Course Name : **Master of Science**
Discipline : **PHYSICS**
(For those who joined in June 2022 and after)

Course Objectives:

- To develop a general competence in core Physics. This is a pre-requisite for contributing flexibly in today's cross- disciplinary research areas.
- To nurture the creative imagination of young minds and to reinforce the spirit of rational enquiry in a co-operative ambience.
- To cultivate specific strengths in the flourishing and future oriented areas of Nano Physics and Molecular Spectroscopy respectively.
- To enable students to develop insights into the techniques used in current projects.
- To give students the experience of teamwork, to develop presentational skills and to train students to work to deadlines.
- To develop the professional skills necessary for students to play a meaningful role in industrial or academic life and satisfy the need, nationally for well qualified post-graduates who will be able to respond to the challenges that arise form future developments.

This course will put students in a strong position when applying for a PhD and other higher studies.

VIRUDHUNAGAR HINDU NADARS' SENTHIKUMARA NADAR COLLEGE

(An Autonomous Institution Affiliated to Madurai Kamaraj University)

[Re-accredited with 'A' Grade by NAAC]

Virudhunagar – 626 001.

Semester	Part	Subject	Hour	Credit	Int+Ext =Tot	Local	Regional	National	Global	Professional Ethics	Gender	Human Values	Environment & Sustainability	Employability	Entrepreneurship	Skill Development	Subject Code	Revised/ New/No Change/ Interchanged If Revised % of Change
I	Core 1	Mathematical Physics-I	6	5	40+60=100				✔				✓	✓			**P22PHC11**/ P19PHC11	No Change
	Core 2	Electronic Circuits and Systems	6	4	40+60=100				✔				✓	✓			**P22PHC12**	New
	Core 3	Classical Mechanics	6	4	40+60=100				✔				✓	✓			**P22PHC13**	Revised 20%
	Major Elective 1	Electronic Communication	6	4	40+60=100				✔				✓			✓	**P22PHE11**	New
	Core Lab 1	Lab: General Physics	6	5	40+60=100				✔				✓			✓	**P22PHP11**	Revised 12%
II	Core 4	Mathematical Physics -II	6	5	40+60=100				✔				✓	✓			**P22PHC21**	Revised 5%
	Core 5	Electromagnetic Theory			40+60=100				✔				✓	✓			**P22PHC22/** P19PHC22	No Change
	Core 6	Quantum Mechanics I	6	4	40+60=100				✔				✓	✓			**P22PHC23**	New
	NME	Non-Conventional Energy Sources	6	4	40+60=100				✔				✓			✓	**P22PHN21/** P19PHN21	No Change
	Major Elective 2	Solar Energy Systems and Storage Devices	4	4	40+60=100				✔				✓			✓	**P22PHE21**	Revised 40%
	Core Lab 2	Lab: Electronics	2	2	40+60=100				✔				✓			✓	**P22PHP21**	Revised 12%

Course Title : MATHEMATICAL PHYSICS - I	**Total Hours : 6**
Course Code : P22PHC11/ P19PHC11	**Total Credits : 5**

Course Outcomes

COs	CO Statement
CO1	Understanding Gauss divergence theorem and Stoke's theorems
CO2	Applying vectors in hydrodynamics and heat flow in solids
CO3	Understanding the algebra of matrices and eigen value problems
CO4	Getting knowledge of power series technique
CO5	Understanding Bessel's and Legendre's differential equations and their orthogonal properties.

UNIT: I **18 Hours**

Vectors – The gradient – The divergence and Gauss's theorem (No proof, Applications only) – curl of a vector field and stoke's theorem (No proof, applications only) – Successive applications of the operator – Orthogonal curvilinear coordinates – Application to hydrodynamics (equation of continuity, Euler's equation of motion) – equation of heat flow in solids.

UNIT: II **18 Hours**

Matrices - Direct Sum and direct product of matrices, diagonal matrices, Matrix inversion (Gauss-Jordan inversion method), orthogonal, unitary and Hermitian matrices, normal matrices, Pauli spin matrices, Cayley-Hamilton theorem. Similarity transformation – unitary and orthogonal transformation. Eigen values and Eigen vectors – Diagonalisation using normalized eigen vectors. Solution of linear equation – Gauss elimination method. Normal modes of vibrations.

UNIT: III **18 Hours**

Differential Equation - Introduction- Ordinary Differential equations: First order Homogeneous with variable coefficients, The superposition principle, Second order Homogeneous equations with constant coefficients, Second order Homogeneous equations with variable coefficients- Partial Differential Equations: Introduction, Some important partial differential equations in physics, An illustration of the method of direct integration, Method of separation of variables.

UNIT: IV **18 Hours**

Special Function I – Bessel's Differential equation – Series solution of Bessel's Differential equation – value of $j_n (X)$ and $y_n (X)$ for large and small value of X – Recurrence Formulae for $j_n (X)$ - Expression for $j_n (X)$ when n is half and odd number – Differential equations whose solutions are expressible in terms of Bessel functions – Modified Bessel functions – Expansion in series of Bessel functions – The Bessel Coefficient..

UNIT: V **18 Hours**

Special Function II – Legendre's Differential equation – Rodrigues formula for the Legendre Polynomials – Generating function for $P_n (X)$ – The Legendre Coefficients – The Orthogonality of $P_n (X)$ – The Gamma Function – Gauss pi function the value of $\Gamma(1/2)$ – The Beta Function – The connection of the Beta function and Gamma function..

Book for study:

1. **Applied Mathematical for Engineers and Physicists** - Pipes and Harvill, Mc Graw Hill International Book Company, 3rd Edition, 2014.
   UNIT: I : Appendix – E (Section 8 - 14)

UNIT: IV : Appendix – B (Sections 2,3,5,6,7,9,10,12,13)
UNIT: V : Appendix – B (Sections 14,15,17,18,19,22,23,24,25,26)

2. **Mathematical Methods for Physicists** - G.B. Arfken & H. J Weber, Academic Press, 4th Edition, 1995
   UNIT: II : Chapter 3
3. **Introduction to Mathematical Physics** - C. Harper, PHI, 1st Edition, 2008.k Company,
   UNIT:III : Chapter 5

Books for Reference:

1. **Mathematical Physics**, B. S. Rajput, Pragati Prakashan, 2011
2. **Advanced Engineering Mathematics**, E. Kreyszig, 7th Edition, 1992
3. **Mathematical Physics**, H. K. Dass & Dr. Rama Verma, S.Chand & Co, New Delhi, 2010.
4. **Introduction to Partial Differential Equations**, K. Sankara Rao, 2nd Edition Prentice Hall of India, 2005.

Course Title : ELECTRONIC CIRCUITS AND SYSTEMS	Total Hours : 6
Course Code : P22PHC12	**Total Credits : 4**

Course Outcomes

COs	CO Statement
CO1	Understanding function of Three layer and Four layer devices
CO2	Understanding the technology of integrated circuits
CO3	Learning the basic of op-amp characteristics and its applications
CO4	Getting the knowledge of Signal generators and their design
CO5	Learning the basics of optoelectronic devices and its applications

UNIT: I **18 Hours**

Field Effect Transistors: JFET: n-channel JFET- p- channel JFET - JFET Fabrication and packaging- JFET characteristics - FET amplification and switching - FET Biasing : DC load line and Bias point - Gate Bias - Self Bias -Voltage Divider bias -Thyristors : SCR- Operation, characteristics and parameters -SCR Applications -TRIAC and DIAC - Operation and characteristics -UJT- Operation and characteristics - UJT relaxation oscillator.

UNIT: II **18 Hours**

Technology of integrated circuits: Introduction – Area of microelectronics – Basic IC technology – Monolithic integrated circuit technology – The process involved in formation of IC chips – Substrate preparation – Epitaxial growth – Silicon diode growth – Masking and photo etching – Diffusion of impurities – Basic of diffusion method – Monolithic bipolar junction transistor.

UNIT: III **18 Hours**

IC Operational amplifier and basic op-amp circuits: Integrated circuit operational amplifiers- circuit symbol and packages- Basic internal circuit- important parameters- Biasing operational amplifiers- Voltage follower circuits- Non-Inverting amplifiers- Inverting amplifiers-Summing Amplifier - Difference Amplifier -Instrumentation Amplifier -Voltage level Detectors- Schmitt Trigger circuits.

UNIT: IV **18 Hours**

Signal Generators- Classification of oscillators-Conditions for oscillation; Barkhausen Criterion- Op-amp Phase shift oscillator and its Design - Op-amp Colpitts oscillator and its design - Op-amp Hartley Oscillator - Wein Bridge Oscillator- Oscillator amplitude stabilization- square wave generator- 555 Pulse generator - Triangular wave generator - Oscillator frequency stabilization.

UNIT: V **18 Hours**

Optoelectronic Devices: Light Emitting diodes (LED)- Operation and construction-characteristics and parameters-LED circuits- LED seven segment display- Photoconductive cells- cell construction, characteristics and parameters- Applications-Photodiodes and Solar cells- Photodiode operation- characteristics- specification- construction-Applications- Solar cells - Phototransistors(BJT)- characteristics- and specification- Applications-Photo FET-Optocouplers- Operation and construction- specification and applications.

