

M.Sc PHYSICS
(For students admitted from the academic year 2014-2015)
CURRICULUM AND SYLLABUS

FACULTY OF SCIENCE AND HUMANITIES
SRM UNIVERSITY
SRM NAGAR, KATTANKULATHUR – 603 203.

M.Sc PHYSICS
(For students admitted from the academic year 2014-2015)
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Objectives

1. To develop strong student competencies in Physics and its applications in a technology-rich and interactive environment.
2. To develop strong student expertise in the research, analysis and interpretation of complex information related to the areas of Spectroscopy, Crystallography, Nanoscience and Nanotechnology, Quantum Physics, Atmospheric Physics, Electronics and Thin Film Technology.
3. To prepare the students to successfully compete for employment in Electronics and Manufacturing Industries, Nuclear and Defence sectors apart from Teaching Profession.

Eligibility:

- B.Sc. Degree examination with Physics as Major (or)
- B.Sc. Degree examination with Electronics as Major (or)
- B.Sc. Degree examination in Applied Sciences with Physics/Materials Science as one of the main subjects of any recognized University.

Duration:

- 2 Years in 4 semesters

CURRICULUM

COURSE CODE	COURSE NAME	L	T	P	Total of L+T+P	C
SEMESTER I						
PPY14101	Mathematical Physics	3	3	-	6	4
PPY14102	Classical Mechanics	3	3	-	6	4
PPY14103	Condensed Matter Physics	3	3	-	6	4
PPY14104	General Physics Laboratory	-	-	6	6	3
PPY14105	Materials Science Laboratory	-	-	6	6	3
Total		9	9	12	30	18
SEMESTER II						
PPY14201	Electromagnetic Theory	3	2	-	5	4
PPY14202	Quantum Mechanics	3	2	-	5	4
PPY14203	Statistical Mechanics and Thermodynamics	3	2	-	5	4
PPY14204	Electronic Devices and Applications	3	2	-	5	4
PPY14205	Electronic Devices Laboratory	-	-	6	6	3
xxxxxxx	Supportive Course	2	-	2	4	3
Total		14	8	8	30	22
SEMESTER III						
PPY14301	Applied Spectroscopy	3	2	-	5	4
PPY14302	Nuclear and Particle Physics	3	2	-	5	4
PPY14303	Microprocessors and Microcontrollers	3	2	-	5	4
PPY14304	Nanoscience and Nanomaterials	3	2	-	5	4
PPY14305	Microprocessor and Microcontroller Laboratory	-	-	5	5	2
xxxxxxx	Technology Based Elective Course	2	-	-	2	2
PPY14306	Mini Project*	-	-	3	3	2
Total		14	8	8	30	22
SEMESTER IV						
xxxxxxx	Core Based Elective Course	3	-	-	3	3
PPY14401	Seminar*	-	-	2	2	1
PPY14402	Career Comprehensive Course	2	-	-	2	2
PPY14403	Project Work	-	-	12	12	12
Total		5	-	14	19	18
total number of credits to be earned for the award of degree				80		

Supportive Courses

COURSE CODE	COURSE NAME	L	T	P	Total of L+T+P	C
PPY14206	Programming in C & C++	2	-	2	4	3
PPY14207	Programming in MATLAB	2	-	2	4	3
PPY14208	Computational Methods and Programming	2	-	2	4	3

Technology Based Elective Courses

COURSE CODE	COURSE NAME	L	T	P	Total of L+T+P	C
PPY14E01	Non Destructive Testing Techniques	2	-	-	2	2
PPY14E02	Photovoltaic Technology	2	-	-	2	2
PPY14E03	Thin film Technology	2	-	-	2	2
PPY14E04	Optical Fiber Communications	2	-	-	2	2
PPY14E05	Cryogenics	2	-	-	2	2
PPY14E06	Optical Systems Design	2	-	-	2	2

Core Based Elective Courses

COURSE CODE	COURSE NAME	L	T	P	Total of L+T+P	C
PPY14E21	Nanoelectronics	3	-	-	3	3
PPY14E22	Crystal Growth and Characterization Methods	3	-	-	3	3
PPY14E23	Nonlinear Optics	3	-	-	3	3
PPY14E24	Fundamentals of Atmospheric Physics	3	-	-	3	3
PPY14E25	Radiation Therapy and Medical Diagnosis	3	-	-	3	3
PPY14E26	Photonics	3	-	-	3	3

Note:

* - Continuous Assessment (Full Internals)

L – Lecture Hours, T – Tutorial Hours, P – Practical Hours & C – Credits

Guidelines for selecting courses				
Category	No. of Courses			
	I Semester	II Semester	III Semester	IV Semester
Core Courses	5	5	5	-
Supportive Courses	-	1	-	-
Technology Based Elective Courses	-	-	1	-
Core Based Elective Courses	-	-	-	1
Seminar	-	-	-	1
Career Comprehensive Course	-	-	-	1
Mini Project	-	-	1	-
Project work	-	-	-	1
Total number of credits				80

SYLLABUS
SEMESTER I

COURSE CODE	COURSE TITLE	L	T	P	Total of L+T+P	C
PPY14101	MATHEMATICAL PHYSICS	3	3	-	6	4
INSTRUCTIONAL OBJECTIVES						
1.	To develop knowledge in mathematical physics and its applications.					
2.	To develop expertise in mathematical techniques those are required in physics.					
3.	To enhance problem solving skills.					
4.	To give the ability to formulate, interpret and draw inferences from mathematical solutions.					

UNIT I: VECTOR ANALYSIS

Vectors and Vector Spaces - Definition - Transformation of Vectors - Rotation of the Coordinate Axes - Invariance of the Scalar Product Under Rotations - Gradient - Divergence - and Curl of Vectors - Physical Interpretation - Vector Integration - Line- Surface and Volume Integrals - Gauss' theorem - Stokes' theorem - Dirac Delta Function - Integral Representations- Vector Analysis in Curved Coordinates - Expression for Gradient- Divergence and Curl in Spherical Polar Coordinates- Tensors - Contravariant and Covariant tensors- Definition of tensor of rank two.

UNIT II: DIFFERENTIAL EQUATIONS

Leibnitz's first order differential equation - General solution and radioactive decay as a special solution - Second Order Differential Equations with constant coefficient - Bessel polynomials - Legendre Polynomials - Hermite and Laguerre polynomials and their differential equations- Generating functions- Recurrence relations- Orthogonality of functions - One dimensional Green's functions - Sturm Liouville's type equation.

UNIT III: COMPLEX VARIABLES

Functions of a complex variable - Single and multivalued functions- Analytic functions - Cauchy Riemann Conditions - Cauchy's Integral Theorem - Cauchy Integral Formula- Taylor and Laurent Expansions - Laurent Series - Essential Singularities - Removal Singularities - Isolated Singularities - Poles and Branch Points - Conformal Mapping - Translation - Rotation and Inversion.

UNIT IV: MATRICES & GROUP THEORY

Matrices - Basic Definitions - Inverse of a matrix - Direct Product of matrices - Orthogonal - Hermitian - Unitary and Normal Matrices- Eigenvalues and Eigenvectors - Degenerate eigenvalues - Introduction to Group Theory- Definition of a Group- Homomorphism- Isomorphism - Rotations as an example- Generators of Continuous Groups- Rotation Groups $SO(2)$ and $SO(3)$ - Rotation of Functions- Discrete Groups.

UNIT V: INTEGRAL TRANSFORMS

Introduction of Integral Transforms- Fourier Transforms - Definition- Linearity- Development of the Fourier Integral- Fourier Cosine and Sine Transforms- Application to heat flow and wave equations- Convolution theorems- Parseval's Relation- Momentum Representation- Laplace Transforms -Definition- Linearity- Shifting formula and Inverse Laplace transforms.

TEXTBOOKS

1. Arfken and Weber, *Mathematical Methods for Physicists*, 6th Edition, Elsevier, 2012.
2. Murray R. Spiegel, *Schaum's Outline of Advanced Mathematics for Engineers and Scientists*, 1st Edition, McGraw Hill, 2009.

REFERENCES

1. Mary L. Boas, *Mathematical Methods in the Physical Sciences*, 3rd Edition, John Wiley, 2005.
2. Murray R. Spiegel, Seymour Lipschutz, John J. Schiller, and Dennis Spellman, *Schaum's outline of Complex Variables*, 2nd Edition, McGraw Hill, 2009.
3. Gupta B. D., *Mathematical Physics*, 4th Edition, Vikas Publishing House, 2009.
4. Sadri Hassani, *Mathematical Physics: A Modern Introduction to Its Foundations*, 2nd Edition, Springer, 2013.
5. Chattopadhyay P. K., *Mathematical Physics*, 1st Edition, New Age International, 2009.

COURSE CODE	COURSE TITLE	L	T	P	Total of L+T+P	C
PPY14102	CLASSICAL MECHANICS	3	3	-	6	4
INSTRUCTIONAL OBJECTIVES						
1.	To give students a solid foundation in classical mechanics.					
2.	To introduce general methods of studying the dynamics of particle systems.					
3.	To give experience in using mathematical techniques for solving practical problems.					
4.	To lay the foundations for further studies in physics and engineering.					

UNIT I: LAGRANGIAN FORMULATION

Mechanics of a system of particles - Constraints and their classifications - Examples of constraints-Principle of virtual work-Lagrange's equations of first kind-D'Alembert's Principle- Lagrangian formulation - Degrees of freedom and generalized coordinates- Euler-Lagrange equations of motions- Simple applications-Linear Harmonic oscillator-Isotropic oscillator- Atwood's machine-Motion of a particle under earth gravity-Simple pendulum-Invariance of Euler-Lagrange equations of motion under generalized coordinate transformations.

UNIT II: HAMILTONIAN FORMULATION

Hamilton's equation of motion from Lagrangian by Legendre's dual transformation- Properties of the Hamiltonian- Configuration space-Phase space-State space-Lagrangian and Hamiltonian of relativistic particles- Hamilton's principle - Derivation of Hamilton's and Euler-Lagrange equations of motion-Invariance of Hamilton's principle under generalized coordinate transformation-Hamilton's principal and characteristic functions.

UNIT III: CANONICAL TRANSFORMATIONS

Definition of canonical transformations- Generating functions- Conditions for canonicity- Poisson brackets- Poisson's theorem- Jacobi-Poisson theorem-Invariance of Poisson brackets under canonical transformation-Hamilton Jacobi equation-Connection with canonical transformation- Applications to simple problems-One dimensional simple harmonic oscillator-Swinging Atwood's machine-Action-Angle variables.

