tutors//
2. https://www.quantum Physics .com
3. web.mst.edu/~parris/QuantumTwo/Class_Notes/GeneralFormulation.pdf
4. www.damtp.cam.ac.uk/user/tong/aqm/aqmsix.pdf
5. https://en.wikipedia.org/wiki/Matrix_mechanics

Programme: M.Sc., **Subject: Physics**

Semester: III **Course: Solid State Physics**

Course Type: Part – I/ Core Paper – III **Credits: 5**

Hours Required: 5 Hrs. / Week **CIA: 25 /CA: 75**

PPHT33 SOLID STATE PHYSICS

Course Outcomes:

After completion of the course, certain outcomes are expected from the learners.

Description	Blooms' Taxonomy Level
Understanding of the basics of fundamental building blocks of atoms and crystal structure through the concept of a lattice values	Comprehension (Level 2)
Knowing the Vibrations of linear monoatomic and diatomic chains. And lattice dynamics	Knowledge (Level 1)
Using an understanding of Free electron theory of solids and concept of Kronig-Penny model, Bloch Theorem. Approximate solution near a zone boundary	Application (Level 3)
On applying Occurrence of super conductivity, Destruction of superconductivity by magnetic fields,	Analysis (Level 4)
Applying the knowledge of crystal structure, electron theory and thermal properties of materials to Ferro magnetic materials	Evaluation (Level 5)

COURSE CONTENT

Unit I: Crystal Lattices

Periodic Arrangements of atoms – concept of a lattice – lattice translation vectors – primitive lattice cell – two and three dimensional lattice types. Miller indices of crystal plane- simple crystal structure like sodium chloride type – cesium Chloride type hexagonal and face cantered-close packed structures. Diamond structure and cubic zinc sulphide structure- Diffraction of waves by crystals: Bragg's law – reciprocal lattice vectors- Laue equations- Brillouin zones-Reciprocal lattices to Sc, Bcc, Fcc lattices

Unit II: Lattice Dynamics

Vibrations of linear monoatomic and diatomic chains - quantisation of elastic waves – phonon momentum. Plank distribution for a system of identical harmonic oscillators. Periodic boundary conditions and density of states in one and two dimensions. Einstein and Debye's theories of specific heat. A harmonicity of lattice vibrations, Thermal expansion. Thermal conductivity and Umklapp process

Unit III: Free Electron Theory

Energy levels in one dimensions. Fermi- Dirac distribution for a free electron gas. Periodic boundary condition and free electron gas in three dimensions. Heat capacity of the electron gas. Ohm's law, Mattiessen's rule and Umklapp process. Hall Effect, Wiedmann- Franz law – Nearly free electron model and the origin and the magnitude of the energy gap. Bloch functions. Motion of an electron in a periodic potential, Kronig-Penny model, Bloch Theorem. Approximate solution near a zone boundary

Unit IV: Super Conductivity

Occurrence of super conductivity, Destruction of superconductivity by magnetic fields, Meissner Effect, Heat Capacity, Energy gap, Microwave and infrared properties, Isotope effect, Thermodynamics of the superconducting transition,(Stabilization energy of the superconductor), London equation, Coherence Length, BCS theory of superconductivity, BCS ground state, Flux quantization in a superconductionring, duration of persistence currents, type II superconductors, Vortex state, Estimation of$Hc_1$and Hc_2,single particle tunnelling, DC Josephson effect, AC Josephson effect, macroscopic quantum interference , High temperature superconductors

Unit V: Magnetism of Solids

Ferromagnetic order, Curie point and exchange integral, Temperature dependence of the saturation magnetization at absolute zero,Magnons,Quantisation of spin waves, Thermal excitations of magnons, Ferri magnetic order, Curie temperature and susceptibility below the Neel temperature, Ferromagnetic domains, Anisotropy energy, Transition region between domains, Origin of domains, Coercivity and Hysteresis

Book for Study:

1. C. Kittel, Introduction to Solid State Physics (8^{th} Edition), John Wiley & Sons (2005) (Unit I-V).

Books for Reference:

1. S.O. Pillai, Solid State Physics (7^{th} Edition), New Age International Publishers Ltd. 2010.
2. R.Asokamani,SolidStatePhysics,AnamayaPublishers,2006
3. A.J.Dekker, Solid State Physics, Macmillan (1965).
4. N.W.AshcroftandN.D.Mermin,SolidStatePhysics,HarcourtCollegePublishers(1976)

Web Reference:

1. https://en.wikipedia.org/wiki/Debye_model
2. https://en.wikipedia.org/wiki/Bloch_wave
3. https://en.wikipedia.org/wiki/Reciprocal_lattice
4. https://en.wikipedia.org/wiki/Tight_binding

Programme: M.Sc., **Subject: Physics**

Semester: III **Course: Practical III**

Course Type: Part – I/Practical III **Credits: 5**

Hours Required: 5 Hrs. / Week **CIA: 25 /CA: 75**

HP33 PRACTICAL III

Course Outcomes:

After completion of the course, certain outcomes are expected from the learners.

Description	Blooms' Taxonomy Level
Understanding the. Ascending and descending order of numbers and characters Matrix addition, subtraction and multiplication, Transpose of a matrix programmes	Knowledge (Level 1)
Acquiring hands on knowledge and training of straight line fit using the method of least squares for a table of data points and polynomial curve fitting	Evaluation (Level 5)
Using an understanding of tabulated data using trapezoidal rule, Simpson's rule and the solution of a first order differential equation of type y'=f(x,y) using the fourth order Runge-Kutta method can be understood.	Application (Level 3)
Designing the programme interpolation value at a specified point, given a set of data points using Newton's interpolation representation and calculate and print the mean, variance and standard deviation of set of N numbers.	Analysis (Level 4)
Designing of to read a set of numbers, count them and find and print the largest and smallest numbers in the list and their positions in the list are studied	Evaluation(Level 5)

COURSE CONTENT

1. Ascending and descending order of numbers and characters
2. Matrix addition, subtraction and multiplication
3. Transpose of a matrix
4. Evaluating a root of non-linear equation by Newton-Raphson method using external function
5. Program to solve system of linear equations using simple Gaussian elimination method
6. Program for straight line fit using the method of least squares for a table of data points
7. Program for polynomial curve fitting
8. Program to integrate any function or tabulated data using trapezoidal rule
9. Program to integrate any function or tabulated data using Simpsons rule

10. Program to compute the solution of a first order differential equation of type y'=f(x,y) using the fourth order Runge-Kutta method
11. Program to compute the interpolation value at a specified point, given a set of data points using Lagrangian interpolation representation
12. Program to compute the interpolation value at a specified point, given a set of data points using Newton's interpolation representation
13. Program to calculate and print the mean, variance and standard deviation of set of N numbers
14. Program to solve the quadratic equation
15. Program to read a set of numbers, count them and find and print the largest and smallest numbers in the list and their positions in the list

Online Resource

1. https:// www.teacheron.com. Programming C&C ++ tutors//
2. https://www.c++& c Practical.**com**

Programme: M.Sc., **Subject: Physics**

Semester: III **Course: Material Science**

Course Type: Part – II/ Elective Paper – I **Credits: 5**

Hours Required: 5 Hrs. / Week **CIA: 25 /CA: 75**

PPHE33 MATERIALS SCIENCE

Course Outcomes:

After completion of the course, certain outcomes are expected from the learners.