Text Books:

1. **Electronic devices and Circuits**- David A. Bell, Oxford University Press, Fifth edition, 2008

Unit – I : 9.1 ,9.2,9.4,20.1,20.3,20.4,20.7
Unit - III : 14.1 - 14.10
Unit - IV : 16.1 - 16.9
Unit - V : 21.1 - 21.7

2. **Integrated Circuit** – G.K. Mithal, Khanna Publisher, 23rd Edition, 2014.

Unit – II: 10.1 -10.4

Reference Books:

1. Electronic Devices and Circuits – Jacob Millman & Christos Halkins, Tata Mc Graw Hill Company International Student Edition, 2015.
2. Op-amps and Linear Integrated Circuits – Ramkant A.Gayakwad, 3rd Edition, PHI, 1993.
3. Electronic fundamentals and Application – John D. Ryder, Published by Asoke K.Ghosh, PHI Learning Pvt. Ltd, New Delhi, 4th edition, 2009.

Course Title : CLASSICAL MECHANICS	**Total Hours : 6**
Course Code : P22PHC13	**Total Credits : 4**

Course Outcomes:

COs	CO Statement
CO1	Solving the Lagrangian equations and Hamilton's equation from the Variational principle
CO2	Understanding the concepts of the Canonical transformations, Poisson's brackets and Hamilton-Jacobi equations
CO3	Understanding Canonical Transformations and the Hamilton – Jacobi Theory
CO4	Getting knowledge of theory of oscillations of small amplitudes
CO5	Learning the problem of two bodies moving under the influence of a mutual central force as an application of the Lagrangian formulation.

Unit I: Variational Principles and Lagrange's Equations 18 Hours

Mechanics of a particle – Mechanics of a system of particles – Constraints – Virtual work and D' Alembert's principle and Lagrange's function – Simple applications. Hamilton's principle – Some Techniques of the calculus of variations – Lagrange's equations from Hamilton's principle - Applications of variational principle – Conservation theorems and symmetry properties.

Unit II: Hamilton's Equations of Motion 18 Hours

Legendre Transformation and Hamilton's equation of Motion – Symmetry, Cyclic coordinates and Conservation theorems – Routh's procedure and equation of motion of oscillations about steady motion – Derivation of Hamilton's equation of motion from variational principle – Simple applications – The Hamiltonian formulation of relativistic mechanics - The principle of least action.

Unit III: Canonical Transformations and the Hamilton – Jacobi Theory 18 Hours

The equation of canonical transformation – Generating Functions – Examples of canonical transformation – Poisson brackets and other canonical invariants – Canonical equation of motion in terms of Poisson bracket – Conservations theorems in the Poisson bracket formulation - The angular momentum Poisson bracket relations – Liouville's Theorem – The Hamilton-Jacobi equations for Hamilton's principle function with example – Characteristic function and Separation variables in Hamilton-Jacobi equation

Unit IV: Small Oscillations 18 Hours

Formulation of the problem – The eigenvalue equation and the principle axis transformation – Frequencies of free vibration and Normal coordinates – Application of Small Oscillation Theory: Free vibrations of a linear triatomic molecule – Free oscillations of Double pendulum – Small oscillations of particles on string.

Unit V: The Two-body Central Force Problem 18 Hours

Reduction to the equivalent One-body problem – The equation of motion and first integrals – The equivalent one dimensional problem and classification of orbits – The Virial theorem – The Differential equation for the orbit and integrable power-law potentials – Bertrand's Theorem – The Kepler problem: Inverse-square law of force – The motion in time in the Kepler problem.

Text book:

1. Classical Mechanics – by Herbert Goldstein, Charles Poole and John Safko (Third edition), Addison Wesley, 2001
   Unit I : Chapter – 1.1 to 1.4 and 2.1 to 2.6
   Unit II : Chapter – 8.1 to 8.6
   Unit III: Chapter – 9.1 to 9.3, 9.5 to 9.7, 9.9 and 10.1 to 10.4
   Unit IV: Chapter – 6
   Unit V : Chapter – 3.1 to 3.8

Reference Books:

1. Introduction to Classical Mechanics – by R. G. Takwale and P. S. Puranik, Eleventh Reprint 1990, Tata McGraw-Hill.
2. Variational Principles in Classical Mechanics – by Douglas Cline, 2017, University of Rochester River Campus Libraries, University of Rochester, Rochester, NY 14627.

Course Title : ELECTRONIC COMMUNICATION	**Total Hours : 6**
Course Code : P22PHE11	**Total Credits : 4**

Course Outcomes:

COs	CO Statement
CO1	Getting knowledge of basic elements of Communication system
CO2	Learning various types of modulation principles
CO3	Distinguishing Frequency and Pulse modulation techniques
CO4	Understanding theories and characteristics of antennas
CO5	Getting idea of satellite communication

Unit I: **18 hours**

Introduction: Elements of Communication system – Electromagnetic Spectrum and applications – Technologies in Communication system - Noise – External Noise – Atmospheric , Extraterrestrial , Industrial Noise –Internal Noise - Thermal agitation, Shot Transit time noise - Noise figure – Signal to noise ratio

Unit II: **18 hours**

Amplitude Modulation: Technique –Power relations in AM wave – Double side band suppressed carrier DSBSC technique –Frequency spectrum – Power in DSBSC – Single side band technique – Power in SSB – Vestigial Sideband technique –Power in VSB wave – Generation of AM signal –Balanced Modulator for DSBSC signal –Generation of SSB – Analog multiplier –Filter method – Phase shift method - Third method - Generation of VSB by analog multiplier and filter method

Unit III: **18 hours**

Angle Modulation Technique: Frequency Modulation –Mathematical representation of FM – Phase Modulation – Mathematical Representation of PM – Comparison of FM and PM – Narrow and wideband FM - noise and frequency modulation Pre and De – emphasis – Stereophonic FM multiplex system - FM and AM comparison- Generation of FM Direct methods – Basic reactance modulator - Varactor diode modulator - Stabilized reactance modulator – Indirect method of FM generation – Pulse modulation technique – PPAM, PWM, PPM, PCM

Unit IV: **18 hours**

Antennas : Introduction – Equivalent circuits –Coordinate system – Radiation fields – Polarization –Isotropic radiator- Power gain of an Antenna –Effective area and length of an antenna – Hertizian dipole –Half wave dipole- Vertical antenna- Ground refelction – Grounded vertical antenna –Loop and ferrite rod antenna- Long wire and rhombic antenna – Driven and broad side array – Parasitic array – Parasitic directors – VHF and UHF antenna- Microwave antenna

Unit V: **18 hours**

Satellite Communications: Introduction – Keplers laws – Orbits –Power systems – Altitude control – Satellite station keeping – Antenna look angles – Limits of visibility – Frequency plans and polarization – Transponders – Multiple access methods

Book for Study:

1. **Electronic Communication Systems -** George Kennedy, Bernard Davis and SRM Prasanna, TMH Publication – New Delhi , Fifth edition 2011

Unit I – Page 1-32
Unit II – Page – 33 -66
Unit III – Page – 67 - 116

2. **Electronic Communication** – Dennis Roddy, John Coolen, Published by Pearson Education (Singapore) Pvt. Ltd, New Delhi, 4th edition, 2008

Unit IV – Page – 505 - 541
Unit V – Page 620 -650

Books for Reference:

1. Principles of Electronic Communication Systems, Louis E. Frenzel, David L. Heiserman, 2004, McGraw-Hill Higher Education
2. Electronic Communication Systems, Roy Blake, 2nd edition, 2012, Cengage Publisher

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Course Title : LAB: GENERAL PHYSICS	Total Hours : 6
Course Code : P22PHP11	**Total Credits : 5**

Course Outcomes:

COs	CO Statement
CO1	Determining the refractive index of a liquid
CO2	Forming Edser-Butler fringes using a sheet and determining its thickness
CO3	Measuring the Young's modulus of a material
CO4	Determining Self inductance of a coil
CO5	Determining Mutual inductance between coils

1. Determination of refractive index of a liquid using Hollow Prism.
2. Determination of wavelength of laser sources by diffraction.
3. Measuring thickness of the film by making Edser Butler fringes.
4. Determination of the Young's modulus of the material of the beam by forming Elliptic Fringes.
5. Determination of the Young's modulus of the material of the beam by forming Hyperbolic Fringes.
6. Determination of Mutual Inductance of Coils by Carey Foster's method.
7. Determination of Self-inductance by Anderson's Bridge AC method.
8. Determination of Self-inductance of coil by Maxwell's Bridge and Determination of unknown capacitance by Schering Bridge

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SEMESTER - II

Course Title : MATHEMATICAL PHYSICS - II	Total Hours : 6
Course Code : P22PHC21	Total Credits : 5

Course Outcomes:

COs	CO Statement
CO1	Learning Fourier series and transforms and its applications to physical problems
CO2	Understanding the properties of complex number and integrals and evaluation of definite integrals.
CO3	Getting knowledge of Cauchy's residue theorem
CO4	Understanding the algebra of tensors and their applications to electrodynamics
CO5	Understanding the concept of groups

UNIT: I **18 Hours**

Fourier Series, Fourier Integrals & Fourier Transform – Fourier series and integrals – representation of more complicated periodic phenomena – Fourier series – Examples of Fourier expansion of functions – Fourier integrals – Fourier Transforms – Properties of Fourier Transforms – Fourier Sine & Cosine Transforms.