UNIT IV: RIGID BODY DYNAMICS

Rigid body - Independent co-ordinates of a rigid body-Orthogonal transformation-Eulerian angles- Euler's equation of motion-Angular momentum and kinetic

energy of motion about a point- Theorems on moment of inertia and moment of inertia tensors-Eigen values and principal axis transformation-Torque free motion of a rigid body-Heavy symmetrical top with one point fixed-Chandler wobbling of the Earth-Steady precession of a symmetric top under external torque.

UNIT V: SMALL OSCILLATIONS

Types of equilibrium and the potential at equilibrium-Study of small oscillations using generalized coordinates-Eigen value equations-Normal modes of vibrations and normal co-ordinates-Non-degenerate and degenerate systems-Linear Triatomic molecule-Introduction to the Lagrangian and Hamiltonian formulations for continuous systems-Transition from discrete to continuous systems.

TEXT BOOKS

1. Rana N. C and Joag P.S., *Classical Mechanics*, 1st Edition, 2011.
2. Herbert Goldstein, Charles P. Poole and John L. Safko, *Classical Mechanics*, 3rd Edition, Pearson, 2011.

REFERENCES

1. John. R. Taylor, *Classical Mechanics*, 1st Edition, University Science Books, 2005.
2. David Morin, *Introduction to Classical Mechanics*, 1st Edition, Cambridge University Press, 2008.
3. Harald J. W. and Muller-Kirsten, *Classical Mechanics and Relativity*, 1st Edition, World scientific Publishing Ltd, 2008.
4. Dieter Strauch, *Classical mechanics-An Introduction*, 5th Edition, Springer, 2009.
5. Frank H. Berkshire, Kibble T. W. B. and Tom W. B. Kibble, *Classical Mechanics*, 5th Edition, World Scientific Publishing Company, 2004.

COURSE CODE	COURSE TITLE	L	T	P	Total of L+T+P	C
PPY14103	CONDENSED MATTER PHYSICS	3	3	-	6	4
INSTRUCTIONAL OBJECTIVES						
1.	The course is to understand the basic knowledge on crystal structures and crystal systems.					
2.	To understand the various techniques available using X-Ray Crystallography.					
3.	To acquire the knowledge of Lattice waves and Polaritons.					
4.	To comprehend the concepts of superconductivity and magnetic properties of solids.					

UNIT I: CRYSTAL STRUCTURE

Crystal solids- Lattice and basis-Lattice translations and Lattices-Basis and crystal structure-Unit cell and primitive lattice cell-Wigner-Seitz primitive cell-translation vectors- Crystal systems - Two and three-dimensional lattice types-Symmetry operations for a two-dimensional crystal- Translation and point operation-Screw axis - Glide plane-Direct lattice-Bravais lattices- Crystal planes and Miller indices-Interplanar distances-Index system for crystal planes-Close packed structures-Cubic and hexagonal structure.

UNIT II: RECIPROCAL LATTICE AND EXPERIMENTAL X-RAY DIFFRACTION TECHNIQUES

Reciprocal lattice and its applications to diffraction techniques-Ewald Sphere-interaction of X-rays with matter- Absorption of X-rays-crystal grating-Experimental diffraction techniques-Laue diffraction technique-Rotating crystal method-Powder X-ray diffraction technique-Indexing of powder photographs and lattice parameter determination-Applications of powder method-General concept of atomic scattering factor and structure factor.

UNIT III: LATTICE DYNAMICS AND ELECTRON - PHONON INTERACTION

Lattice waves-Vibrations of one-dimensional monatomic lattice-Linear diatomic lattice-Three dimensional lattice-Lattice optical properties in ionic crystal-Quantization of Lattice vibrations concept of Phonon-Inelastic scattering of neutrons and X-rays by phonon-Debye's model of specific heat- Anharmonicity-Plasmons- Plasma optics- Transverse optical modes in Plasma- Longitudinal Plasma oscillations- Polaritons- Long wavelength optical phonon in isotropic crystal (Lyddans- Sachs and Teller relation)-Electron-phonon interaction In polar solids - Polarons- electron-phonon interaction in metals.

UNIT IV: ELECTRONIC PROPERTIES OF SOLIDS

Electrons in periodic lattice: Bloch theorem- the Kronig-Penny model-Classification of solids on the basis of band theory- Effective mass- Fermi surface and Fermi gas- Hall effect-superconductivity- Critical temperature- Persistent current- Effect of magnetic fields- Meissner effect-Thermodynamics of superconducting transitions-Manifestation of energy gap-Cooper pairing due to phonons-BCS theory-Type I and Type II Superconductors-Josephson superconductor tunneling-DC and AC Josephson effect-SQUID-Applications of superconductors.

UNIT V: MAGNETIC PROPERTIES OF SOLIDS

Classification and general properties of magnetic materials-Weiss theory of ferromagnetism-Temperature dependence of spontaneous magnetization-Heisenberg's model and molecular field theory-Curie-Weiss law for susceptibility-Domain structure and ferromagnetic domains-Bloch-Wall energy- Spin waves and magnons-Quantization of spin waves- The Bloch $T^{3/2}$ law-Neel model of antiferromagnetism and ferrimagnetism- Origin of domains-Coercive force and hysteresis.

TEXT BOOKS

1. Gerald D. Mahan, *Condensed Matter in a Nutshell*, Princeton University Press, 2011.
2. Ali Omar. M, *Elementary Solid State Physics: Principles and Applications*, Addison-Wesley Publishing Co., 2011.
3. Kittel.C, *Introduction to Solid State Physics*, 8th Edition, Wiley Publishing, 2005.

REFERENCES

1. Ashcroft W. and Mermin N.D., *Solid State Physics*, Holt-Rinehart-Winston, 1976.
2. Blakemore J. S., *Solid State Physics*, 2nd Edition, Cambridge University Press, 1974.
3. Dekker A. J., *Solid State Physics*, Mac Millan, 1971.
4. Giuseppe Grosso and Giuseppe Pastori Parravicini, *Solid State Physics*, 2nd Edition, Academic Press, 2014.
5. Woolfson M. M., *An Introduction to X-ray Crystallography*, Cambridge University Press, 1991.
6. Pillai S. O., *Solid State Physics*, New Age International, 2005.

COURSE CODE	COURSE TITLE	L	T	P	Total of L+T+P	C
PPY14104	GENERAL PHYSICS LABORATORY	-	-	6	6	3
INSTRUCTIONAL OBJECTIVES						
1.	To make the student familiarize with the basics of experimental physics.					
2.	To enable the students to explore the concepts involved in the thermodynamic processes.					
3.	To make the students understand the basics of modern optics.					
4.	To make the students verify experimentally the basic laws of physics.					

LIST OF EXPERIMENTS (ANY 10 EXPERIMENTS)

1. Determination of Stefan-Boltzmann's constant by studying the radiation received from a Black body Radiator as a function of time.
2. Measurement of a diameter of given thin wire using interference pattern formed due to an Air wedge between two glass plates.
3. Paramagnetic susceptibility of a FeCl_3 solution at variable magnetic fields using Quincke's tube method and deducing the magnetic moment of the ion.
4. To study the rate of flow of heat through a material per unit area per unit temperature gradient and to determine the thermal conductivity of the bad conductor using Lee's disc method.
5. Cornu's method of determination of Elastic constants-Young's modulus and Poisson's ratio of a transparent beam by formation of Newton's rings.
6. Temperature characteristics of a Thermistor using Wheatstone network and to determine the band gap of the material of the thermistor.
7. Determination of Compressibility of a liquid and Study of parameters- Wavelength and Velocity of the Ultrasonic wave in liquid using Ultrasonic Interferometer.
8. Photoconductivity Experiment.
 - (i) To plot the current-voltage characteristics of a Photo-resistor at constant irradiance.
 - (ii) To measure the photo-current as a function of irradiance at a constant voltage.
9. Measurement of Numerical aperture and attenuation characteristics of the optical fibre for variable lengths.
10. Determination of Young's modulus of a material of a beam by Uniform bending using single optic Lever.
11. Study of Fresnel diffraction at straight edge and a slit.
12. Study of Fraunhofer diffraction at a single slit.
13. To determine the refractive indices of liquids using hollow prism.

TEXT BOOKS

1. Chattopadhyay.D, Rakshit.P.C., and Saha.B, *An Advanced Course in Practical Physics*, 6th Edition, 2002.
2. Wersnop and Flint, *Advanced Practical Physics for Students*, 2nd Edition, Methuen publishers, 2007.

REFERENCES

1. Jasprit Singh, Semiconductor Devices: Basic Principles, John Wiley, 2001.
2. Behekar.D.R., Seman.S.T., Gokhale. V.M., and P.G. Kale, Practical Physics, Kitab Mahal Publication, 2000.
3. Adrian.C.Mellissinos, Experiments in Modern Physics, 2nd Edition, Academic Press, 2003.
4. Khandelwal.D.P., A Laboratory Manual of Physics for Undergraduate Classes, Vani Publishing House, 2002.
5. G. L. Squires Practical Physics , 4th edition ,Cambridge University Press, 2001.

COURSE CODE	COURSE TITLE	L	T	P	Total of L+T+P	C
PPY14105	MATERIALS SCIENCE LABORATORY	-	-	6	6	3
INSTRUCTIONAL OBJECTIVES						
1.	To understand laboratory experiments that explores the properties of materials.					
2.	To make gain practical experience on search, retrieval, and analysis of technical/scientific information.					
3.	To understand the operation of the advanced characterization instruments.					
4.	To learn students about fundamental concepts needed to pursue research.					

LIST OF EXPERIMENTS

1. Determination of phase, strain and particle size using XRD spectrum for metal oxide nanopowder.
2. Preparation and identification of functional groups for polymers using FTIR spectroscopy.
3. Determination of mineral concentration using XRF Spectrometer.
4. Particle size determination of given metal oxide nanopowder using UV - Vis spectroscopy.
5. Separation of different sizes using differential centrifugation and their characterization for the band gap by UV - Vis spectroscopic techniques.
6. Determination of Hall coefficient, carrier density and carrier mobility for a semiconductor.
7. Determination of dielectric constant of the sample using parallel plate capacitor.
8. Determination of resistivity of Germanium crystal at different temperature and estimation of energy band gap using four probe method.
9. To trace Hysteresis loop for a given magnetic material using BH curve apparatus.
10. Thin Film Deposition using dip coating and spray coating techniques.

TEXT BOOKS

1. Raghvan.V, *Experiments in Materials Science*, 5th Edition, PHI Learning Pvt. Ltd., 2004.
2. Peter M. Martin, *Handbook of Deposition Technologies for Films and Coatings*, 3rd Edition, Elsevier Inc., 2010.