Description	Blooms' Taxonomy Level
Understanding the Nanomaterial and its application	Comprehension (Level 2)
Applying the polymers characteristics for preparation of types of polymers.	Application (Level 3)
Understanding of the Dielectrics materials and Electrical polarization, Mechanisms of polarization	Knowledge (Level 1)
Acquiring knowledge about Purification of electronic materials and crystal growth.	Comprehension (Level 2)
Getting information about Classification of magnetism Concept of soft and hard magnetic domain structure	Knowledge (Level 1)

COURSE CONTENT

Unit I: Nano materials

Grains in solids, measurement of grain size, nanomaterial, methods of preparation – Electro deposition, Sol gel, Spark discharge and other methods, characterization and applications, Hetro junction–Quantum well, wire and dots

Unit II: Polymers

Structural features of polymer material – Mechanisms of polymerization and types of Polymers-Thermoplastics – rubbers and elastomers- mechanical physical and chemical properties- Cellular plastics-Liquid crystal polymers

Unit III: Dielectrics

Electrical polarization–Mechanisms of polarization–Optical, molecular and interfacial polarizability- some dielectric materials – piezoelectric materials – pyro electric and Ferro electric material-Applications of these materials

Unit IV: Electronic Materials

Purification of electronic materials – Crystal growth and doping techniques (an over view)-Epitaxial growth – Impurity Diffusion- Ion Implantation – Junction Formation – Metallisation –Lithography (an overview) –contact formation

Unit V: Magnetic materials

Classification of magnetism – Concept of magnetic domain structure – Soft magnetic materials iron and iron based materials, perm alloys Ni-Zn and Mn-Zn ferrite- Microwave ferrite and garnets- Amorphous magnets (meta glasses) Hard magnetic materials High Carbon steel $A_lN_iC_o$ alloys – Structure and magnetic properties of Barium ferrite, Sm-Co and Nd_2Fe_4B magnets- Rare earth element magnets-Effects of 3rdtransition elements–Application of hard vs Soft magnets

Books for Study

1. J.C.Anderson, K.D.Leaver, R.D.Rawlings and J.M.Alexander, Material Science. 4th edition (Chapman – Hall, London) 1990
2. V.Ragavan, Materials Science and Engineering 3rd Ed. 2011 (Prentice-Hall India, New Delhi) (For Units 2,3, &5)
3. C.M.Srivata and C.Srinivasan, Science of Engineering Materials and Carbon Nanotubes, Wiley– Eastern Ltd, New Delhi 2010 (For Units 1,2, &5)

Books for Reference

1. H.I backhand H.Luth, Solid State Physics An Introduction to Principles of Material Science 2nd Ed 2009
2. R.K.Gupta (Editor)Physics of Particles Nucleus and Materials–Recent trends(new Horozon of Physics Series, Narosa, New Delhi)2002

Programme: M.Sc., **Subject: Physics**

Semester: IV **Course:** Spectroscopy

Course Type: Part – I/ Core Paper I **Credits: 5**

Hours Required: 5 Hrs. / Week **CIA: 25 / CA: 75**

PPHT41 SPECTROSCOPY

Course Outcomes:

After completion of the course, certain outcomes are expected from the learners.

Description	Blooms' Taxonomy Level
Knowledge gaining, and regarding of Infrared spectroscopy, IR spectrophotometer-Instrumentation	Knowledge (Level 1)
Assessing the Theory of Raman scattering for stocks line and anti-stocks line	Evaluation (Level 5)
Using an understanding of Electronic spectroscopy for vibrational electronic spectra functions	Application (Level 3)
Designing NMR and ESR experiments Techniques for theory instrumentation applications	Analysis (Level 4)
Solving the Chemical bonding-Halogen quadrupole resonance. Moment using EQR technique	Synthesis (Level 6)

COURSE CONTENT

Unit I: Infrared spectroscopy

Vibrational energy of a diatomic molecule- Infrared selection rules-Vibrating diatomic molecule-Diatomic vibrating rotator-Vibrations of polyatomic molecules-Fermi resonance-Rotation vibration spectra of polyatomic molecules-Normal modes of vibration in crystal-Interpretation of vibrational spectra-Group frequencies-IR spectra photometer-Instrumentation-Sample handling techniques-Fourier Transform Infrared spectroscopy-Applications