UNIT: II **18 Hours**

Complex Variables - Introduction – Functions of a Complex Variable – The Derivative and the Cauchy – Riemann Differential Equations – Line Integral of Complex functions – Cauchy's integral theorem – Cauchy's integral formula – Taylor's Series - Laurent's series.

UNIT: III **18 Hours**

Residues - Cauchy's Residue theorem – Singular points of an analytic function - The point at infinity – Evaluation of Residues - Evaluation of definite integrals, Jordan's Lemma.

UNIT: IV **18 Hours**

Tensor Analysis: Introduction-Occurrence of tensors in physics-Notation and conventions-Contravariant vector-Covariant vector-Tensors of second rank-General definition. **The Algebra of tensors:** Equality and null tensor-Addition and subtraction-Outer product of tensors-Inner product of tensors-Contraction of a tensor-Symmetric and antisymmetric tensors-The Kronecker delta-**Quotient law:** Examples of quotient law-Conjugate symmetric tensors of second rank. **Fundamental Tensor:** The metric tensor-Contravariant metric tensor-Associate tensors-Raising and lowering of indices- Order of indices. **Cartesian tensors:** Rotation and translation Orthogonal transformations-Cartesian tensors-Isotropic tensors-Stress, strain and Hooke's law-Piezoelectricity and dielectric susceptibility-Moment of inertia tensor. **Four vectors in special theory of relativity:** Scalars and vectors in 4-D spacetime-Lorentz transformation of coordinates-Transformation of a four-vector-Other mathematical properties-Lorentz invariance and physical laws. **Covariant formulation of electrodynamics:** Lorentz gaugeElectromagnetic field-strength tensor-Maxwell equations-Transformation of electromagnetic fields-Fields of a uniformly moving charge.

UNIT: V **18 Hours**

Group Theory – Introductory definition and concept of group – point group, cyclic group, homomorphism and isomorphism - Classes, reducible and irreducible representations

– Schur's Lemmas and great orthogonality theorem. Group character table – C2V, C3V and C4V groups, Lie group, concept of generators

Book for study:

1. **Applied Mathematical for Engineers and Physicists** - Pipes and Harvill, Mc Graw Hill International Book Company, 3rd Edition, 2014.
   UNIT: I : Appendix C (Sections 15, 21,22,23,28)
   UNIT: II : Chapter 1 (Sections 1-7)
   UNIT: III : Chapter 1 (Sections 8-12, 14, 15)
2. **Matrices and Tensors in Physics** - A. W. Joshi, Wiley Eastern Ltd., 2nd Edition,2010 19
   UNIT: IV : Chapter 2
3. **Elements of Group theory for Physicists** - A. W. Joshi, New Age India, 19971970.
   UNIT: V : Chapter 1 and 3

Books for Reference:

1. **Mathematical Physics**, B. S. Rajput, Pragati Prakashan, 2011
2. **Advanced Engineering Mathematics**, E. Kreyszig, 7th Edition, 1992
3. **Mathematical Physics**, P. K.Chattopadhyay, New Age International Publishers, 2nd Edition, 2013
4. **Mathematical Physics**, H. K. Dass & Dr. Rama Verma, S.Chand & Co, New Delhi, 2010.
5. **Schaum's Outline Series Theory and Problems of Fourier analysis**, M R. Spiegel, 2000
6. **Theory and Problems of Fourier Analysis with Applications in Boundary Value Problems**, M R. Spiegel, Mc Graw Hill Book Company, 2000.

Course Title : ELECTROMAGNETIC THEORY	Total Hours : 6
Course Code : P22PHC22/ P19PHC22	Total Credits : 4

Course Outcomes:

COs	CO Statement
CO1	Getting knowledge about electrostatic field in vacuum and dielectric media.
CO2	Understanding the general methods for solving Laplace's and Poisson's equations
CO3	Learning to apply mathematical methods to electrostatic problems
CO4	Getting knowledge of magnetic induction and derivation of Maxwell's equations
CO5	Learning about the propagation of an electromagnetic wave through non conductors and conductors and coaxial lines

UNIT: I **18 Hours**

Electrostatic fields in a vacuum: The equations of Poisson and Laplace – Conductors - calculation of the Electric field produced by a simple charge distribution - The electric dipole - The linear electric Quadrupoles - Electric Multipoles.

Dielectric Materials: The Electric Polarization - Electric field at an Exterior point - Electric field at an Interior point - The local field - The Electric susceptibility – The Divergence of E - The Electric displacement D - calculation of the Electric field involving dielectrics - The Clausius Mossatti equation - polar dielectrics – frequency dependence, Anisotropy & Non Homogeneity - potential energy of a charge distribution in the presence of dielectrics - Forces on dielectrics - Forces on conductors in the presence of Dielectrics.

UNIT: II **18 Hours**

General methods for solving Laplace's and Poisson's equations : Continuity of V, Dn, E at the interface between two different media – The uniqueness theorem - Solution of Laplace's equation in rectangular coordinates - Solution of Laplace's equation in spherical coordinates. Legendre's equation. Legendre Polynomials.

Steady current & non magnetic materials: magnetic forces – the magnetic induction B. The Biot savat law – The force on a point charge moving in a magnetic field – The divergence of the magnetic induction B - The vector potential A – The curl of the magnetic induction B - Ampere's circuital law.

UNIT: III **18 Hours**

Induced electromotance and magnetic energy: The Faraday induction law – the induced electric field intensity E in terms of the vector potential A. Induced Electromotance in a moving system

Maxwell's equations: The conservation of electric charge - The potentials V&A – The Lorentz condition – the divergence of E and the Non homogenous wave equation for V - the Non homogenous wave equation for A – the curl of B – Maxwell's equations.

UNIT: IV **18 Hours**

Plane Wave in Infinite Media: Plane electromagnetic waves in free space – the E & H vectors in homogeneous, Isotropic, Linear & stationary Media – Propagation of plane electromagnetic waves in Non conductors - Propagation of plane electromagnetic waves in conducting media - propagation of plane electromagnetic waves in good conductors.

UNIT: V **18 Hours**

Guided waves: Propagation in a straight line – the coaxial line – the hollow rectangular wave guide.

Radiation of electromagnetic waves: Electric dipole radiation. The scalar potential V - the vector potential A & the magnetic field intensity H – the electric field intensity E – the Average poynting Vector & the Radiated power – the electric & Magnetic lines of force.

Book for study:

1. **Electromagnetic Fields & waves** - Paul Lorain & Date R. Corson, Second edition, CBS Publ. New Delhi, 1986.

UNIT: I : 2.6-2.11, 3.1-3.13.
UNIT: II : 4.1, 4.2, 4.4, 4.5, 7.1 – 7.7.
UNIT: III : 8.1-8.3, 10.1-10.7
UNIT: IV : 11.1-11.5.
UNIT: V : 13.1-13.3, 14.1.1-14.1.5

Books for Reference:

1. Foundation of electromagnetic theory - John R. Reitz, Federih J. Milford and Robert W. Christy, 3rd edition – Narosa Publishing House, 1979.
2. Introduction to electrodynamics - D.J. Griffiths, 4th edition, Pearson Education India, Learning Private Limited, 2015.

3. Electromagnetic waves and radiating systems - E.C. Jordan and Balmain, 2^{nd} edition, PHI, 2015.

Course Title : QUANTUM MECHANICS - I	Total Hours : 6
Course Code : P22PHC23	**Total Credits : 4**

Course Outcomes:

COs	CO Statement
CO1	Understanding the concept of Wave function
CO2	Getting knowledge of Time-independent Schrodinger equation
CO3	Knowing the formalisms of Quantum mechanics
CO4	Getting knowledge of Quantum mechanics in three dimensions
CO5	Learning the concept of Time-independent perturbation theory

Unit I: **18 Hours**

The wave function: The Schrodinger equation – The statistical interpretation: Discrete variables, Continuous variables – Probability – Normalization – Momentum – The Uncertainty principle.

Unit II: **18 Hours**

Time-independent Schrodinger equation: Stationary states – The infinite square well – The Harmonic oscillator: Algebraic method – The free particle – The Delta-function potential – The Finite square well

Unit III: **18 Hours**

Formalism: Hilbert space – Observables – Eigen functions of a Hermitian operator – The Uncertainty principle – Dirac notation

Unit IV: **18 Hours**

Quantum mechanics in three dimensions: Schrodinger equation in spherical coordinates: separation of variables, The Angular equation, The radial equation – The Hydrogen atom – Angular momentum – Spin

Unit V: **18 Hours**

Time-independent perturbation theory: Non-degenerate perturbation theory – Degenerate Perturbation theory – The fine structure of Hydrogen – The Zeeman effect – Hyperfine splitting in Hydrogen.