REFERENCES

1. Günter Gauglitz and Tuan Vo-Dinh, *Hand book of Spectroscopy*, 3rd Edition, Wiley -VCH Verlag GmbH & Co., 2003.
2. Prof. Yang Leng, *Materials Characterization: Introduction to Microscopic and Spectroscopic Methods*, 2nd Edition, Wiley - VCH Verlag GmbH & Co., 2013.
3. Richard Brundle.C, Charles A. Evans Jr.and Shaun Wilson, *Encyclopedia of Materials Characterization*, Butterworth Heinemann, 1992.
4. ErnoPretsch, Philippe Buhlmann, Martin Badertscher, *Structural Determination of Organic Compounds*, 4th Edition, Springer-Verlag Berlin Heidelberg, 2009.
5. Mario Birkholz, *Thin Film Analysis by X-Ray Scattering*, Wiley-VCH Verlag GmbH & Co., 2006.

SEMESTER II

COURSE CODE	COURSE TITLE	L	T	P	Total of L+T+P	C
PPY14201	ELECTROMAGNETIC THEORY	3	2	-	5	4
INSTRUCTIONAL OBJECTIVES						
1.	To make the student understand the principles of electrostatics and magnetostatics.					
2.	To enable the student to explore the field of electrodynamics.					
3.	To make the student understand the basic concepts in Electromagnetic wave and radiation.					
4.	To allow the student to have a deep knowledge of the fundamentals of Electromagnetism.					

UNIT I : ELECTROSTATICS

Coulomb's Law - Electric Field- Gauss's law of electrostatics - Sphere- Shell- Plane- line- Electrostatic Potential- Multipole expansion- Work and energy in electrostatics-Poisson's Equation - Laplace equation- Boundary condition and uniqueness theorem- Method of Images - Classic image problem- Induced Surface charge- Separation of variables - Electrostatics in matter - Polarization - Free charges - Bound charges - Linear isotropic homogenous medium.

UNIT II: MAGNETOSTATICS

Lorentz force law-Biot-Savart law-Divergence and curl of B-Magnetic field of steady currents - Ampere's law -Magnetic field of a straight wire - Magnetic field of a solenoid-Comparison of electrostatics and magneto statics- Magnetic potential -Magnetization- Fields of a magnetized object- Bound currents- Physical interpretation of bound currents- Magnetic field inside a matter.

UNIT III : ELECTRODYNAMICS AND ELECTROMAGNETIC WAVES

Electromotive force- Ohm's law- Electromagnetic induction - Faraday's law - Lenz law- Maxwell's equations -Displacement current- Electromagnetic waves- In vacuum- In dielectric media- Skin depth-Poynting vector- Boundary conditions- reflection and transmission at normal incidence- Reflection and transmission at oblique incidence - Fresnel's equations - Perpendicular polarization - Parallel polarization.

UNIT IV: POTENTIALS AND RADIATION

Continuous distribution - Retarded scalar and vector potentials-Jefimenko's potential - Point charges -Lienard-Wiechert potentials for a moving point charge- Electric and magnetic fields of a moving point charge-Electric dipole radiation- Magnetic dipole radiation - Power radiated by a point charge - Radiation reaction - The physical basic of a radiation reaction.

UNIT V: RELATIVISTIC ELECTRODYNAMICS

Potential formulation of electrodynamics - Gauge transformations-Coulomb gauge and Lorentz gauge- Introduction to special theory of relativity - Magnetism as a relativistic phenomenon- Field transformation- Field Tensor- Electrodynamics in Tensor notation - Relativistic potentials - The four potential of a moving charge - The invariance of the equations of electrodynamics.

TEXT BOOKS

1. Griffith D.J, *Introduction to Electrodynamics*, 4th Edition, Prentice Hall of India, 2012.
2. Murugesan.R, *Electricity and Magnetism*, 7th Revised Edition, S. Chand, 2008.
3. Laud B.B, *Electromagnetics*. 2nd Edition, New Age International Publication, 2005.

REFERENCES

1. John David Jackson, *Classical Electrodynamics*, 3rd Edition, John Wiley & Sons Ltd, 1998.
2. Kip A.F, *Fundamentals of Electricity & Magnetism*, International Student Edition, Mc Graw, Hill, 2008.
3. Berkeley, *Physics Course: Electricity & Magnetism*, 2nd Edition, Tata Mc Graw Hill, 2007.
4. Feynman, Leighton and Sands, *The Feynman Lectures on Physics*, Volume 2, Narosa Publishing house,2008.
5. Stratton and Julius Adams, *Electromagnetic Theory*, Vol. 33, John Wiley & Sons, 2007.

COURSE CODE	COURSE TITLE	L	T	P	Total of L+T+P	C
PPY14202	QUANTUM MECHANICS	3	2	-	5	4
INSTRUCTIONAL OBJECTIVES						
1.	To illustrate the inadequacy of classical theories and the need for a quantum theory.					
2.	To explain the basic principles of quantum mechanics.					
3.	To develop solid and systematic problem solving skills.					
4.	To apply quantum mechanics to simple systems occurring in atomic and solid state physics.					

UNIT I: GENERAL FORMALISM

Postulates of quantum mechanics - Wave function and its Physical Interpretation- Schrödinger equation- Time-independent Schrödinger equation- Dynamical variables and operators- Commutation relations of operators- Hermitian operators- Expansion in Eigen functions- Heisenberg Uncertainty relation- Time evolution operator-Schrödinger and Heisenberg pictures of time evolution- Time variation of expectation values.

UNIT II: DISCRETE EIGENVALUE PROBLEMS

Harmonic oscillator in one dimension - Analytic method -Abstract operator method- Schrödinger equation in three dimensions - Spherical polar coordinate form- Angular momentum eigen functions and eigen values- Total angular momentum and Spherical harmonics- Radial equation- Hydrogen atom wave functions and their discussion.

UNIT III: PERTURBATION THEORY

Time independent perturbation theory for discrete levels - Non-degenerate cases and degenerate cases- Removal of degeneracy- Spin-Orbit coupling- Fine Structure of Hydrogen- Variational method- Time-dependent perturbation theory - constant and periodic perturbations - Fermi Golden rule - WKB approximation - sudden and adiabatic approximations.

UNIT IV: IDENTICAL PARTICLES AND SCATTERING THEORY

Mutual scattering of two particles - Schrödinger equation in laboratory and center of mass frames- System of identical particles - Symmetric and anti symmetric wave functions- Two electron atoms - Exchange interactions- Spin half particles in a box - Fermi gas- Band structure- Quantum Scattering theory - Differential and

total cross sections- Scattering amplitude- Formal expression for scattering amplitude - Green's functions- Born approximation - Application to spherically symmetric potentials.

UNIT V: RELATIVISTIC QUANTUM MECHANICS

The Klein-Gordon (KG) equation - Charged particle in an electromagnetic field, Interpretation of the KG equation- Dirac equation, free particle solution, Negative energy states-Equation of continuity-Plane wave solutions of the Dirac Equation-Non-relativistic limit of the Dirac equation- Fine structure of Hydrogen-Dirac equation in Electromagnetic field.

TEXT BOOKS

1. David J. Griffiths, *Introduction to Quantum Mechanics*, 2nd Edition, Pearson, 2009.
2. Mathews P.M. and Venkatesan K., *Quantum Mechanics*, 2nd Edition, McGraw Hill, 2010.

REFERENCES

1. Bransden B.H. and Joachain C.J., *Quantum Mechanics*, 2nd Edition, Pearson, 2007.
2. Yoav Peleg, Reuven Pnini, Elyahu Zaarur, and Eugene Hecht, *Schaum's Outline of Quantum Mechanics*, 2nd Edition, McGraw Hill, 2010.
3. Leonard I Schiff, *Quantum mechanics*, 3rd Edition, McGraw Hill Book Company, 1968.
4. Satya Prakash, *Advanced Quantum mechanics*, Revised Edition, Pragathi Prakashan publishing Limited, 2008.
5. Gupta, Kumar and Sharma, *Quantum Mechanics*, 29th Edition, Jai Prakash Nath & Co, 2010.

COURSE CODE	COURSE TITLE	L	T	P	Total of L+T+P	C
PPY14203	STATISTICAL MECHANICS AND THERMODYNAMICS	3	2	-	5	4
INSTRUCTIONAL OBJECTIVES						
1.	The course is to understand the basics of thermodynamics and Statistical systems.					
2.	Understand the various laws of thermodynamics.					
3.	Acquire the knowledge of various statistical distributions.					
4.	To comprehend the concepts of enthalpy, phase transitions and thermodynamic functions.					

UNIT I: BASIC ELEMENTS OF STATISTICAL MECHANICS

Foundations of statistical mechanics-Bridging microscopic and macroscopic behavior -Contact between statistics and thermodynamics- Free energy-Partition function of an ideal monatomic gas -Partition function of a diatomic molecule-Classical ideal gas- Entropy of mixing and Gibb's paradox-Sackur -Tetrode equation-The semi-classical perfect gas- Specific heat of solids -Saha's ionization formula.

UNIT II: THEORY OF ENSEMBLES

Ensembles- Microcanonical ensemble-Phase space- Trajectories and density of states-Liouville's theorem-Canonical ensemble -Thermodynamic properties of the canonical ensemble-Evaluation of the total partition function-Partition function in the presence of interactions-Fluctuation of the assembly energy in a canonical ensemble- Grand canonical ensemble- The grand partition function and its evaluation- Fluctuations in the number of systems-The chemical potentials in the equilibrium state.

UNIT III: STATISTICAL DISTRIBUTIONS AND APPLICATIONS

Maxwell-Boltzmann distribution- Determination of undetermined multipliers β and α -equipartition of energy- Bose-Einstein statistics-Bose-Einstein condensation-Fermi-Dirac statistics- The electron gas-White dwarfs and their limiting mass, statistical (Thomas - Fermi) model of atom-Comparison of the 3 statistics.

UNIT IV: LAWS OF THERMODYNAMICS AND THERMODYNAMIC PROCESSES

Ideal gases: Equation of state- Internal energy- Specific heats -Entropy-isothermal and adiabatic processes-Compressibility and expansion coefficient-.Real gases: Deviation from the ideal gas equation-Zeroth and first law of thermodynamics-Reversible and irreversible processes- Carnot theorem- Second law of thermodynamics-Clausius inequality- Entropy changes in reversible and irreversible processes- Temperature-entropy diagrams-Unavailable energy-Thermal death of the universe.

UNIT V: THERMODYNAMIC POTENTIALS AND PHASE TRANSITIONS

Thermodynamic potentials: Enthalpy- Gibbs and Helmholtz functions- Maxwell relations and their applications- Magnetic work- Magnetic cooling by adiabatic demagnetization-Approach to absolute zero-Change of phase- Equilibrium between a liquid and its vapour- Clausius-clapeyron- Phase transitions-Landau theory of phase transition-Equilibrium between phases-Pomeranchuk cooling.

