Course Name : **Master of Science**
Discipline : **PHYSICS**
(For those who joined in June 2024 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.

I year M.Sc. PHYSICS

Semester	Part	Subject Name	Hours	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
I	Core 1	**Mathematical Physics-I**	6	5	25+75=100				✔					✔			**P24PHC11**	**Title Change**
	Core 2	**Classical Mechanics & Relativity**	6	4	25+75=100				✔					✔			**P24PHC12**	**Revised 50%**
	Core 3	**Electronic Circuits and Systems**	6	4	25+75=100				✔					✔			**P24PHC13**	**New**
	Core Lab 1	**LAB: General Physics**	6	5	40+60=100				✔					✔	✔	✔	**P24PHCP11**	**New**
	Major Elective 1	**Electronic Communication**	6	4	25+75=100				✔							✔	**P24PHE11**	**Title Change**
	Total		**30**	**22**														

II	Core 4	**Mathematical Physics -II**	6	5	25+75=100				✔					✔			**P24PHC21**	**New**
	Core 5	Electromagnetic Theory	6	4	25+75=100				✔					✔			P23PHC22	No Change
	Core 6	**Quantum Mechanics I**	6	4	25+75=100				✔					✔			**P24PHC23**	**Revised 50%**
	Core Lab 2	**LAB: Electronics**	6	5	40+60=100				✔					✔	✔	✔	**P24PHCP21**	**New**
	Major Elective 2	**Solar Energy Systems and Storage Devices**	2	2	25+75=100				✔					✔	✔	✔	**P24PHE21**	**New**
	NME	Non-Conventional Energy Sources	4	4	25+75=100				✔					✔		✔	P23PHN21	No Change
	Total		**30**	**24**														

TENTATIVE SYLLABUS STRUCTURE

SEMESTER III

Part	Subject	Hour	Credit	Marks			Subject Code	Focus on Employability/ Entrepreneurship/ Skill Development	Revised/ New/No Change/ Interchanged If Revised % of Change
				I	E	T			
Core 7	Solid State Physics I	6	4						
Core 8	Quantum Mechanics II	6	4						
Core 9	Nuclear and Particle Physics	6	4						
Major Elective 3	Applied optics / Fibre optic communication	6	5						
Core Lab 1	Digital Electronics & GeneralPhysics	6	5						
	Total	30	22						

SEMESTER IV

Part	Subject	Hour	Credit	Marks			Subject Code	Focus on Employability/ Entrepreneurship/ Skill Development	Revised/ New/No Change/ Interchanged If Revised % of Change
				I	E	T			
Core 10	Solid State Physics II	6	4						
Core 11	Molecular Spectroscopy	6	4						
Core 12	Thermodynamics and Statistical Mechanics	6	4						
Major Elective4	Nano Physics / Bio Physics	6	5						
	Project & Viva-voce	6	5						
	Total	30	22						

SEMESTER - I

Course Title : MATHEMATICAL PHYSICS - I	Total Hours : 6
Course Code : P24PHC11	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, McGraw 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, PragatiPrakashan, 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. SankaraRao, 2nd Edition Prentice Hall of India, 2005.

Course Title : CLASSICAL MECHANICS & RELATIVITY	**Total Hours : 6**
Course Code : P24PHC12	**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: **18 Hours**

Variational Principles and Lagrange's Equations 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: **18 Hours**

Hamilton's Equations of Motion Legendre Transformation and Hamilton equation of Motion – Symmetry, Cyclic coordinates and conservation theorems – **Routh's procedure** and equation of motion of oscillations about steady motion – Hamilton's equation of motion from variational principle – Simple applications - **The principle of least action.**

Unit III: **18 Hours**

Canonical Transformations and the Hamilton – Jacobi Theory The equation of canonical transformation – Generating Functions – Examples of canonical transformation –

Poisson brackets – Canonical equation of motion in terms of Poisson bracket – Conservations theorems in the Poisson bracket formulation - Liouville's Theorem – **The Hamilton-Jacobi equations** for Hamilton's principle – Characteristic function and Separation variables.