Book for study:

Introduction to Quantum mechanics, David J. Griffiths, Tenth Impression, 2018, Pearson.
Unit 1: Section 1 – 1.1 to 1.6
Unit 2: Section 2 – 2.1, 2.2, 2.3, 2.3.1, 2.4, 2.5, 2.6
Unit 3: Section 3 – 3.1 to 3.3, 3.5 & 3.6
Unit 4: Section 4 – 4.1 to 4.4
Unit 5: Section 6 – 6.1 to 6.5

Books for reference:

1. Quantum mechanics, G. Aruldhas, Sixth printing, 2006, PHI

2. A Text book of Quantum Mechanics - P.M.Mathews & K.Venkatesan - TMH Pub. Com. Ltd., New Delhi (2010) - II edition.
3. Basic Quantum mechanics, Ajoy Ghatak, Reprint 2014, Trinity

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Course Title : NON-CONVENTIONAL ENERGY SOURCES (NME)	Total Hours : 4
Course Code : P22PHN21/ P19PHN21	Total Credits : 4

Course Outcomes:

COs	CO Statement
CO1	Getting knowledge of conventional and non-conventional energy sources
CO2	Understanding solar energy basics
CO3	Learning about wind energy and its potential applications
CO4	Understanding basic concepts of producing and utilizing bio-mass energy
CO5	Learning about Geothermal tidal and Ocean thermal energy concepts

UNIT: I **18 Hours**

Classification of energy resources – Consumption trend of primary energy sources – importance of non-conventional energy sources – Advantages and disadvantages of conventional energy sources – salient features of non-conventional energy sources – Environmental aspects of energy –World energy status.

UNIT: II **18 Hours**

Solar Energy Basics – Introduction – The Sun as a source of energy – The earth – Extraterrestrial and Terrestrial radiations – Spectral distribution of solar radiation –Depletion of solar radiation – Measurements of solar radiation – Solar collectors –Classification – Liquid flat plate collector – Evacuated tube collector – Solar water heater – Box type solar cooker

UNIT: III **18 Hours**

Wind energy – Introduction – Global winds – Local winds – nature of winds –Wind turbine siting – Major applications of wind power – Horizontal axis wind turbine – Environmental aspects – Wind energy programme in India

UNIT: IV **18 Hours**

Biomass Energy – Introduction – useful forms of biomass, their composition and fuel properties – Biomass resources – Biomass gasification – Downdraft type – Updraft type – Biogas production from waste biomass – Availability of raw materials and gas yield - Biomass energy programme in India

UNIT: V **18 Hours**

Geothermal energy – Introduction – Applications – Origin and distribution of geothermal energy – Tidal energy - Origin and nature of tidal energy – Limitations of tidal energy – Ocean thermal energy – Origin and characteristics of resource - Ocean thermal energy conversion technology.

Book for study:

1. **Non-Conventional Energy resources,** B H.Khan, McGraw Hill, 2nd edition, 2009.
   UNIT: I : 1.3 – 1.5, 1.8 – 1.10 & 1.13
   UNIT: II : 4.1, 4.2, 4.4 – 4.7, 5.1, 5.1.1, 5.1.4, 5.1.7, 5.2 & 5.6.1
   UNIT:III : 7.1.1, 7.1.2, 7.2, 7.2.1, 7.3, 7.4, 7.7.1, 7.12 & 7.13
   UNIT: IV : 8.2, 8.3, 8.6, 8.6.1, 8.6.2, 8.9, 8.9.6 & 8.11
   UNIT: V : 9.1, 9.2, 10.1, 10.1.1, 10.1.2, 10.3, 10.3.1, 10.3.2

Books for Reference:

1. **Non Conventional energy sources** - G.D. Roy, Khanna Publications
2. **Solar energy utilization** - G.D. Roy, Khanna Publications.

Course Title : SOLAR ENERGY SYSTEMS AND STORAGE DEVICES	Total Hours : 2
Course Code : P22PHE21	**Total Credits : 2**

Course Outcomes:

COs	CO Statement
CO1	Knowing about Solar energy basics
CO2	Getting knowledge about solar thermal energy systems
CO3	Knowing the potential applications of solar thermal systems
CO4	Understanding fundamentals of solar photovoltaics
CO5	Learning about energy storage devices

UNIT: I **6 Hours**

Solar Energy Basics - The Sun as a Source of Energy- The Earth – Sun, Earth, Radiation Spectrums- Extraterrestrial and Terrestrial Radiations-Spectral Energy Distribution of Solar Radiation- Depletion of solar Radiation-Measurements of Solar Radiation: Pyranometer, Pyrheliometer - Solar Radiation Data- Solar Time- Solar radiation Geometry-Solar Day Length

UNIT: II **6 Hours**

Solar Thermal Systems – Solar Collectors: Classifications- Comparison of Concentrating and Non-Concentrating types of Solar Collectors- Performance Indices-Liquid Flat-plat Collector- solar water heater- solar Cookers: Box-Type Solar Cooker, Paraboloidal Dish-Type Solar Cooker, Community Solar Cooker, Advanced Solar cooker. Solar Furnaces-Solar Green House: Regulation of Internal Environment of a Greenhouse- Solar Dryer- Solar Distillation /Desalination of water- Solar Thermo Mechanical Systems: Solar Thermal Water Pump, Solar Vapour Compression Refrigeration, Solar-Pond Electric-Power plant.

UNIT: III **6 Hours**

Solar Photovoltaic Systems - Solar Cell Fundamentals: Semiconductors, A p-n junction, Generation of Electron-Hole Pair by Photon Absorption, Photoconduction - Solar Cell Characteristics: I-V Characteristic, Equivalent Circuit, Effect of Variation of Isolation and temperature, Energy Losses and Efficiency, Maximizing the Performances, Cell size, Energy Payback Period (EPP) - Solar Cell, Solar PV Module, Solar PV Panel, Solar PV

Array - Solar PV systems: Classifications, Stand –Alone Solar PV System, Grid-Interactive Solar PV System, Hybrid Solar PV System.

UNIT: IV **6 Hours**

Battery energy storage - Basics of Electrochemical cell- elements and operation of electrochemical cell- Theoretical cell voltage and capacity- losses in a cell - Battery classification - Cell to Battery- Battery parameters- Factors affecting Battery performance - Battery voltage level - Battery discharge current - battery temperature during discharge - Choice of a Battery - Battery charging and discharging methods-Batteries for PV systems - Lead-acid Batteries - Nickel-Cadmium(Ni-Cd) Batteries - Comparison of Batteries.

UNIT: V **6 Hours**

Emerging Technologies - Fuel Cell: Potential Applications, Classification of fuel cells, Phosphoric Acid Fuel Cell (PAFC), Alkaline Fuel Cell (AFC), Polymer Electrolyte Membrane Fuel Cell (PEMFC) or Solid Polymer Fuel Cell (SPFC) - Hydrogen Energy: Properties of Hydrogen, Production, Storage, Delivery, Conversion, Applications, Safety issues, Present Status.

Book for study:

1. **Non-Conventional Energy Resources,** B H.Khan, McGraw Hill, 2nd edition, 2009.
   UNIT: I : 4.1 to 4.11
   UNIT: II : 5.1.1 to 5.1.4, 5.2,5.6 ,5.7,5.8 ,5.8.1,5.9,5.10,5.11.1 to 5.11.3
   UNIT:III : 6.1, 6.2 & 6.4
   UNIT: V : 12.1.1 - 12.1.5, 12.2.1 -12.2.8
2. **Solar Photovoltaics** - Fundamentals, Technologies and Applications , Chetan Singh Solanki, PHI Learning private limited, 2nd edition 2012.
   UNIT: IV : 13.1.1 - 13.1.8, 13.2.1 - 13.2.5 ,13.3.1 - 13.3.3

Books for Reference:

1. **Non-Conventional Energy Sources** - G.D. Rai, Khanna Publishers, 2011
2. **Solar Energy Principles of Thermal Collection and Storage** - S.P. Sukhatme, J.K. Nayak, Tata McGraw Publisher, 3rd Edition.

Course Title : CORE LAB: ELECTRONICS	**Total Hours : 6**
Course Code : P22PHP21	**Total Credits : 5**

Course Outcomes:

COs	CO Statement
CO1	Learning to construct and study amplifiers
CO2	Designing amplitude modulator circuits
CO3	Studying construction of Oscillators
CO4	Learning construction of Saw tooth wave generators
CO5	Studying wave shaping properties of clipping and clamping circuits

1. Construction and study of FET Amplifier.
2. Construction and study of Amplitude Modulation Circuit.
3. Construction and study of Phase shift oscillator.
4. Construction of Emitter follower and determination of its I/O impedances.
5. Construction and study of Wien's bridge oscillator.
6. Construction and study of Saw tooth wave generator using transistors.