TEXT BOOKS

1. Richard E. Sonntag , Gordon J. Van Wylen ,*Introduction to Thermodynamics, Classical and Statistical*, 3rd Edition, 2008.
2. Pathria R.K., *Statistical Mechanics*, 2nd Edition, Elsevier, 2000.

REFERENCES

1. John M.Seddon and Julian d. gale *Thermodynamics and Statistical Mechanics*, 3rd Edition, RSC publication, 2001.
2. Cengel Y.A. and Boles M.A., *Thermodynamics An Engineering Approach*, 5th Edition, McGraw- Hill, 2006.
3. Atkins C.J., *Equilibrium Thermodynamics*, 3rd Edition, Cambridge University press, 2000.
4. Sameul Glasstone, *Thermodynamics for Chemists*, 3rd Edition, Eastwest Press publisher, 2007.
5. David R. Gask, *Introduction to the Thermodynamics of Materials*, 5th Edition , CRC press , 2008

COURSE CODE	COURSE TITLE	L	T	P	Total of L+T+P	C
PPY14204	ELECTRONIC DEVICES AND APPLICATIONS	3	2	-	5	4
INSTRUCTIONAL OBJECTIVES						
1.	To enhance comprehension capabilities of students through understanding of electronic devices.					
2.	To give clear understanding of various fabrication techniques of semiconducting devices.					
3.	To understand the physical construction, working and operational characteristics of Semiconductor devices.					
4.	To introduce the basic building blocks of linear integrated circuits & Digital Converters.					

UNIT I: NETWORK ANALYSIS AND NEGATIVE RESISTANCE DEVICES

Kirchoff's laws - Thevenin- Norton theorems - superposition- reciprocity- compensation theorems - source transformation - delta and star transformations - Laplace Transformation - convolution integral- Gunn and Impatt Diode-Tunnel Diode- Backward Diode- Unijunction Transistor- p-n-p-n devices- p-n-p-n characteristics Thyristor- Silicon Controlled switch- SCS Characteristics- L Addition four Layer Devices- Basic Circuit Principles for NR Switching Circuits: Monostable- Bistable and Astable Operations.

UNIT II: PHOTOELECTRIC AND OTHER ELECTRONIC DEVICES

Zener Diode- Power Diode- Photodiode- Varactor Diode- Light sources and Displays - Light emitting diodes - Surface emitting LED - Edge Emitting LED - Seven segment display - LDR - Diode lasers - Photo detectors - Basic parameters - Photo diodes - p-i-n Photo diode - Solar cells - Photo transistors - IR and UV detectors- Transistor Register- Piezo-electric Crystals- Diode Lasers- Condition for Laser Action- Optical Gain- Memory Devices- Transistor Register- Random Access Memory- Read Only Memory.

UNIT III : OPERATIONAL AMPLIFIER

Characteristics of op-amp- inverting and non-inverting inputs- Input offset current and Input offset voltage- Slew rate and power band width- Op-amp as an Amplifier- Bode plot and frequency response of op-amp. Voltage follower- current follower- Op-amp as integrating and differentiating circuits- Voltage to frequency and frequency to voltage converter- Voltage controlled oscillator and wave shaping circuits (Triangular and Square wave)- Astable- Monostable and Bistable Multivibrators- Clipping and Clamping circuits.

UNIT IV : ANALOG TO DIGITAL AND DIGITAL TO ANALOG CONVERTER

Analog switches- High speed sample and hold circuits and sample and hold ICs- Types of D/A converter- Current driven DAC -Switches for DAC- A/D converter-Flash Single slope- Dual slope -Successive approximation - Delta Sigma Modulation - Voltage to Time converters. Astable and Monostable Multi vibrators using 555 Timer Voltage regulators - linear and switched mode types - Switched capacitor filter - Non Linear Amplifiers-Log-Antilog Amplifiers - Analog Multipliers - Phase Locked loops.

UNIT V : INTEGRATED CIRCUITS AND THEIR FABRICATIONS

Types of Integrated Circuits- Analog and Digital Integrated Circuits- Semiconductor Fabrication - Planar Technology- Fabrication of Monolithic-Integrated Circuits Schottky TTL - ECL - I²L - P and NMOS Logic - CMOS Logic - Tristate logic circuits.- Monolithic Passive and Active Circuit components- Typical IC Low Frequency Amplifier- New Technology Trends.

TEXT BOOKS

1. Robert L. Boylestad and Louis Nashelsky, *Electronic Devices and Circuit Theory*, 9th Edition, Pearson Education, 2009.
2. Anil K. Maini, *Digital Electronics - Principles & Integrated Circuits*, 1st Edition, Wiley Precise, 2008.

REFERENCES

1. Chattopadhyaya D. and Rakshith, *Electronics Fundamentals and Applications*, 11th Edition, New Age Publishers, 2008.
2. Deshpande N.P., *Electronic Devices and Circuits - Principles and Applications*, Tata McGraw - Hill publications company Ltd., 2008.
3. Salivahanan S and Suresh Kumar N, *Electronic devices and Circuits*, Tata McGraw - Hill Publications company Ltd., 2011.
4. Sze S.M., Kwok K Ng, *Physics of Semiconductor Devices*, 3rd Edition, John Wiley and Sons, 2007.
5. Metha V.K.and R.Mehta, *Principles of Electronics*, S. Chand & Company Ltd., 2008.

COURSE CODE	COURSE TITLE	L	T	P	Total of L+T+P	C
PPY14205	ELECTRONICS DEVICES LABORATORY	-	-	6	6	3
INSTRUCTIONAL OBJECTIVES						
1.	To familiarize the students with electronic components and basic electronic instruments.					
2.	To impart hands-on experience on verification of circuit laws and theorems.					
3.	To study experimentally the characteristics of diodes, BJT's and FET's.					
4.	To make the student understand the basic concepts in multivibrators Ic's and digital devices.					

LIST OF EXPERIMENTS (ANY 10 EXPERIMENTS)

1. To verify the Network theorem.
2. To Study the characteristics of the following.
 - a. Current Vs. Voltage.
 - b. Rectifiers.
 - c. Filtering and Ripple.
 - d. Diode Clamps.
3. To obtain common emitter/base/collector characteristics of NPN/PNP transistor.
4. To understand working of transistor as a switch and to draw DC load line for the given circuit.
5. To observe input-output waveforms of common emitter (CE) amplifier and to measure gain of amplifier at different frequencies and plot frequency response.

6. To observe input-output waveforms of common collector (CC) amplifier and to measure gain of amplifier at different frequencies and plot frequency response.
7. To measure the gain of two stage RC coupled amplifier.
8. To measure the gain of FET common source (CS) amplifier.
9. UJT characteristics and Design of Saw tooth wave oscillator.
10. To observe the input and output characteristics of Adder, Subtractor, Differential amplifier, Inverting amplifier and Non Inverting amplifier, Summing Amplifier by using IC741.
11. Design of square wave generator using IC 741 and Timer 555 IC's - 555 IC as VCO.
12. Design of Monostable multivibrator using the IC's 741 and 555 timer-study of frequency divider.
13. Design of Schmitt's Trigger using the ICs 741 and 555 timer - squarer.
14. Counters and shift registers - 7476/7473 IC.
15. Design of binary weighted and R/2R Ladder DAC using the IC 741.
16. Construction of ADC using DAC, comparator and counter.

TEXT BOOKS

1. David A. Bell, *Laboratory manual for Electronic Devices and Circuits*, 4th Edition, Oxford University Press, 2009.
2. Norman Ahlhelm, *Lab Experiments in Digital Electronics*, CreateSpace Independent Publishing Platform, 2010.

REFERENCES

1. Gaykwad A., *Operational Amplifier and Linear Integrated Circuits*, 11th Edition, Prentice Hall, 2006.
2. David A Bell, *Fundamentals of Electrical Circuits : Lab Manual*, 4th Edition, Oxford University Press, 2009.
3. Maheswari.L.K and Anand.M.M.S, *Laboratory Manual for Introductory Electronic Experiments*, New Age, 2010.
4. Michael Wiesner, *Lab Experiments-Digital Electronics,A Practical Approach*, Prentice Hall, 2009.
5. Salivahanan.S and Suresh Kumar.N, *Electronic devices and circuits*, Tata McGraw – Hill Publications company ltd., Second print 2011.

SUPPORTIVE COURSES

COURSE CODE	COURSE TITLE	L	T	P	Total of L+T+P	C
PPY14206	PROGRAMMING IN C & C++	2	-	2	4	3
INSTRUCTIONAL OBJECTIVES						
1.	To understand the general concepts in c language.					
2.	To apply the Physics concepts in solving problems.					
3.	To educate statements and array of C language.					
4.	To emphasize the significance of C++ theory.					

UNIT I: C FUNDAMENTALS

Introduction - Basic structure of C Programming - Character set - constants - Keywords - Identifiers - Variables - declaration of variables - Assigning values to variables - defining symbolic constants - Operators - Arithmetic- relational- logical- assignment- increment- decrement conditional and special type conversion in Expressions. Statements-Symbolic Constants-Data Input and Output- getchar()- putchar()- scanf()- printf()- gets()- puts() functions.

UNIT II: CONTROL STATEMENTS

If-else- while- do-while- goto- for statements- nested control structures- switch-break- continue statements comma operator. Concepts of loops- example of loops in C using for- while and do-while. C expressions- arithmetic operations- relational and logic operations. C assignment statements- extension of assignment to the operations. C primitive input output using getchar and putchar-exposure to the scant and printf functions.

UNIT III: OPERATORS AND STRINGS

Arrays - one- two and multi dimensional arrays - Initializing two dimensional arrays - Declaring and Initialising string variables - Reading and Writing Strings on the screen - Arithmetic operations on strings- Simple Programmes- User defined functions - their needs - Multiplication programme - Return values and their types - Calling Functions - Categories of functions - Matrix multiplication - Diagonalisation and inversion - Solution to simultaneous equations- intergration and differential equations.

UNIT IV: ARRAYS

Defining - processing array- passing arrays to functions- Introduction to multidimensional arrays- One dimensional arrays and example of iterative programs using arrays- 2-d arrays- Use in matrix computations- Concept of Sub-programming- functions- Example of functions- Argument passing mainly for the simple variables-Pointers- Declarations- Referencing and de-referencing- passing pointers to functions- Programming with C algorithms for root extraction- solving linear equations- interpolation and extrapolation- curve fitting- numerical integration and solving ordinary differential equations with applications to physics problems.