Unit IV: **18 Hours**

Small Oscillation Theory – Linear Oscillation Formulation of the problem – Transformation to normal coordinates – Frequencies of normal modes – **Application of Small Oscillation Theory**: - Free vibration of diatomic molecule - Free vibrations of a linear triatomic molecule – Free oscillations of Double pendulum – Small oscillations of particles on string.

Unit V: **18 Hours**

Special Theory of Relativity – Lorentz Transformation GalileanTransformation-Inertial and non-inertial frames - Principle of relativity - Postulate of special theory of relativity - Lorentz transformation equations and its Consequences - **Relativistic Mechanics:** Einstein's mass-energy relation - Lorentz-invariant formulation of Lagrangian mechanics - Lorentz-invariant formulation of Hamiltonian mechanics - **Four Dimensional Formulation:** Minkowski's space - Four vectors and their transformations.

Text book:

1. Classical Mechanics –Herbert Goldstein, 3rdEdition, Pearson Edu, 2002
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 9.4, 9.9and10.1 to 10.4

2. Classical Mechanics,J. C. Upadhyaya, 2019, Himalaya Publishing. Co. New Delhi.
Unit IV: Chapter – 9.2 to 9.6

3.Introduction to Classical Mechanics - R. G. Takwale and P.S. Puranik, 1980,Tata-McGraw Hill, New Delhi.
Unit III : Chapter – 12.5 to 12.8
Unit V : Chapter – 14.1, 14.3 to 14.11

Reference Books:

1. K. R. Symons, 1971, Mechanics, Addison Wesley, London.
2. S. N. Biswas, 1999, Classical Mechanics, Books & Allied, Kolkata.
3. Donald T. Greenwood, 1997, Classical Dynamics, Dover publications Inc., New York.

Course Title : ELECTRONIC CIRCUITS AND SYSTEMS	**Total Hours : 6**
Course Code : P24PHC13	**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

ReferenceBooks:

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

Course Title : LAB: GENERAL PHYSICS	**Total Hours : 6**
Course Code : P24PHCP11	**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 Young's modulus and Poisson's ratio by Elliptical fringes – Cornu's method.
2. Measurement of refractive index of a liquid using hollow prism.
3. Determination of refractive index of a prism and Cauchy's constants by spectrometer.
4. Determination of Young's modulus and Poisson's ratio by hyperbolic fringes - Cornu's method
5. Determination of thickness of mica sheet by Edser butler fringes.
6. Determination of mutual inductance by Carey Foster's bridge method.
7. Determination of self inductance of a coil by Maxwell's bridge and determination of unknown capacitance of a capacitor by Scherringbridge.
8. Determination of coupling coefficient and the inductance of pair of coils using Anderson's bridge by AC method.

Course Title : ELECTRONIC COMMUNICATION	**Total Hours : 6**
Course Code : P24PHE11	**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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SEMESTER – II

Course Title : MATHEMATICAL PHYSICS - II	**Total Hours : 6**
Course Code : P24PHC21	**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 - Tensor Analysis- Contra-variant vector – covariant vector – Tensors of second rank – General definition- The Algebra of tensors - Fundamental Tensor - Cartesian tensors - Four vectors in special theory of relativity - Covariant formulation of electrodynamics

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 – C_{2V}, C_{3V} and C_{4V} groups

Book for study:

1. **Applied Mathematical for Engineers and Physicists** - Pipes and Harvill, McGraw 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, PragatiPrakashan, 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, McGraw Hill Book Company, 2000.

Course Title : ELECTROMAGNETIC THEORY	**Total Hours : 6**
Course Code : P23PHC22	**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 ClausiusMossatti 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 Biotsavat 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, 2nd edition, PHI, 2015.