7. Construction and study of Relaxation oscillator using UJT.
8. Construction and study of Push pull amplifier.

Course Name : Master of Science
Discipline : Physics
CHOICE BASED CREDIT SYSTEM
(For those who join in June 2018 and after)
COURSE OBJECTIVES:

- To develop a general competence in Physics. This is a pre-requisite for contributing flexibility in today's cross- disciplinary research arenas.
- To nurture the creative imagination of young minds and to reinforce the spirit of rational enquiry in a co-operative ambience.
- To cultivate specific strengths in the flourishing and future oriented areas of Nano Physics and Molecular Spectroscopy respectively.
- To enable students to develop insights into the techniques used in current projects.
- To give students the experience of teamwork, to develop presentational skills and to train students to work to deadlines.
- To develop the professional skills necessary for students to play a meaningful role in industrial or academic life and satisfy the need, nationally for well qualified post-graduates who will be able to respond to the challenges that arise form future developments.
- This course will put students in a strong position when applying for a PhD and other higher studies.

Sem	Subject	Hrs	Credit	Int+Ext =Total	Local	Regional	National	Global	Professional Ethics	Gender	Human Values	Environment & Sustainability	Employability	Entrepreneurship	Skill Development	Subject Code	Revised / New / No Change / Interchanged & Percentage of revision
III	Core 7 - Solid State Physics I	6	4	40+60=100				✔				✔				**P19PHC31**	No change
	Core 8 - Quantum Mechanics - II	6	4	40+60=100				✔				✔				**P19PHC32**	Interchange & Revised / 2%
	Core 9- Nuclear and Particle Physics	6	4	40+60=100				✔				✔				**P19PHC33**	No change
	Major Elective-Fiber Optic Communication /Applied Optics	6	5	40+60=100				✔				✔				**P19PHE31/ P19PHE32**	No change
	Core Lab4-LAB:Digital Electronics & General Physics	6	5	40+60=100				✔				✔				**P19PHP31**	No change
IV	Core10- Solid State Physics II	6	4	40+60=100				✔				✔				**P19PHC41**	No change
	Core11-Molecular Spectroscopy	6	4	40+60=100				✔				✔				**P19PHC42**	No change
	Core12- Thermodynamics and Statistical Mechanics	6	4	40+60=100				✔				✔				**P19PHC43**	Interchange
	Major Elective-Nanophysics/ Biophysics	6	5	40+60=100				✔				✔				**P19PHE41/ P19PHE42**	No change
	Core Lab 5: Project& Viva-voce	6	5	40+60=100				✔				✔				**P19PH4PV**	No change

COURSE : II M.Sc. PHYSICS SEMESTER : III	SOLID STATE PHYSICS – I CORE PAPER 7	Hours : 6 Credit : 4

Subject Code: P19PHC31

Objectives

- To understand the structure of crystals.
- To get knowledge about the Imperfections of crystals.
- To study the lattice vibrations.
- To impart the knowledge about energy band theories and band gap in semiconductors.

Unit I: Crystal Physics

Crystal structure: Lattice translation vectors – Basis – Primitive lattice cell – 2D and 3D lattice types – Index system for crystal planes – Simple crystal structures. *Diffraction and Reciprocal lattice*: Diffraction of waves by a crystal lattice – Bragg law – Reciprocal lattice vectors – Diffraction conditions – Brillouin Zones – Structure factor – Atomic form factor. *Crystal binding*: Inert gas crystals – Ionic crystals – Covalent crystals – Metallic binding.

Unit II: Lattice Imperfections

Lattice vacancies: Point defects – Schottky defects – Frenkel defects – Diffusion in metals – Fick's law. *Colour centers*: F-Centers – Other centers in Alkali halides. *Dislocations*: Burger vectors – Phenomenon of slip, edge and screw dislocations – Stress fields of dislocations – Low angle grain boundary

Unit III: Lattice Dynamics and Thermal Properties

Lattice vibrations: Monoatomic lattices – Lattice with two atoms per primitive cell – Group and phase velocities – Quantization of lattice vibrations – Phonon momentum. *Lattice heat capacity*: Debye's theory of lattice heat capacity – Einstein's model and Debye's model of specific heat. *Thermal conductivity*: Thermal expansion – Umklapp processes.

Unit IV: Free Electron and Energy Band Theories

Free electron gas: Periodic boundary conditions and free electron gas in 3D – Heat capacity of electron gas – Ohm's law – Mathiessen's rule and Umklapp process – Hall effect and Wiedmann Franz law – Nearly free electron model – *Energy bands*: Origin and the magnitude of energy gap – Bloch functions – Kronig-Penny model – *Wave equation of an electron in a periodic potential*: Restatement of Block theorem –Solution of the Central equation – Kronig-Penny model in Reciprocal space – Approximate solution near zone boundary – Number of orbitals in a band.

Unit V: Semiconductor Crystals

Band gap: Band gap in semiconductors. *Equation of motion*: Physical derivation – Holes – Effective mass – Physical interpretation of effective mass – Effective masses in semiconductors – Intrinsic career concentration – Intrinsic mobility – Impurity conductivity – Donor and acceptor states. *Thermoelectric effect*: Thermal ionization of donors and acceptors.

Book for Study:

1. C. Kittel, 1996, Introduction to Solid State Physics, 7th Edition, Wiley, New York.

   Unit I: Chapters 1, 2 & 3
   Unit II: Chapters 18 & 20
   Unit III: Chapters 4 & 5
   Unit IV: Chapters 6 & 7

Unit V: Chapters 8

Books for Reference:

1. J.P. Srivastava, 2006, Elements of Solid State Physics, PHI Learning Pvt. Ltd., New Delhi.
2. S.O. Pillai, 1997, Solid State Physics, New Age International, New Delhi.
3. N.W. Aschroft and N.D. Mermin, Solid State Physics, Rhinehart and Winton, New York.
4. A.J. Dekker, Solid State Physics, Macmillan India, New Delhi.
5. H. Ibach and H. Luth, 2003, Solid State Physics, Springer (India), New Delhi.
6. S.O. Pillai, 1994, Problems and Solutions in Solid State Physics, New Age International, New Delhi.

SEMESTER : III	QUANTUM MECHANICS - II CORE PAPER	Hours : 6 Credit : 4

Subject Code : P19PHC32

Objectives

- To understand the scattering mechanism in microscopic interactions such as nuclear reactions.
- To understand the fundamentals of Quantum Mechanics using Dirac vector notations and Hilbert space.
- To learn about the operators of total angular momentum, addition of angular momenta and the procedure to evaluate CG coefficients.
- To impart the knowledge about time dependent perturbation theory and its applications to Physics problems.
- To understand the Relativistic Quantum Mechanics using KG equation and Dirac equation.

UNIT-I

Scattering Theory; **The Scattering Cross Section: General Considerations;** Kinematics of the Scattering Process: Differential and Total Cross Sections - Wave mechanical picture of scattering: The scattering amplitude - Green's Functions; Formal expression for scattering amplitude. **The Born and Eikonal Approximations;** The Born approximation - Validity of the Born approximation - The Born series - The Eikonal approximation - **Partial Wave Analysis;** Asymptotic behavior of partial waves: Phase Shifts - The scattering amplitude in terms of phase shifts - The differential and Total cross sections - Phase Shifts: Relation to the potential - Low energy scattering - **Exactly Soluble Problems;** Scattering by a square well potential - Scattering by a Hard Sphere - Scattering by a coulomb potential.

UNIT - II

Representations, Transformations and Symmetries; Quantum States: State Vectors and Wave Functions - The Hilbert Space of State vectors; Dirac notation - Dynamical variables and linear operators - Representations - Continuous basis - The Schrödinger representation - Degeneracy; Labeling by commuting observables - Change of basis; Unitary transformations - Unitary transformations induced by change of coordinate systems: Translations - Unitary transformation induced by rotation of coordinate system -The algebra of rotation generators - Transformation of dynamical variables - symmetries and conservations laws - space inversion - Time reversal.

UNIT - III

Angular Momentum; The eigen value spectrum - Matrix representation of J in the |jm> Basis - Spin Angular Momentum - Non relativistic Hamiltonian Including spin - Addition of

Angular Momenta - Clebsch-Gordan Coefficients - Spin Wave Functions for a system of Two Spin-1/2 particles - Identical particles with spin.

UNIT - IV

Evolution with Time: **Perturbation theory for time Evolution Problems;** Perturbative solution for transition amplitude - Selection Rules - First Order Transitions: Constant perturbation - Transitions in the second order: Constant perturbation - Harmonic Perturbations - Interaction of an Atom, with Electromagnetic Radiation - The Dipole Approximation: Selection Rules - The Einstein Coefficients: Spontaneous Emission. **Alternative Picture of Time Evolution;** The Schrödinger Picture, The Heisenberg Picture, The Interaction Picture.

UNIT - V

Relativistic Wave Equations; The Klein - Gordon Equation; Plane wave solutions: Charge and Current Densities - interaction with Electromagnetic Fields; Hydrogen like Atom - Non relativistic limit. **The Dirac equation;** Dirac's Relativistic Hamilton - 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 - Relativistic Electron in a Central Potential: Total Angular Momentum.

Text Book:

P.M.Mathews and K.Venkatesan. ***A Text book of Quantum Mechanics.*** New Delhi: TMH Pub.Com.Ltd; 2010. 2nd Edition.