UNIT V: INTRODUCTION TO C++

Introduction to C++- Object-oriented programming concepts- The Basics of C++- Working with Operators and Expressions- Controlling the Program flow- Using Functions/Procedures- Pointers and Arrays- Binding data and functions- Function and Operator Overloading- Reusing classes- Virtual functions and Polymorphism- Exception Handling- Structuring programs- header files- multiple source files- namespaces- Advanced C++ features- static data- templates- runtime type checking- error handling.

LIST OF EXPERIMENTS

1. Program to understand the basic data types.
2. Program for looping and decision statements.
3. Program for finding Fibonacci series.
4. Finding a factorial for a given number.
5. Programs using library functions.
6. Programs using built-in math functions.
7. Programs on functions.
8. Programs on arrays.
9. Programs on string manipulations.
10. Programs on pointers.

TEXT BOOKS

1. Brian Kernighan and Dennis, *The C Programming Language, 2nd Edition* Prentice Hall, 2012.
2. Bjarne Stroustrup, *The C++ Programming Language, 3rd Edition*, Addison-Wesley, 2011.
3. Stroustrup. B, *Programming - Principles and Practice Using C++*, Addison Wesley, 2000.

REFERENCES

1. Kernighan, B. W., D .M. Ritchie, *The C Programming Language*, Prentice Hall of India, 2001.
2. Byron, S. Gottfreid, *Programming with C*, Tata McGraw Hill, 2nd Edition, 2002.
3. Rajaraman C, V., *Programming in C*, PHI, 2014.
4. Koenig A. and B. E. Moo, *Accelerated C++* , Addison Wesley, 2000.
5. Sudhit Kaicker, *The Complete ANSI C*, BPB Publications, 1996.

COURSE CODE	COURSE TITLE	L	T	P	Total of L+T+P	C
PPY14207	PROGRAMMING IN MATLAB	2	-	2	4	3
INSTRUCTIONAL OBJECTIVES						
1.	To understand the basic programming techniques in MatLab.					
2.	To understand different plotting and graphical representation methods in matlab					
3.	To understand and use various specialized toolboxes available in Matlab					
4.	To show how physics can be applied in a much broader context than discussed in traditional curriculum.					

UNIT I: VECTORS AND MATRICES

Creating and Concatenating Matrices - Matrix Indexing - Getting Information About a Matrix - Resizing and Reshaping Matrices - Shifting and Sorting Matrices - Operating on Diagonal Matrices - Empty Matrices-Scalars and Vectors - Full and Sparse Matrices -Multidimensional Arrays - MATLAB Linear Algebra Functions - Matrices in the MATLAB Environment - Systems of Linear Equations - Inverses and Determinants - Factorizations - Powers and Exponentials - Eigen values - Singular Values.

UNIT II: LOOP AND SELECTION STATEMENTS

Functions and Scripts - Evaluation-Timer - Variables and Functions in Memory - break statement- continue statement - end statement - error - for statement -for nested loop statement if/elseif/else statement -returnstatement - switch/case/otherwise statement - try/catch statement- while statement - nested while statement.

UNIT III: PLOTTING AND I/O

Plot functions - plot - plotyy - surf - mesh - contour - pie chart- bar diagram - animations - movie - 3D plots- customized plots- handle graphics and plot properties- plot applications-extracting data from graph -saving and printing plots-Lower file I/O functions- file formats- writing and reading spreadsheet files- Using MAT files for variables.

UNIT IV: GRAPHICAL USER INTERFACE

Creating GUI with GUIDE -GUIDE preferences and options- laying out a GUIDE GUI- saving and running a GUIDE GUI - Programming a GUIDE GUI- Example- Creating GUIs programmatically-Laying out a Programmatic GUI- Coding a Programmatic GUI- Managing a application defined data- managing a callback execution- Example.

UNIT V: TOOLBOXES

Curve fitting toolbox - Interactive Curve Fitting- Interactive Curve Fitting Example - Preprocessing Data - Fitting Data Programmatic Curve Fitting - Curve Fitting Objects and Methods - Generating Code from Curve Fitting Tool.

Signal Processing toolbox - Filter Design Process Overview - Basic Filter Design Process - Design a Filter Using filter builder.

Symbolic math toolbox - Symbolic Objects - Creating Symbolic Variables and Expressions - Performing Symbolic Computations - Assumptions for Symbolic Objects Practical's.

LAB EXPERIMENTS

1. Scalar and Matrix operations : addition, subtraction, multiplication, division.
2. Generate Fibonacci series.
3. Generate x , x^2 , x^3 , and plot x Vs x^2 and x Vs x^3 .
4. Read excel file. write to a notepad. Read a notepad file and write it to excel.
5. Generate a 2 D Gaussian curve. Save as JPEG. Generate a 3D Gaussian curve and save EPS.
6. Write a program to enter the name of n students, and their respective subject and grade. Take the mean of grade.
7. Generate two sine curves. Design a GUI to show the Lissajou's figures.
8. Generate pure random numbers from any natural source.
9. Mini project with MATLAB.

TEXT BOOKS

1. Stormy Attaway, *MATLAB: A Practical Introduction to Programming and Problem Solving*, 3rd Edition, Butterworth-Heinemann Publisher, 2013.
2. Brian R Hunt, Ronald L Lipsman, Jonathan M Rosenberg, *A Guide to MATLAB: For Beginners and Experienced Users*, Cambridge University Press, 2006.
3. Scott T. Smith, *MATLAB: Advanced GUI Development*, Dog ear publishing, 2006.

REFERENCES

1. Hanselman, Duane and Bruce C. Littlefield, *Mastering MATLAB 5: A Comprehensive Tutorial and Reference*, Prentice Hall PTR, 1997.
2. Marchand, Patrick, *Graphics and GUIs with MATLAB*. CRC Press, Inc., 1995.
3. Palm, William J. *MATLAB for Engineering Applications*, McGraw-Hill Higher Education, 1998.
4. Borse and Garold. J, *Numerical methods with MATLAB: A Resource for Scientists and Engineers*, International Thomson Publishing, 1996.
5. Fausett and Laurene. V, *Applied Numerical Analysis Using MATLAB*, Pearson, 2008.

COURSE CODE	COURSE TITLE	L	T	P	Total of L+T+P	C
PPY14208	COMPUTATIONAL METHODS AND PROGRAMMING	2	-	2	4	3
INSTRUCTIONAL OBJECTIVES						
1.	To understand the basic programming techniques in Computational Physics.					
2.	To address analytically intractable problems in physics using computational tools.					
3.	To understand various numerical techniques.					
4.	To show how physics can be applied in a much broader context than discussed in traditional curriculum.					

UNIT I : ERRORS

Definition of error - Absolute error - Relative error - Precision - Addition - subtraction -multiplication - Division - Error in numerical methods - Truncation error - Round off Errors - Error propagation in arithmetic operations - Error propagation in iterated algorithms - Methods for reducing error - Mean - Median - mode - Standard deviation -Variance - Correlation.

UNIT II: NUMERICAL SOLUTION OF SIMULTANEOUS LINEAR EQUATIONS

Solution by Successive Elimination of the Unknowns- Gauss elimination method- solving numerical problems- Solution by Inversion of Matrices- Definitions- Addition and Subtraction of matrices- Multiplication of matrices- Inversion of matrices- Solution of equations by matrix methods- solving numerical problems- Solution by Iteration- Solutions of Linear systems (Gauss -Seidel iteration method)- Solving numerical problems.

UNIT III: THE PRINCIPLE OF LEAST SQUARES, INTERPOLATION, EXTRAPOLATION

Principle of Least Squares- Curve Fitting-Fitting a straight line- Nonlinear curve fitting- Weighted least square approximations-Linear and Non linear Weighted Least square approximations- Solving numerical problems- Differences- Newton's Formula for Interpolation- Introduction- Differences- Differences of a polynomial- Newton's formula for Forward Interpolation- Newton's formula for Backward Interpolation- Solving numerical problems -Interpolation with Unequal Intervals of the argument-Newton's General Interpolation Formula- Lagrange's Interpolation formula-Solving numerical problems. Extrapolation- Richardson's extrapolation-Solving numerical problems.

UNIT IV : NUMERICAL DIFFERENTIATION AND INTEGRATION

Numerical Differentiation- Errors in Numerical Differentiation- Cubic-Spline Method- Solving numerical problems- Numerical Integration- Introduction- Trapezoidal Rule-Simpson's 1/3-rule- Weddle's rule- Gauss quadrature formula- Solving numerical problems.

UNIT V: NUMERICAL SOLUTION OF ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS

Ordinary Differential Equations- Introduction- Solution by Taylor's series- Euler's method- Runge Kutta method- Predictor-Corrector methods (Milne's Method)- Simultaneous equations- Solving numerical problems- Partial Differential Equations- Introduction-Laplace's equation (Jacobi's method)- Parabolic and Hyperbolic equations- Solving numerical problems.

PROGRAMMING NUMERICAL METHODS USING MATLAB: (ALGORITHM & PROGRAM)

1. Basic MATLAB programming using control, loop structures, arrays and functions (Faculty choice minimum 3 to 5 programs).
2. Successive approximation (Method of Iteration), Newton Raphson method
3. The Bisection method.
4. Gauss Elimination method.
5. Matrix Inversion, Lagrange's Interpolation formula.
6. Trapezoidal Rule, Simpson's 1/3-rule.
7. Euler's method, Runge Kutta method (Fourth Order).
8. Predictor corrector methods.

TEXT BOOKS

1. Sastry S.S., *Introductory Methods of Numerical Analysis*, Prentice Hall of India, 2005.
2. James B Scarborough, *Numerical Mathematical Analysis*, Oxford and IBH Publishing company, 1966.
3. Rizwan Butt, *Introduction to Numerical Analysis using MATLAB*, Jones and Bartlett Publishers, 2008.

REFERENCES

1. Stormy Attaway, *MATLAB: A Practical Introduction to Programming and Problem Solving*, 3rd Edition, Butterworth-Heinemann Publisher, 2013.
2. Brian R Hunt, Ronald L Lipsman, Jonathan M Rosenberg, *A Guide to MATLAB: For Beginners and Experienced Users*, Cambridge University Press, 2006.
3. Koonin, Steven E., and Dawn C. Meredith. *Computational physics*, Addison-Wesley, 1990.
4. Thijssen, Jos, *Computational physics*, Cambridge University Press, 2007.
5. Tao Pang, *Introduction to Computational Physics*, 2nd Edition, Cambridge University Press, 2010.