Unit II: Raman spectroscopy

Introduction-Theory of Raman scattering-Rotational Raman spectra-Vibrational Raman spectra-Mutual Exclusion principle-Raman spectrometer-Sample handling techniques-Polarization of Raman scattered light-Structure determination using IR and Raman spectroscopy-Raman investigation of phase transitions-Resonance Raman scattering-Nonlinear Raman phenomena- Preliminaries-Hyper Raman effect-Stimulated Raman scattering-Inverse Raman effect-Coherent Anti-Stokes Raman scattering

Unit III: Electronic spectroscopy

Introduction-Vibrational Coarse structure-Vibrational analysis of band systems-De slandres table-Progression and sequences-Information derived from vibrational analysis-Franck-Codon principle-Intensity of vibrational electronic spectra-Rotational fine structure of electronic vibration spectra-The Fortran parabola-Dissociation-Pre dissociation-Electronic angular momentum in di atomic molecules-Photoelectron spectroscopy

Unit IV: NMR Techniques:

Magnetic properties of Nuclei-Resonance condition-NMR instrumentation-Relaxation processes-Bloch equations-Dipolar interaction-Chemical shift-Indirect spin-spin interaction-High resolution Hamiltonian-Matrix elements of the High resolution Hamiltonian-NMR spectrum of a spin ½ AB systems-NMR spectra of solids-Magic angle spinning NMR-Resonance of other Nuclei-Nuclear quadrupole effects-Intermolecular exchange-Hindered rotation-NMR imaging-Interpretation of certain NMR spectra

ESR Techniques:

Introduction-Principle of ESR-ESR spectrometer-Total Hamiltonian-Hyper fine structure-ESR spectra of free radicals in solution-Anisotropic systems-System in Triplet states-EPR of Transition metal ions

Unit V: NQR Techniques:

Introduction-Principle of Nuclear quadrupole resonance-Transitions for axially symmetric systems-Transitions form on-axially symmetric systems-NQR instrumentation-Crystallographic in equivalence-Chemical bonding-Halogen quadrupole resonance-Quadrupole resonance of minerals- Nitrogen Quadrupole resonance-NQR group frequencies-Hydrogen bonding

Mossbauer Techniques:

Recoilless emission and absorption- Experimental techniques-Isomer shift - Quadrupole interaction-Magnetic hyperfine interaction-Applications

Book for Study:

1. G.Aruldhas, Molecular structure and spectroscopy (Second Edition), PHIL earning Private Ltd, 2017.(Unit I-V)

Books for Reference:

1. Colin N.Banwell, Elaine M.Mc Cash, Fundamentals of Molecular Spectroscopy (Fourth Edition), Tata McGraw-Hill Publishing Company Ltd, 1995.
2. J.D.Graybeal, Molecular Spectroscopy, McGraw-Hill, New York, 1988.
3. Hollas, Michael, Modern Spectroscopy (Fourth Edition) John Wiley, New York, 2004.
4. R.P Straughen, S.Walker, Spectroscopy Vols. I,II and III, Chapman & Hall, London, 1976

Programme: M.Sc., **Subject: Physics**

Semester: IV **Course: Nuclear Physics And Particle Physics**

Course Type: Part I/ Elective Paper II **Credits: 5**

Hours Required: 5 Hrs. / Week **CIA: 25 / CA: 75**

PPHT42 NUCLEAR PHYSICS AND PARTICLE PHYSICS

Course Outcomes:

After completion of the course, certain outcomes are expected from the learners.