Unit I: Chap. (6) Secs. 6.1 - 6.11 & 6.13 - 6.16.
Unit - II: Chap. (7) Secs. 7.1 - 7.14
Unit-Ill: Chap. (8) Secs. 8.1 - 8.8
Unit IV: Chap. (9) Secs.9.7 - 9.10, 9.14 - 9.17, 9.18, 9.19, & 9.23.
Unit- V: Chap. (10) Secs. 10.2 - 10.11.

Reference Books:

1. L.I. Schiff. ***Quantum Mechanics.*** India: McGraw Hill Education Pvt Ltd; 1968. 3rd Edition
2. E. Merzbacher. ***Quantum Mechanics.*** New York: John Wiley & Sons; 1998. 3rd Edition.
3. Ghatak, Ajoy, S. Lokanathan. ***Quantum Mechanics: Theory and Applications.*** London: Kluwer Academic Publishers; 2004.
4. A.S. Davydov. ***Quantum Mechanics***. U.K: Pergamon Press Ltd; 1976. 2nd Edition.

COURSE : II M.Sc. PHYSICS SEMESTER : III	NUCLEAR AND PARTICLE PHYSICS CORE PAPER 9	Hours : 6 Credit :4

Subject Code: P19PHC33

Objectives

- To understand the Nuclear forces.
- To study Nuclear models.
- To learn Nuclear Reactions.
- To impart the knowledge of Nuclear fission and fusion.
- To study the elementary particles

Unit –I

Nuclear Forces : Introduction- Binding energy-Semi empirical mass formula-Quantum numbers for individual nucleons-Independence of atomic and nuclear properties-Quantum properties of nuclear states-Deuteron-Neutron –Proton scattering at low energies-Proton Proton scattering at low energies-Effective range theory of p-p scattering-Meson theory of exchange forces.

Unit_II

Nuclear models: Introduction-Fermi gas model-Liquid drop model-Shell model-Collective nuclear model-Unified model-Super conductivity model.

Unit III

Nuclear Reactions: Types of nuclear reactions-Conservation laws-Nuclear reaction kinematics-Nuclear Transmutations-Nuclear cross section-Classical analysis of cross section-Partial wave analysis of reaction cross section-Requirement for a reaction-Reaction mechanism -General features of reaction cross sections- Compound nucleus-Compound nucleus reactions-Disintegration of a compound nucleus-continuum theory of nuclear reaction- Breit Wigner dispersion formula-Optical model.

Unit IV

Nuclear Fission and Fusion: Nuclear fission-Nuclear fusion and thermonuclear reactions-controlled thermonuclear reactions.

Nuclear chain reaction (four factor formula)-The critical size of a reactor-General aspects of reactor design.

Unit V

Elementary Particles: Introduction-Classification of elementary particles-Fundamental interactions-Conservation laws.

Elementary particle symmetries - Quarks - Isospin of Quarks-Quantum chromodynamics

BOOKS FOR STUDY:

1. Nuclear Physics by D.C.Tayal. Fifth revised & enlarged edition reprint 2010-Himalya publishing house.

Unit I : 1.1, 1.6 - 1.10, 8.1 - 8.3,8.5,8.12
Unit II : 9.1 - 9.8
Unit III : 10.1 - 10.4, 10.7- 10.9, 10.11 – 10.13,10.15-10.17, 10.19 - 10.21
Unit IV : 13.1 - 13.3, 15.2 - 15.4
Unit V : 18.1 - 18.4, 18.18 - 18.20, 18.24

BOOKS FOR REFERENCE:

1.Nuclear Physics an Introduction by S.B.Patel. Reprint 1992 – Wiley Eastern Limited.
2.Nuclear Physics by Devanathan. Second edition – Narosa publishing house.
3.Nuclear Physics by S.N.Ghoshal. Reprint 2012 – S.Chand.
4.Nuclear and Particle Physics an Introduction by B.R.Martin. Second edition – Wiley.
5.Introduction to Particle Physics by M.P.Khanna.

COURSE : II M.Sc. PHYSICS SEMESTER : III	FIBER OPTIC COMMUNICATION MAJOR ELECTIVE	Hours : 6 Credit : 5

Subject Code: P19PHE31

Objectives

- To get fundamental idea about Optical Fiber Communication.
- To understand the structure and types of Optical Fiber.
- To learn about the types of solid state optical sources.
- To understand the different techniques of power Launching & Coupling in optical fiber.
- To get knowledge about Photo detectors.

UNIT -I Overview of Optical Fiber Communication

The path to optical networks - Advantages of optical fibers –Optical spectral bands - Channel capacity – Decibel units – Telecom signal multiplexing – SONET/SDH multiplexing Hierarchy – WDM concepts – overview of element applications – windows and spectral bands – standards for optical fiber communications.

UNIT – **II** Optical Fibers and Signal Degradation

Single-mode fibers – propagation modes in single-mode fibers – Graded index fiber structure – Fiber materials – Glass fibers – Active glass fibers – plastic optical fibers – photonic crystal fibers – index guiding PCF – Photonic band gap fiber – Fiber fabrication – outside vapor – phase oxidation – vapor phase axial deposition – Modified chemical vapor deposition – Plasma activated chemical vapor deposition – Photonic crystal fiber fabrication- Fiber optic cables, Attenuation – Scattering losses – Core and Cladding losses – Signal distortion in fibers .

UNIT – **III** Optical Sources

Energy bands – intrinsic and extrinsic material – The p-n junctions – Direct and Indirect band gaps – Semiconductor device fabrication – LED's – LED structures – Light source materials – Quantum efficiency and LED power - Modulation of an LED – Laser diodes – Laser diode modes and Threshold conditions.

UNIT –IV Power Launching & Coupling

Source to fiber power launching – Power coupling calculation – Power launching versus wavelengths – Equilibrium Numerical aperture – Lensing schemes for coupling improvement – non-imaging microsphere – Laser diode to fiber coupling – fiber to fiber joints – Mechanical misalignment – Fiber related losses – fiber-end face preparation – LED coupling to single-mode fibers – fiber splicing – splicing techniques – splicing single-mode fibers – optical fiber connectors – connector types – single-mode fiber connectors.

UNIT – V Photo detectors

Physical principles of photodiodes – the pin photodetection – Avalanche photodiodes – Photodetector noise – noise sources – signal to noise ratio – Detector response time – Depletion layer photocurrent – Response time – Double hetero-structure photodiodes – avalanche multiplication noise structure for InGeAs APD's.

Text Books for study:

Optical Fiber Communication - Gerd Keiser - Fourth Edition Mc Graw Hill, International publishing Company Limited, New Delhi, 2008..

Unit I: Chap. (1) Sections 1.1.1, 1.1.2, 1.2, 1.3.5, 1.3.6, 1.4.1, 1.4.2, 1.5, 1.6.1, 1.6.2, 2.3.1 - 2.3.5,2.4.1, 2.4.2.

Unit - II: Chap. (2) Sections 2.5.1-2.5.2, 2.6, 2.7.1-2.7.3, 2.8.1-2.8.2, 2.9.1-2.9.5, 2.11.1-2.11.3, 3.1.1-3.1.5.

Unit-Ill: Chap. (4) Sections 4.1.1-4.1.5, 4.2.1-4.2.4, 4.3, 4.3.1.

Unit IV: Chap. (5) Sections 5.1, 5.1.1-5.1.4, 5.2, 5.2.1-5.2.2, 5.3, 5.3.1-5.3.3, 5.4, 5.5, 5.5.1-5.5.2, 5.6, 5.6.1-5.6.2.

Unit- V: Chap. (6) Sections 6.1, 6.1.1-6.1.2, 6.2, 6.2.1-6.2.2, 6.3, 6.3.1-6.3.3, 6.4, 6.5.

COURSE : II M.Sc. PHYSICS **SEMESTER : III**	**APPLIED OPTICS** **Major Elective**	**Hours : 6** **Credit : 5**

Subject Code: P19PHE32

Objectives

- To study the matrix methods in Gaussian optics.
- To understand the Fresnel and Fraunhoffer diffraction pattern and Fourier Transforming properties of lenses.
- To understand the Frequency analysis of imaging system.
- To learn about the Non-linear optics.
- To learn the laser and its properties.

UNIT I

Matrix Methods in Gaussian Optics – Refraction and translation matrices – Image formation Process – Combination of image forming systems – Matrix representation in polarization – Jones calculus Anisotropic medium – Interference by reflections from non-identical interfaces – Interference by multiple reflections.

UNIT II

Fourier optics: Scalar diffraction theory – Mathematical preliminaries – Kirchoff's formulation of diffraction pattern by a plane screen – Fresnel and Fraunhoffer diffraction pattern – Fourier transformation and imaging properties of lenses – Thin lenses as a phase transformation – FT properties of lenses – Spatial filtering – Introduction to Fourier optics Frequency – domain synthesis – The Vander Lugt. Filter – Concept of spatial and temporal coherence.

UNIT III

Frequency analysis of imaging system – Frequency response of a diffraction – Limited coherence imaging system – Coherent transfer functions – frequency response of a diffraction limited in coherent – Imaging system.