SEMESTER III

COURSE CODE	COURSE TITLE	L	T	P	Total of L+T+P	C
PPY14301	APPLIED SPECTROSCOPY	3	2	-	5	4
INSTRUCTIONAL OBJECTIVES						
1.	To understand the general concepts in Microwave Spectroscopy.					
2.	To explore the field of Vibrational Spectroscopy.					
3.	To understand the principles in Nuclear Spectroscopy.					
4.	To emphasize the significance of Surface Spectroscopy.					

UNIT I: MICROWAVE SPECTROSCOPY

Rotation of molecules-Rotational spectra-Rigid and non-rigid diatomic rotator-Intensity of spectral lines-Isotopic substitution-Poly atomic molecules (Linear and symmetric top)-Hyperfine structure and quadrupole effects-Inversion spectrum of ammonia-Chemical analysis by microwave spectroscopy-Techniques and instrumentation.

UNIT II: VIBRATIONAL SPECTROSCOPY

Infrared spectroscopy-Vibration of molecules-Diatomic vibrating rotator-Vibrational rotational spectrum-Interactions of rotations and vibrations-Influence of rotation on the vibrational spectrum of linear and symmetric top and poly atomic molecules-Analysis by infrared techniques-Instrumentation-FTIR spectroscopy. Raman spectroscopy- Classical and quantum mechanical picture of Raman effect-Polarizability-Pure rotational Raman spectrum-Vibrational Raman Spectrum-Raman activity of vibrations of CO₂ and H₂O-Rule of mutual exclusion-Overtones and combination - Structural determination from IR and Raman spectroscopy techniques-Instrumentation-FT Raman Spectroscopy.

UNIT III: ELECTRONIC SPECTROSCOPY

Electronic spectra-Frank-Condon principle-Dissociation energy and dissociation products-Fortrat diagram-predissociation-Shapes of some molecular orbits-Chemical analysis by electronic spectroscopy-Techniques and instrumentation-Mass spectroscopy-ESR spectroscopy-Introduction-Techniques and instrumentation-Double resonance.

UNIT IV: NUCLEAR SPECTROSCOPY

Nuclear magnetic resonance spectroscopy-Introduction-Interaction of spin and magnetic field-Population of energy levels-Larmor precession-Relaxation times-Chemical shift and its measurement-Coupling constant-coupling between several nuclei-Quadrupole effects-C¹³ NMR spectroscopy- Mossbauer spectroscopy-Principle-Instrumentation-Effect of electric and magnetic fields.

UNIT V: SURFACE SPECTROSCOPY

Electron energy loss spectroscopy (EELS)-Reflection absorption spectroscopy (RAIRS)-Photoelectron spectroscopy (PES)- X-ray Photoelectron spectroscopy(XPES)- Ultra violet Photoelectron spectroscopy(UPES)-Auger electron spectroscopy (AES) X-ray Fluorescence (XRF) spectroscopy -Secondary mass ion spectroscopy(SIMS).

TEXT BOOKS

1. Colin Banwell and Mc Cash, *Fundamentals of Molecular Spectroscopy*, 4th Edition, TMH Publishers, 2002.
2. SuneSvanbag , *Atomic and Molecular Spectroscopy : Basic Aspects and Practical Applications*, 3rd Edition, Springer, 2001.
3. Jeanne L Mc Hale , *Molecular Spectroscopy*, 1st Edition, Pearson Education, 2008.

REFERENCES

1. Aruldhas G., *Molecular Structure and Spectroscopy*, Prentice Hall of India, 2001.
2. Feynman R. P. et al, *The Feynman Lectures on Physics Vol. III*, Narosa, 1989.
3. Halina Abramczyk, *Introduction to Laser Spectroscopy*, 4th Edition, Elsevier, 2005.
4. Jerry Workman, Jr. Art Springsteen , *Applied Spectroscopy A Compact Reference for Practitioners*, 1st edition, Academic Press, 1998.
5. P.S. Kalsi, *Spectroscopy of Organic Compounds*, 6th edition , Newagepublishers, 2006

COURSE CODE	COURSE TITLE	L	T	P	Total of L+T+P	C
PPY14302	NUCLEAR AND PARTICLE PHYSICS	3	2	-	5	4
INSTRUCTIONAL OBJECTIVES						
1.	To study the general properties of nucleus.					
2.	To study the nuclear forces and nuclear reactions.					
3.	To know about the theories and models of nucleus.					
4.	To understand the concept of elementary particles.					

UNIT I: GENERAL PROPERTIES OF NUCLEUS

Nuclear mass and binding energy- Spin- parity- mass defect- mass excess- packing and binding fraction-Weizacker's semi empirical formula- Nuclear stability- Nuclear mass measurement- Double focusing mass spectrograph using cyclotron principle- Quadrapole mass spectrometer.

UNIT II: NUCLEAR FORCES

General characteristics of nuclear forces-Ground state of D2 (simple theory) - The meson theory of nuclear forces- Neutron- proton scattering at low energy-Spin dependence f-n-p forces. Nuclear models- Liquid drop model-Shell and collective model.

UNIT III: NUCLEAR REACTIONS AND NEUTRON PHYSICS

Types of nuclear reaction- Conservation laws of nuclear reaction- Theories of nuclear reaction- The compound nuclear theory- Nuclear reaction cross section- Resonance scattering and reaction cross section-Bried Wigner single level formula for scattering. Discovery of neutron- Neutron sources- Detection of neutron-Fundamental properties of neutron - Interaction of neutron with metal in bulk- Slowing down of fast neutron- Neutron diffusion-Diffusion of fast neutron and Fermi age equation.

UNIT IV: NUCLEAR FISSION AND FUSION

Discovery of fission-Energy release in fission-Nature of fission fragments-Energy of fission fragments- Bohr Wheeler theory of nuclear fission- Neutron multiplication and fission chain reaction- Thermal utilization fraction-multiplication factor- Four factor formula- Critical size of reactor-Reactor materials-Research and development reactor-Power reactor- Nuclear fusion and thermo nuclear reactions-Sources of energy in stars- Controlled thermo nuclear reaction.

UNIT V: ELEMENTARY PARTICLES

Building blocks of nucleus - Nucleons- Leptons- Mesons- Baryons- Hyperons- Hadrons- strange particles - Classification of fundamental forces and elementary particles - Basic Conservation laws - Additional Conservation laws - Baryonic-leptonic- Strangeness and isospin charges/quantum numbers - Gell-Mann-Nishijima formula - Multiplets - Invariance under time reversal (T) charge conjugation (C) and parity (P) - CPT theorem - Parity non-conservation in weak interactions - CP violation - Eight-fold way and supermultiples - SU(3) symmetry and quark model - Basic ideas on the theories of weak and strong interactions.

TEXT BOOKS

1. Kenneth S. Krane, *Introductory nuclear physics*, Wiley India, 2008.
2. Griffiths.D, *Introduction to elementary particles*, 2nd Edition, Wiley VCH, 2008.

REFERENCES

1. Devanathan.V, *Nuclear Physics*, 2nd Edition, Narosa Publishers, 2012.
2. Basdevant.J, J. Rich and M. Spiro, *Fundamentals in Nuclear Physics*, Springer, 2005.
3. Tayal.D.C., *Nuclear Physics*, 4th Edition, Himalaya House, 1980.
4. Boyarkin O.M., *Introduction to Physics of Elementary Particles*, Nova Publishers, 2007.
5. Patel S. B., *Nuclear Physics: An Introduction*, New Age International, 1991.

COURSE CODE	COURSE TITLE	L	T	P	Total of L+T+P	C
PPY14303	MICROPROCESSORS AND MICROCONTROLLERS	3	2	-	5	4
INSTRUCTIONAL OBJECTIVES						
1.	To Understand the architecture of 8085, 8086 and 8051.					
2.	To Impart the knowledge about the instruction set.					
3.	To Understand the basic idea about the data transfer schemes and its applications.					
4.	To develop skill in writing simple program for 8085, 8086 & 8051 and its applications.					

UNIT I: ARCHITECTURE AND PROGRAMMING OF 8085

Architecture of 8085- Organization of 8085- Control - Data and Address buses- registers in 8085- Addressing modes in 8085- Pin configuration of 8085. Instruction set of 8085-Instruction types(based on number of bytes, operation), data transfer – Arithmetic- Logical- Branching- Stack and I/O instructions- Timing and sequencing instruction cycles- Machine cycle of weight state-timing diagram of opcode fetch- Memory read and memory write cycles- Assembly language programming- Simple programs using arithmetic and logical operations- interrupts-Maskable- Non maskable -Hardware and multilevel interrupts.

UNIT II: DATA TRANSFER SCHEMES AND APPLICATIONS

Programmed data transfer scheme-Synchronous and Asynchronous and serial data transfer schemes-Interfacing devices- Types of interfacing devices- Programmable Peripheral Interface (PPI- 8255)- Communication interfacing device (Universal Synchronous Asynchronous Receiver Transmitter (USART- 8251)- Programmable Direct Memory Access(DMA) controller (8257).

UNIT III: ARCHITECTURE AND PROGRAMMING OF 8086

Architecture-Memory organization- Input and output structure-Programmable hardware resistors- Addressing modes-Minimum and maximum modes- Systems bus timing- Interrupts and interrupts service routines- Assembler instruction format- data transfer instructions- Arithmetic and logical instructions-Branch instructions- processor control instructions- String operator instructions- Simple programs.

UNIT IV: ARCHITECTURE OF MICROCONTROLLER 8051

Introduction -Comparison between microprocessor and microcontroller-architecture of 8051- Key features of 8051- Memory organization- Data and program memory- Internal RAM organization- Internal ROM organization - Special function registers-Accumulator- Data pointer- Control registers-I/O port-Counters and timers- Interrupt structures.

UNIT V: PROGRAMMING THE MICROCONTROLLER 8051

Instruction set of 8051- Arithmetic- Logical- Data movable- Jump and call instructions - Addressing modes-Immediate- Register- Direct and indirect addressing modes- Assembly language programming- Simple program to illustrate arithmetic and logical operations -Sum of numbers- Biggest and smallest numbers in an array - Software time delay system.

TEXT BOOKS

1. Ramesh S Goankar, *Micro Processor Architecture, Programming and Applications with the 8085*, 6th Edition, Penram International Publishing (India) Pvt. Ltd., 2011.
2. Kenneth J. Ayala, *The 8051 Microcontroller*, 3rd Edition , Publisher Cengage Learning, 2007.
3. Douglas V. Hall, *Microprocessors and Interfacing Programming and Hardware Gregg Division*, McGraw-Hill, 2006.