Description	Blooms' Taxonomy Level
Understanding the concepts of General Properties of nuclei	Knowledge (Level 1)
Acquiring knowledge about structure, properties of nucleus, isotopes and isobars for nuclear models	Comprehension (Level 2)
Using an understanding of Experimental Techniques for Detectors and champers.	Application (Level 3)
Designing experiments for types of Nuclear reactions	Analysis (Level 4)
Understanding the concept of cosmic rays, classification of elementary particles and conservation laws.	Comprehension (Level 2)

COURSE CONTENT

Unit I: General Properties of nuclei

Charge-Mass-Radius-Angular momentum (Spin)-Magnetic dipole moment-Electric Quadra pole moment-Parity-Isobaric spin (iso spin)–statistics-The nuclear level spectrum-Nuclear forces

Unit II: Nuclear models

Types of models- The liquid drop model, Shell model – Empirical evidence for the regularity of nuclear properties- The single particle shell model- The collective Model –Collective vibration & rotation–Single Particle motion in a deformed potential–Decay of unstable nuclei-Electromagnetic transitions–General properties and selection rules-the life time-energy relation-internal conversion-determination of transition profanities-angular correlation-decay–General prosperities-Neutrinos and antineutrinos-The Fermi theory–selection rules-electron capture-Alpha decay-general properties-barrier penetration of alpha decay-Spontaneous fission-decay

Unit III: Experimental Techniques:

Passage of charged particles and radiation through matter–Energy loss by collision-Energy loss by radiation-Absorption of electromagnetic radiation-Detectors for nuclear structure studies–Gaseous detector-Solid state detector-Detectors for particle physics studies-Bubble chamber-Multi wire proportional chambers and drift chambers-streamer chamber-spark chamber-Cherenkov and transition radiation detectors-total absorption calorimeters

Unit IV: Nuclear reactions

Disintegration of nitrogen by alpha particles & proton- induced activity & fission– Formalism –Compound nuclear reactions-origin-discrete resonance-continuum states-The Optical model of particle induced nuclear reactions

Unit V: Elementary Particle Physics

Classification of elementary particles – Leptons, Hadrons and Quarks – Fundamental interactions and their unification Symmetry Transformations and conservation laws: The group SU (2) and isospin symmetry an example of the SU(2) group - charge conjugation – Time reversal – The CPT theorem – SU(3)symmetry ,Nucleon doublet and piontriplet– Meson octet, Baryon octet and decuplet.

Book for study:

1. W.E.Burcham and M.Jobes, Nuclear and Particle Physics, International student edition, Addison Wesley Longmen, Inc. (1998)(Unit I-V)

Books for reference:

1. D,C,Tayal, Nuclear Physics(2nd Edition),Himalayan Publishing House, Bombay(2009)
2. K.S.Krane, Introductory Nuclear Physics (John- Wiley, New York, 1987.
3. M.L.Pandya and R.P.S.Yadav, Elements of Nuclear Physics, Kedar NathRamNath, Meerut, 2004.
4. Nuclear Physics–R.R. Roy and B.P.Nigam. New age international pvt. 2011.
5. Nuclear physics–S.N.Ghoshal. S.Chand and Co., New Delhi.2012.
6. Nuclear Physics and particle physics-Satya prakash.,Sultan Chand and Sons,2014
7. Moden Physics R. Murugeshan and Er.Kiruthiga sivaprasath. S. Chand and Co New Delhi. 2015.

Online Reference:

1. https://en.wikibooks.org/wiki/Digital_Circuits/Registers and Countess
2. https://brilliant.org/wiki/nuclear-decay/

Programme: M.Sc.,	**Subject: Physics**
Semester: IV	**Course: Project and Viva-Voce**
Course Type: Part – III	**Credits: 5**
Hours Required: 5 Hrs. / Week	**CIA: 25/ CA: 75**

PHP44 PROJECT AND VIVA-VOCE

Each Candidate will submit a project report on a topic in Physics/ Material Science/Astrophysics after carrying out the project work under the supervision of a guide. The project may be theoretical or experimental or even a compilation of literature on a current topic. The duration of the project will be roughly two months (including the vacation of one month) in the final semester.

The project report will be evaluated by an external examiner and viva voce will be conducted by a committee consisting of the external examiner, guide and the department faculty.

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