UNIT IV

Non- linear optics – Harmonic generations – Second harmonic generation and Phase matching – Optical mixing – Parametric generation of light – Self focusing of light.

UNIT V

Laser: Introduction – stimulated emission and thermal radiation, amplification in a medium, methods of producing population inversion, Laser oscillation, optical resonator theory, gas lasers, optically pumped solid state lasers, dye lasers, Semiconductor diode lasers, Q switching and mode locking.

BOOKS FOR STUDY:

1. Optics. M.V. Klein and T.E. Furtak, John Wiley, 1986

   Unit I : Sections 3.4, 5.2, 5.5, 5.6, 6.1, 6.2, A1

2. Introduction to Fourier Optics. J.W. Goodman

   Unit II : Sections 3.1 - 3.4,5.1, 5.2, 7.1(up to P146), 7.4, 7.5

   Unit III: Sections 6.1, 6.2, 6.3

3. Lasers and nonlinear optics. B.B. Laud.

   Unit IV: Sections 13.1 – 13.7

4. Introduction to Modern Optics. G.R. Fowles, Holt Rinchart andWinston Inc.

   Unit V: Sections 9.1 – 9.12

BOOKS FOR REFERENCE:

1. Introduction to Optics. F.L. Pedrolt, Prentice hall of India.
2. Optical electronics. A. Ghatak and K. Thyagarajan, Cambridge University Press, 1991.

COURSE : II M.Sc. PHYSICS SEMESTER : III	**LAB: Digital Electronics and General Physics**	Hours : 6 Credit : 5

Subject Code : P19PHP31

INTERNAL: 40 **EXTERNAL: 60**

1. Active Filters – Low, high pass Filters.
2. Active Filters – Band pass Filters.
3. Solving Simultaneous equations (IC 741).
4. Half adder, Full adder,Half subtractor and Full subtractor using IC's.
5. Optimization of Boolean function- K-Map method.
6. Determination of Hall Coefficient, R_H, n andμ_e.
7. Refractive index of liquid using Newton's rings.
8. Determination of wavelength of Laser Source Using Grating.

COURSE : II M.Sc. PHYSICS **SEMESTER : IV**	**SOLID STATE PHYSICS II** **CORE PAPER 10**	**Hours : 6** **Credit : 4**

Subject Code : P19PHC41

Objectives

- To understand the nature of Fermi surfaces in metals.
- To study about the Plasma oscillations.
- To impart the knowledge about super conductivity.
- To understand the electric and magnetic properties of solids.

Unit I: Fermi Surfaces and Metals

Zone schemes: Reduced, Extended and Periodic zone schemes. *Fermi surface and Energy bands*: Electron orbits – Hole orbits and Open orbits – Tight binding method for the calculation of energy bands – Wigner Seitz method – Cohesive energy. *Experimental methods in Fermi surface*: Quantization of orbits in a magnetic field –De Haas -van Alphen effect – Extremal orbits – Fermi surface of Copper and Gold.

Unit II: Elementary Excitation States

Plasmons: Dielectric function of the electron gas – Plasma optics – Longitudinal plasma oscillations - Electrostatic screening – Screened coulomb potential – Mott transition. *Polaritons and Polarons*: LST relation – Electron and electron interaction – Fermi liquid – Electron and Phonon interaction – Peierls instability of Linear metals. *Excitons*: Frenkel and Mott-Wannier excitons – Exciton condensation.

Unit III: Superconductivity

Experimental survey: Occurrence – Destruction by magnetic fields – Meissner effect – Type I and Type II superconductors – Heat capacity – Energy gap – Microwave and infrared properties – Isotope effect. *Theoretical Survey*: London effect – Coherence length – Basic idea of BCS theory – BCS ground state – Flux quantization – DC and AC Josephson effect. *High temperature Superconducting (HTSC) materials*.

Unit IV: Dielectrics and Ferroelectrics

Maxwell equations: Polarization – Macroscopic electric field – Depolarization field – Local electric field – Lorentz field – Dipole field. *Dielectric constant and Polarizability*: Clausius-Mossoti relation – Various types of polarizability – Ferro electricity – its occurrence and classification – Soft optical phonons. *Structural phase transition*: Landau theory of phase transitions – First and second order phase transitions – Ferroelectric domains– Piezoelectric crystals.

Unit V: Magnetism

Dia and para magnetism: Langevin's diamagnetism equation – Quantum theory of Para magnetism – Hund rules – Quenching of orbital angular momentum –*Ferromagnetism*: Curie point and exchange field – Weiss molecular field theory – Ferromagnetic domains – Origin of domains – Coercivity and Hysteresis – Bloch wall – *Magnons*: Quantization of spin waves and thermal excitation of magnons – Solitons.

Book for Study:

1. C. Kittel, 1996, Introduction to Solid State Physics, 7th Edition, Wiley, New York.

Unit I: Chapter 9
Unit II: Chapter 10
Unit III: Chapter 12
Unit IV: Chapter 13
Unit V: Chapters 14 &15

Books for Reference:

1. J.P. Srivastava, 2006, Elements of Solid State Physics, PHI Learning Pvt. Ltd., New Delhi.
2. S.O. Pillai, 1997, Solid State Physics, New Age International, New Delhi.
3. N.W. Aschroft and N.D. Mermin, Solid State Physics, Rhinehart and Winton, New York.
4. A.J. Dekker, Solid State Physics, Macmillan India, New Delhi.
5. H. Ibach and H. Luth, 2003, Solid State Physics, Springer (India), New Delhi.
6. S.O. Pillai, 1994, Problems and Solutions in Solid State Physics, New Age International, New Delhi.

COURSE : II M.Sc. PHYSICS SEMESTER : IV	MOLECULAR SPECTROSCOPY CORE PAPER 11	Hours : 6 Credit : 4

Subject Code : P19PHC42

Objectives

- To get knowledge about rotational spectrum of molecules.
- To understand the nature of vibration of molecules.
- To impart the knowledge about Raman spectra of molecules.
- To get knowledge about electronic spectra and spin resonance spectra of molecules.

Unit I: Introduction and Microwave spectroscopy:

Characterization of Electromagnetic Radiation - Quantization of energy – Regions of spectrum Representation of spectra – Basic Elements of Practical Spectroscopy – Signal-to-noise: Resolving Power - The width and intensity of spectral transition – Fourier transform spectroscopy – Enhancement of Spectra: Computer Averaging – Stimulated Emission: Lasers – Synchrotron Radiations.

The rotation of molecules – Rotational spectra – Diatomic molecules – Polyatomic molecules – Techniques and Instrumentations – Chemical Analysis by Microwave Spectroscopy – The Microwave Oven.

Unit II: Infrared spectroscopy:

The vibrating diatomic molecules – The diatomic vibrating rotator – The vibrational and rotational spectrum of carbon monoxide – Breakdown of the Born-Oppenheimer approximation: The interaction of Rotations and Vibrations – The vibrations of polyatomic molecules – The influence of Rotation on the spectra of polyatomic molecule – Analysis by Infra-red Techniques – Techniques and Instrumentation.

Unit III: Raman spectroscopy:

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 – Near Infra-red FT- Raman spectroscopy.

Unit IV: Electronic spectroscopy of molecules:

Electronic spectra of diatomic molecules – Electronic structure of diatomic molecules – Electronic spectra of polyatomic molecules - Techniques and Instrumentation – Molecular photoelectron spectroscopy.

Unit V: Spin resonance spectroscopy:

Spin and an Applied Field – Nuclear Magnetic Resonance Spectroscopy: Hydrogen Nuclei - Nuclear Magnetic Resonance Spectroscopy: Nuclei other than Hydrogen - Techniques and Instrumentation – Electron Spin Resonance Spectroscopy.

Book for Study:

Fundamentals of Molecular Spectroscopy –4^{th} Edition (2005) C. N. Banwell and E. M. McCash – Tata McGraw-Hill.

Unit – I : Chapter 1 (Section 1.1 – 1.11)
Chapter 2 (Section 2.1 – 2.7)
Unit – II : Chapter 3 (Section 3.1 – 3.8)
Unit – III : Chapter 4 (Section 4.1 – 4.7)
Unit – IV : Chapter 6 (Section 6.1 – 6.5)
Unit – V : Chapter 7 (Section 7.1 – 7.5)

Books for Reference:

1. Spectroscopy – Vol. 2 – B. P. Staughan and S. Walker – Chapman and Hall.

2. Molecular Spectroscopy – Jack D. Graybeal – McGraw-Hill.
3. Molecular Spectra and Molecular Structure – Vol. I 2nd Edition – G. Herzberg, Van Nostrand Reinhold.