REFERENCES

1. Anokh singh, A.K. Chhabra , *Fundamentals of Digital Electronics and Microprocessors*, S.Chand, 2011.
2. Mazidi, *The 8051 Microcontroller And Embedded Systems*, 2nd Edition, Pearson Education India, 2007.
3. Kenneth J.Ayala , *The Microprocessor 8086 Programming and Interfacing*, West Publishing Company, 1995.
4. Barry B.Bery, *Intel Microprocessor: Architecture, Programming and Interfacing- 8086, 8088,80186,80286,80386 and 80486*, Prentice Hall PTR Upper Saddle River, NJ, 1993.
5. Kumar. N, Senthil, Saravanan M, and Jeevananthan.S, *Microprocessors and Microcontrollers*, Oxford University Press, Inc., 2011.

COURSE CODE	COURSE TITLE	L	T	P	Total of L+T+P	C
PPY14304	NANOSCIENCE AND NANOMATERIALS	3	2	-	5	4
INSTRUCTIONAL OBJECTIVES						
1.	To comprehend the principles of nanotechnology.					
2.	To enable the student to explore the field of nanomaterials.					
3.	To make the student understand the basic concepts in nanoscience.					
4.	To allow the student to have a deep knowledge of the fundamentals of nano molecular materials.					

UNIT I: INTRODUCTION TO NANOTECHNOLOGY

History and Importance of Nanotechnology-Opportunity at the nano scale-Length and time scale in structures- Difference between bulk and nanoscale materials and their significance- Properties at the nanoscale- Optical property- Magnetic property and electronic property-Size dependent behavior- Scaling- Mechanical properties of Nano materials and Chemical properties of Nanoparticles.

UNIT II: CLASSES OF NANOMATERIALS

Zero dimensional- One-dimensional and two dimensional nanostructures – Clusters of metals semiconductors and nanocomposites - Quantum dots- Nano wells- Nano ribbons and Nano Wires- Carbon nanotubes- Single walled and Multi walled CNT-Structure- Synthesis- Properties- Functionalization and applications - Fullerenes/Bucky Balls/ C₆₀- Synthesis- Properties- functionalization and Application.

UNIT III: SYNTHESIS OF NANO MATERIALS

Top-down approach: Nanolithography- Soft lithography and hard lithography, Physical Vapor deposition(PVD) - Chemical Vapor Deposition(CVD) - E beam lithography - Bottom-up approach: Sol-gel processing and chemical methods - Self assembly - Laser Ablation - Sputtering - DC Magnetron Sputtering - Chemical synthesis of nanoparticles in Liquid Suspension - Use of Surfactants in maintaining the nanosize.

UNIT IV: CHARACTERIZATION OF NANOMATERIALS

Scanning Electron Microscope (SEM) - Transmission Electron Microscope (TEM), Atomic Force Microscope (AFM) - Comparing SEM, TEM and AFM for different classes of nanomaterials - Scanning Tunneling Microscopy(STM) - Techniques and Imaging properties -Types: Manipulating atoms molecules with STM - Scanning Tunneling Spectroscopy and Dip pen Nanolithography.

UNIT V: APPLICATIONS OF NANO MATERIALS

Nanotechnology in Energy systems – Electronics – Environment - Space and Aviation - Textiles - Food & Agriculture - Automotive Industry - Solar Technology - Biotech and Pharmaceutical and drugs - Molecular Nanoelectronics – Nanobots - Photonic crystals - NEMS(Nano Electro Mechanical Systems) based device - Nanosensors and Devices.

TEXT BOOKS

1. Pradeep T., *Nano: The Essentials, 1st Edition*, Mc Graw Hill, 2007.
2. Robert W. Kelsall, Ian W. Hamley and Mark Geoghegan, *Nanoscale Science and Technology*, John Wiley & Sons, Ltd., 2005.

REFERENCES

1. Yong Zhou, *Nanomaterials and Nanotechnology*, Nova Publishers 2009.
2. Charles P. Poole Jr and Frank J. Owens, *Introduction to Nanotechnology*, Wiley Interscience, 2007.
3. Chris Binns, *Introduction to Nanoscience & Nanotechnology*, 1st Edition, Willey- Publication, 2010.
4. Chattopadhyay K.K., *Introduction to Nanoscience and Nanotechnology*, APH Publishing Corporation, 2006.
5. Parag Diwan, *Handbook of Nanotechnology*, Pentagon Press, 2009.

COURSE CODE	COURSE TITLE	L	T	P	Total of L+T+P	C
PPY14305	MICROPROCESSOR AND MICROCONTROLLER LABORATORY	-	-	5	5	2
INSTRUCTIONAL OBJECTIVES						
1.	To Understand the basic operations of 8085, 8086 and 8051.					
2.	To Impart the knowledge about the code conversions of 8085 and 8051.					
3.	To Understand the basic idea about the temperature conversions of 8085 and 8051.					
4.	To develop skills in decimal counting of 8085 and 8051.					

LIST OF EXPERIMENTS (ANY 10 EXPERIMENTS)

1. Perform the Arithmetic operations (addition and Subtraction) using microprocessor 8085.
2. Perform the Arithmetic operations (multiplication and division) using microprocessor 8085.
3. Code conversion using microprocessor 8085.
4. Temperature conversion using microprocessor 8085.
5. Decimal counters using microprocessor 8085.
6. Perform the Arithmetic operations (addition and Subtraction) using microprocessor 8086.
7. Perform the Arithmetic operations (multiplication and division) using microprocessor 8086.
8. Perform the Arithmetic operations (addition and Subtraction) using microcontroller 8051.
9. Perform the Arithmetic operations (multiplication and division) using microcontroller 8051.
10. Code conversion using microcontroller 8051.
11. Temperature conversion using microcontroller 8051.
12. Decimal counter using microcontroller 8051.
13. Programmable Peripheral Interfacing (PPI- 8251)- Mode 0 and Mode 1 operations using microprocessor 8085.
14. Traffic light control systems using microprocessor 8085.
15. Stepper motor control using microprocessor 8085.

TEXT BOOKS

1. Ramesh S Goankar, *Micro Processor Architecture, Programming & Applications with the 8085*, 6th Edition, Penram International Publishing (India) Pvt. Ltd., 2011.
2. Kenneth J. Ayala, *The 8051 Microcontroller*, 3rd Edition , Publisher Cengage Learning, 2007.
3. Douglas V. Hall, *Microprocessors and Interfacing Programming and Hardware*, Gregg Division, McGraw-Hill, 2006.

REFERENCES

1. Anokh singh, A.K. Chhabra , *Fundamentals of Digital electronics and Microprocessors*, S.Chand, 2011.
2. Mazidi, *The 8051 Microcontroller and Embedded Systems* , 2nd Edition, Publisher Pearson , Education India, 2007.
3. Kenneth J.Ayala, *The Microprocessor 8086 Programming and Interfacing*, West Publishing Company, 1995.
4. Anokh singh, A.K. Chhabra , *Fundamentals of Digital Electronics and Microprocessors* ,S.Chand, 2011.
5. Barry B.Bery, *Intel microprocessor: Architecure, Programming and Interfacing- 8086, 8088,80186,80286,80386 and 80486*, Prentice Hall PTR Upper Saddle River, 1993.
6. Kumar, N. Senthil, Saravanan M., and Jeevananthan S., *Microprocessors and Microcontrollers*, Oxford University Press, Inc., 2011.

TECHNOLOGY BASED ELECTIVES COURSES

COURSE CODE	COURSE TITLE	L	T	P	Total of L+T+P	C
PPY14E01	NON-DESTRUCTIVE TESTING TECHNIQUES	2	-	-	2	2
INSTRUCTIONAL OBJECTIVES						
1.	To make the student understand the basic knowledge about non-destructive testing.					
2.	To enable the student to understand the various methods of testing.					
3.	Students will gain a deep knowledge of the basic concepts of non-destructive testing and surface NDT methods.					
4.	To make the student understand the basic principles and techniques of non-destructive testing.					

UNIT I: VISUAL INSPECTION AND OPTICAL MICROSCOPY

Introduction to various non-destructive methods- Comparison of Destructive and Non destructive Tests- Fundamentals of Visual Testing - Vision- Lighting- Material attributes- Environmental factors- Visual perception- Direct and indirect methods - Mirrors- Magnifiers - Boroscopes- Fibroscopes- Microstructure Analysis - Optical and Scanning Electron Microscopy - Phase Analysis - Transfer Electron microscopy - Electron Probe Micro Analysis (EPMA)- Applications and limitations.

UNIT II: EDDY CURRENT TESTING

Generation of eddy currents - Principles of eddy current inspection- Conductivity of a material- Magnetic properties- Coil impedance- Lift off factor and edge effects- Skin effect- Inspection frequency- Coil arrangements - Inspection probes- types of circuit- Reference pieces- Phase analysis - Display methods - Typical application of eddy current techniques.

UNIT III: MAGNETIC PARTICLE TESTING

Theory of magnetism - Characteristics of magnetic fields - Magnetic hysteresis - Magnetisation by means of direct and alternating current - Surface strength characteristics - Depth of penetration factors- Direct pulsating current typical fields- Principle of MPT- Procedure used for testing a component - Equipment used for MPT- Magnetizing techniques - Applications.

UNIT IV: ULTRASONIC TESTING

Principle - Ultrasonic transducers - Ultrasonic Flaw detection Equipment - Modes of display A scan – B Scan- C Scan – Applications - Inspection Methods - Normal Incident Pulse Echo Inspection - Normal Incident through transmission testing - Applications of Normal Beam Inspection in detecting fatigue cracks- Inclusions-Slag- Porosity and Intergranular cracks - Specification and procedures and case studies in ultrasonic's test.

UNIT V: RADIOGRAPHOY

Principle of Radiography - X-ray and gamma ray sources- Safety procedures and standards- Effect of radiation on Film - Radiographic imaging - Inspection Techniques - Single wall single image - Double wall Penetration - Multiwall Penetration technique - Principles and applications of Fluoroscopy/Real-time radioscopy - Advantages and limitations - Recent advances - Intensifier tubes- Vidicon tubes - Digital Radiography.

TEXT BOOKS

1. Paul E. Mix, *Introduction to Nondestructive Testing*, 2nd Edition, Wiley, 2005.
2. Mohammed Omar, *Nondestructive Testing Methods and New Applications*, Croatia, 2012.
3. Buyukozturk, *Nondestructive Testing of Materials and Structures*, Springer, 2013.
4. Peter J. Shull *Non Destructive Evaluation: Theory- Techniques and Application*, Marcel Dekker-Inc., 2002.

REFERENCES

1. Jayakumar T, Baldev Raj and Thavasimuthu M, *Practical Non-destructive Testing*, Narosa Publishing House, 2012.
2. Louis Cartz, *Non-destructive Testing*, ASM International, 1995.
3. Mordfin Leonard, *Handbook of Reference Data for Non-Destructive Testing*, Astm Intl, 2002.
4. Chuck Hellier, *Handbook of Non-destructive Evaluation*, McGraw-Hill Professional, 2001.
5. David Cheeke, *Fundamentals and Applications of Ultrasonic Waves*, CRC Press, 2002.