Course Title : QUANTUM MECHANICS - I	**Total Hours : 6**
Course Code : P24PHC23	**Total Credits : 4**

Course Outcomes:

COs	CO Statement
CO1	Identifying the origin of quantum mechanics
CO2	Understanding the concept of Wave function
CO3	Knowing the general formalisms of Quantum mechanics
CO4	Understanding One-dimensional eigen value problems
CO5	Getting knowledge of Quantum mechanics in three dimensions

Unit I: **18 Hours**

OriginoftheQuantumTheory: LimitationsofClassicalPhysics - Planck's Quantum Hypothesis - Einstein's Theory of Photoelectric Effect - Compton Effect - Quantum Theory of Specific Heat - Bohr Model of Hydrogen Atom - Existence of Stationary States - Wilson—Sommerfeld Quantization Rule - Elliptic Orbits of Hydrogen Atom - The Harmonic Oscillator - The Rigid Rotator - Particle in a Box - The Correspondence Principle - The Stern-Gerlach Experiment - Inadequacy of Quantum Theory.

Unit II: **18 Hours**

Wave mechanical concepts: Wave Nature of Particles - The Uncertainty Principle - The Principle of Superposition - Wave Packet - Time-Dependent Schrödinger Equation - Interpretation of the Wave Function - Ehrenfest's Theorem - Time-Independent Schrödinger Equation - Stationary States - Admissibility Conditions on the Wave Function.

Unit III: **18 Hours**

General formalism of quantum mechanics: Linear Vector Space - Linear Operator–Eigenfunctions and Eigenvalues - Hermitian Operator - Postulates of Quantum Mechanics - Simultaneous Measurability of Observables - General Uncertainty Relation - Dirac's Notation - Equations of Motion - Momentum Representation.

Unit IV: **18 Hours**

One-dimensional energy eigen value 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 - The Free Particle.

Unit V: **18 Hours**

Three-dimensional energy eigen value problems: Particle Moving in a Spherically Symmetric Potential - System of Two Interacting Particles - Rigid Rotator - Hydrogen Atom - Hydrogenic Orbitals - The Free Particle - Three-Dimensional Square-Well Potential - The Deuteron.

Book for study: Quantum mechanics, G. Aruldhas, 2nd Edition, PHI Learning Private Limited, 2008
Unit 1: Chapter 1 – Section 1.1 – 1.15

Unit 2: Chapter 2 – Section 2.1 – 2.10
Unit 3: Chapter 3 – Section 3.1 – 3.10
Unit 4: Chapter 4 – Section 4.1 – 4.9
Unit 5: Chapter 5 – Section 5.1 – 5.8

Books for reference:

1. Introduction to Quantum Mechanics, David J. Griffiths, Tenth Impression, 2018, Pearson.
2. A Text book of Quantum Mechanics - P.M.Mathews & K.Venkatesan - TMH Pub. Com. Ltd., New Delhi (2010) - II edition.

Course Title : CORE LAB:ELECTRONICS	**Total Hours : 6**
Course Code : P24PHCP21	**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 of Phase shift oscillator.
2. Construction of Emitter follower and determination of its I/O impedances.
3. Construction of Wien's bridge oscillator using IC 741.
4. Construction of Saw tooth wave generator using transistors.
5. Construction of Relaxation oscillator using UJT.
6. Construction of two stage transistor amplifier and study its frequency response.
7. Construction of Op-Amp- 4 bit digital to analog converter (Binary Weighted and R/2R ladder type)
8. Construction of Schmidt trigger circuit using IC 741 for a given hysteresis.

Course Title : SOLAR ENERGY SYSTEMS AND STORAGE DEVICES	**Total Hours : 2**
Course Code : P24PHE21	**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 : NON-CONVENTIONAL ENERGY SOURCES (NME)	**Total Hours : 4**
Course Code : P23PHN21	**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.