SEMESTER : IV	THERMODYNAMICS AND STATISTICAL MECHANICS CORE PAPER	Hours : 6 Credit : 4

Subject Code : P19PHC43

Objectives:

- To describe the state of the system at equilibrium under temperature, free energy, entropy, internal energy, pressure etc.,
- To discuss the physical properties of matter in bulk on the basis of the dynamical behaviour of its microscopic constituents.
- To study the systems of particles in which statistical equation of state of a substance and its energy equation.
- To describe the statistical thermodynamic parameters for ideal gas and solids

Unit I:

Thermodynamic Potential: The laws of thermodynamics and their consequences –The Helmholtz function and the Gibbs function – Thermodynamic potentials – Maxwell's relations – Stable and unstable equilibrium – Phase transition – The Clausius-Clapeyron equation – The third law of thermodynamics (Nernst Heat theorem).

Unit II:

Application of Thermodynamics: Chemical potential – Phase equilibrium and phase rule – The Gibbs-Duhem Equation – Dependence of vapour pressure on total pressure – Surface tension – Vapour pressure of a liquid drop – The reversible voltaic cell – Thermodynamics of Blackbody radiation – Thermodynamics of magnetism.

Unit III:

Statistical Mechanics: Statistical description of system of particles–Basic postulates – Phase-space of a classical system – Liouville's theorem and its consequences – Ensembles: Canonical, Micro canonical, Grand canonical – The thermodynamic functions for ensembles – Energy states and energy levels – Microstates and macrostates – Thermodynamic probability.

Unit IV:

Statistical Thermodynamics: Statistics: Bose-Einstein, Fermi-Dirac and Maxwell-Boltzmann statistics – The statistical interpretation of entropy. Distribution function: Bose-Einstein, Fermi-Dirac, Maxwell-Boltzmann– Comparison of distribution functions for indistinguishable particles – The partition function of a system – Thermodynamic properties of a system.

Unit V:

Statistical Thermodynamics - Applications: The monoatomic ideal gas – The Sackur-Tetrode equation for the monoatomic ideal gas – The distribution of molecular velocities –The Principle of equipartition energy –The quantized linear oscillator – The Einstein theory of the Specific heat capacity of a solid – The Debye theory of the specific heat capacity of solid – Black body radiation

Text Book:

F. W. Sears and G. L. Salinger. ***Thermodynamics, Kinetic theory and Statistical Thermodynamics,*** New Delhi: Narosa Publishing House; 1998. 3rd Edition.

Unit I: Chapter 7

Unit II: Chapter 8
Unit III: Chapter 11 and Ensembles* - reference book (2)
Unit IV: Chapter 11
Unit V: Chapter 12 and 13.

Reference Books:

1. Keith Stowe. ***An Introduction to Thermodynamics and Statistical Mechanics***. UK: Cambridge University Press; 2007. 2nd Edition.
2. R K Pathria&Paul and D. Bealep. ***Statistical Mechanics***. New York: Elsevier- Academic Press; 2011. 3rd Edition.

COURSE : II M.Sc. PHYSICS SEMESTER : IV	NANOPHYSICS MAJOR ELECTIVE	Hours : 6 Credit : 5

Subject Code : P19PHE41

Unit I – Introduction – Nano structures – Nano crystalline materials - Electron microscope – Electron microscopy – General consideration for imaging – Analytical and imaging techniques – Sample preparation – Disadvantages of electron microscopes – Transmission electron microscope – Background – High resolution Transmission electron microscopy – Preparation and visualization of samples – Imaging simulation – Particle size analysis – Scanning electron microscope – detection of secondary electrons - detection of Backscattered electrons - Secondary electron imaging – Microscope imaging – Scanning probe microscopy – Imaging structures – The SPM as a robot – Sensing

Unit II – Atomic force microscopy – Introduction – Theory – Piezoelectric ceramic transducer – AFM instrumentation – Imaging modes – Measuring images with AFM – Resolutions in Atomic force microscope - Probe surface interactions - Surface contamination – Electrostatic forces – Surface material properties – Vibrating sensing mode – Torsion modes – Mechanical surface modification – Electrical surface modification - Atomic force microscopy for nanoparticles – Qualitative analysis – Techniques – Direct growth by Chemical vapour deposition of AFM tips – CVD MWNT tip preparation - CVD SWNT tip preparation – Sample preparation – Nanolithography – Adhesive mask technique – Photolithography – resolution in projection systems – Limitations – Perspectives – Electron beam lithography – Electron energy deposition in matter – Spatial-phase-locked Electron beam lithography

Unit III – Fabrication of nanostructures – Milling – Lithographic processes – Lift-off process – Vapour phase deposition methods of fabrication – Plasma-assisted deposition methods of fabrication – DC glow discharge – Magnetron sputtering – Vacuum arc deposition – Nanofabrication by scanning probe techniques – By Scanning force probes – Electrical structure generation by SFM – By Scanning tunneling microscope – Growth and characterization techniques – Molecular beam epitaxy – MBE apparatus – MOVPE – Liquid phase methods – Colloidal methods – Fabrication by sol-gel methods – basic process – The experimental – Conclusions – Electro deposition

Unit IV – Properties of individual nanoparticles – Metal nanoclusters – Magic numbers - Theoretical modeling of nanoparticles – Geometric structure – Electronic structure – Reactivity – Fluctuations – Magnetic clusters – Bulk to Nanotransition – Carbon nanostructures – Carbon molecules – Carbon clusters – Carbon nanotubes – Applications of carbon nanotubes

Unit V – Quantum wells, Wires and Dots – Preparation of quantum nanostructures – Size and dimensionality effects – Excitons – Single electron tunneling – Applications – Superconductivity – Microelctromechanical systems – Nanoelectromechanical systems

Books for Study:

1. Instrumentations and Nanostructures by A.S. Bhatia, NuTech books, 2009
   Unit I – Page 192-194, 201 -204, Page 1 – 26, Page 52 – 64
   Unit II – Page 65 – 86, Page 124 – 151
   Unit III – Page 219 – 249
2. Introduction to Nanotechnology by Charles P. Poole Jr and Frank J. Owens, Wiley Student edition, Reprint 2008
   Unit IV – Page 72 – 89, Page 103 – 132
   Unit V – Page 226 – 256, Page 332 – 345

COURSE : II M.Sc. PHYSICS	BIOPHYSICS	Hours : 6
SEMESTER : IV	MAJOR ELECTIVE	Credit : 5

Subject Code: P19PHE42

Objectives

- To study the Principle, working of different Microscopes used in Biology.
- To understand the Mechanism of human Ear.
- To get knowledge about different types of Spectroscopy.
- To understand the applications of Bioenergetics.

UNIT - I: Nucleonics in Biology and Medicine

Elementary particles – radioactivity – isotopes – X-rays – Detection and measurement of radioactivity.

UNIT - II: Microscopy in Biology and Medicine

Phase-Contrast Microscope – Interference Microscope – Fluorescence Microscope – Ultra-Violet Microscope – Electron Microscope – Scanning Electron Microscope – Scanning Electron-Probe Micro-Analysis – Centrifuge Microscope.

UNIT – III: Bioacoustic

Sound and its Characteristic – Function of Ear as a Hearing Organ – Physical Basis of Hearing – Unit of Intensity of Sound – transmission of Sound wave in the inner ear-Travelling waves – Electrical Responses of Cochlea or Organ of Corti or Cochlear partition – Pitch Perception – Perception of Loudness – Mechanism of Hearing – Beats and Dissonance – Combination of Tones.

UNIT - IV: Spectroscopies

Light Scattering (Rayleigh Scattering) – Optical Activity – Absorption Spectroscopy – Fluorescence Spectroscopy – Ultraviolet(UV) Spectroscopy – Atomic Spectroscopy – Electron Spin Resonance Spectroscopy – Mass spectroscopy.

UNIT – V : Bioenergetics

Reversible thermodynamics – Irreversible thermodynamics – Information and transmission – Photobioenergetics – Chemobioenergetics(oxidative Phosphorylation).

<u>Book for study</u>

1. A Text Book of Biophysics, R.N. Roy, New Central Book Agency (P) Ltd. 2005 Edition.
   Unit I (Chapter 3 - Section 3.1 – 3.13)
   Unit I (Chapter 7- Section 7.1 – 7.6)

Unit II (Chapter 13 - Section 13.1 – 13.8)
Unit III (Chapter 20 - Section 20.1– 20.4, 20.7 – 20.13)

2. Essentials of Biophysics – P. Narayanan, New age international publishers, 2009.
Unit IV (Chapter 8 - Section 8.1 – 8.5, 8.8 – 8.10).
Unit V (Chapter 13.1-13.3, 14.1, 14.2)

Reference Books

1. Biophysics, Vasantha Pattabhi & N.Gautham. Narosa Publishing House (2003).
2. Biophysics, G.R.Chatwal. Himalaya Publishing House (2011).

COURSE : II M.Sc. PHYSICS **SEMESTER : IV**	**Project & Viva-voce** **CORE LAB 5**	**Hours : 6** **Credit : 5**

Subject Code: P19PH4PV

Internal : 40 Marks
External : 60 Marks

- Project will be done by the final year students in the fourth semester under the guidance of respective guides.
- For projects internal marks(max 40) will be awarded by the respective guide and external marks (max 60) will be awarded in the external examinations(internal examiner 30 marks & external examiner 30 marks) held at the end of the semester.
- Minimum number of pages for M.Sc. project thesis should be 40.