COURSE CODE	COURSE TITLE	L	T	P	Total of L+T+P	C
PPY14E02	PHOTOVOLTAIC TECHNOLOGY	2	-	-	2	2
INSTRUCTIONAL OBJECTIVES						
1.	To learn the fundamentals, design and application of solar photovoltaic systems for power generation.					
2.	To understand the Physics and construction of PV cell.					
3.	To understand the optimization of energy conversion efficiency.					
4.	To understand the advantages of solar technology as an alternate energy resource.					

UNIT I: PROSPECTS OF PHOTOVOLTAIC SOLAR ENERGY

World Energy Requirement - Need for sustainable Energy Sources- Current status of Renewable Energy Sources - Energy Conversion - History of Solar Energy – Photovoltaics - Status and prospects of PV technology - Solar spectrum: Extraterrestrial and terrestrial solar spectrum and Air Mass - Relation between irradiance and spectral power - Direct and diffuse light - Density effect of atmosphere on sunlight - Measuring sunlight - PV cell - PV module - PV array - World production of Solar cell modules and cost.

UNIT II: PHYSICS OF PHOTOVOLTAICS

Fundamental of semiconductors - Semiconductor as solar cells - Excitation of charge carriers - Charge carriers and their transport- Drift - Diffusion and band bending- Generation and recombination of carriers- Semiconductor junction-PN junction in equilibrium and non-equilibrium conditions- PN junction under illumination Generation of photovoltage- Light generated current- Short circuit and Open circuit- IV equations of solar cells- Solar cell Characteristics.

UNIT III: SOLAR CELL PERFORMANCE

Standard test conditions-Solar cell parameters and upper limits- Losses in Solar cells- effect of series and shunt resistance- effect of solar radiation and temperature-utilization of band gap energy- Spectral utilization- external quantum efficiency and Shockley Queisser limit- Light Trapping- Absorption- optical losses and Light management in solar cells - Requirements for High I_{sc} - High V_{oc} and FF -Solar Simulator- I-V Measurement.

UNIT IV: SOLAR CELL TECHNOLOGIES AND CONCENTRATOR PV SYSTEMS

PV Technology based on Silicon cell technology - High Efficiency Si solar cells- From Solar Cells to Module- Thin Film Solar cells: Amorphous Silicon- CdTe solar cells- CIGS solar cells - Organic solar cells - GaAs solar cell-Multi junction concept - Concentrator PV - Light concentration- Concentration ratio- Optics and tracking requirements - Opportunities and challenges.

UNITV: PV SYSTEM COMPONENTS AND CONCEPTS

PV systems- Stand Alone PV systems- Grid connected PV systems- PV modules in a PV system- module parameters- Orientation and tilt- temperature dependency- Maximum power points tracking concepts- Invertors- Batteries- operating life of solar cells and panel- Installation and reliability requirements of PV cells- Installation costs- Economics- Payback period- Electricity cost- Feed-in-tariff- Grid Parity- Environmental considerations.

TEXT BOOKS

1. Chetan Singh Solanki, *Solar Photovoltaics Fundamentals, Technologies and Applications*, 2nd Edition, PHI Learning Private Limited, 2011.
2. Fonash S. J, *Solar Cell Device Physics*, 2nd Edition, Academic Press, 2010.

REFERENCES

1. Messenger R.A., Ventre, J., *Photovoltaic Systems Engineering*, 3rd Edition, CRC Press, 2010.
2. Jha A.R, *Solar Cell Technology and Applications*, CRC Press, 2010.
3. Petrova-Koch V. et al., *Highly-Efficient Low-Cost Photovoltaics*, Springer, 2009.
4. Partain L.D and Fraas L.M., *Solar Cells and their Applications*, 2nd Edition, Wiley, 2010.
5. Peter Würfel, *Physics of Solar Cells: From Basic Principles to Advanced Concepts*, Wiley-VCH, 2009.

COURSE CODE	COURSE TITLE	L	T	P	Total of L+T+P	C
PPY14E03	THIN FILM TECHNOLOGY	2	-	-	2	2
INSTRUCTIONAL OBJECTIVES						
1.	To impart a sound basis for an understanding of vacuum technology.					
2.	To provide a fundamental knowledge on various principles and methods used in the synthesis of materials in thin film form.					
3.	To familiarize with physics and techniques involved in the measurement and characterization of thin films.					
4.	To introduce nucleation and growth mechanisms of thin films based on thermodynamics and molecular theory.					

UNIT I : VACUUM TECHNOLOGY

Vacuum fundamentals - Basic Definition and pressure regions of vacuum - Kinetic theory of gases -Vacuum pumps and systems - Rotary mechanical pump- Diffusion pump- Turbo molecular pump- Sputter ion pump - Measurement of vacuum - Concept of different Gauges - Pirani gauge- Ionization gauge and Penning gauge.

UNIT II : PHYSICAL METHODS OF THIN FILM DEPOSITION

Thermal evaporation - Resistive heating - Flash evaporation- Arc evaporation- laser evaporation- RF heating- Electron bombardment heating - Cathodic sputtering - Glow discharge sputtering - Sputtering variants - Low pressure sputtering - RF sputtering - Reactive sputtering - Magnetron sputtering -Bias Sputtering - Evaporation versus sputtering.

UNIT III : CHEMICAL METHODS OF THIN FILM DEPOSITION

Electrodeposition - Electrolytic deposition - Electroless deposition - Anodic oxidation - Spray pyrolysis - Spin and Dip coating - Chemical vapour deposition - chemical decomposition(Pyrolysis) - Hydrogen reduction- Halide disproportionation- Transfer reactions - CVD Processes and systems - Low pressure CVD - Laser enhanced CVD - Metalorganic CVD (MOCVD).

UNIT IV : FILM GROWTH MECHANISM & THICKNESS MEASUREMENT TECHNIQUES

Introduction - Nucleation and early stages of film growth - Three dimensional nucleation and growth - Two dimensional Nucleation and Growth - Stranski-Krastanov Nucleation and Growth - Capillarity theory.

Thickness Measurement- Electrical methods - Microbalance monitors - Quartz crystal monitor - Mechanical method (Stylus) - Optical interference methods - Interference fringes.

UNIT V: CHARACTERISATION OF THIN FILMS

Structural Characterisation - Low Energy Electron Diffraction (LEED) - Scanning electron microscopy - Transmission electron microscopy - X-ray diffraction - Chemical Characterisation - X-ray Energy dispersive analysis (EDX) - Auger Electron Spectroscopy(AES) - X-ray Photoelectron Spectroscopy - Rutherford Backscattering Spectroscopy (RBS) - Secondary ion mass spectrometry(SIMS).

TEXT BOOKS

1. Ohring M., *Materials Science of Thin Films: Deposition and Structure*, 2nd Edition, Academic Press, 2002.
2. Nagamitsu Yoshimura, *Vacuum Technology: Practice for Scientific Instruments*, Springer Publications, 2007.

REFERENCES

1. Rointan F. Bunshah, *Handbook of Deposition Technologies for Films and Coatings, Science, Technology and Applications*, Noyes Publications, 1994.
2. Dorothy M. Hoffman, Bawa Singh and John H. Thomas , *Hand Book of Vacuum Science & Technology*, Academic Press, 1998.
3. Ludminla Eckertova , *Physics of Thin Films*, Plenum Press, 1977.
4. Kasturi L. Chopra, *Thin Film Phenomena*, Robert E. Krieger Publishing Company, 1979.
5. Hanlon J.F. O', *A User Guide to Vacuum Technology*, John Wiley and Sons, 2003.

COURSE CODE	COURSE TITLE	L	T	P	Total of L+T+P	C
PPY14E04	OPTICAL FIBER COMMUNICATIONS	2	-	-	2	2
INSTRUCTIONAL OBJECTIVES						
1.	To understand the general scientific concepts in fiber optic communication.					
2.	To study the design techniques for fiber optic guides.					
3.	To study the optical transmitters and receivers.					
4.	To study the concepts of amplifiers and dispersion.					

UNIT I:OVERVIEW OF OPTICAL FIBER COMMUNICATIONS

Electromagnetic spectrum - Optical Spectral bands- Evolution of fiber optic system- Multiplexing Techniques- Elements of an optical fiber transmission link with the functional description of each block- WDM concepts- Transmission windows- Advantages of optical fiber link over conventional copper systems- Applications of fiber optic transmission systems.

UNIT II :OPTICAL FIBERS - STRUCTURES WAVEGUIDING FABRICATION AND LOSSES

Optical laws and definitions- Optical fiber modes and configurations- Mode theory- Step Index and Graded Index (GI) fibers- Single mode and graded index fibers- Derivation for numerical aperture- V number and modes supported by step index fiber- Mode field -Numerical aperture and modes supported by GI fibers- Fiber materials- Linearly Polarized modes fiber fabrication techniques and mechanical properties of fibers-Fiber optic cables-Attenuation- Signal distortion in optical waveguides- Pulse broadening in graded index fiber- Characteristics of Single Mode Fibers- Mode coupling- International Standards for optical transmission fibers.

UNIT III: SOURCES AND DETECTORS

Sources -Light emitting diode (LEDs)-Structures – Materials - Figure of merits-characteristics and Modulation-Laser Diodes -Modes and threshold conditions-Diode Rate equations- Resonant frequencies- Structures- Characteristics and figure of merits- Single mode lasers- Modulation of laser diodes- Spectral width - Temperature effects and Light source linearity- Photo detectors- Principles of operation- Types- Characteristics- Figure of merits of detectors photodiode materials-Photo detector noise- Detector response time- Temperature effects on gain.

UNIT IV:RECEIVER AND TRANSMISSION SYSTEMS

Source to fiber power launching- Lensing schemes-fiber-to-fiber joints- LED coupling to single mode fibers-fiber splicing- Optical fiber connectors. Optical Receiver Operation - Calculation of average power required in reception - Pre-amplifier types- receiver performance and sensitivity- Eye diagrams-Specification of receivers - Transmitter - Transmitter Operation - Analog and digital.

UNIT V: ADVANCES IN OPTICAL FIBER SYSTEMS

Semiconductor optical Amplifier- EDFA- Raman Amplifier- Wideband Optical Amplifiers -Principles of Wavelength Division multiplexing (WDM)- Dense Wavelength Division multiplexing (DWDM)- Telecommunications and broadband application- SONET/SDH- MUX-Analog and Digital broadband- Optical switching.

TEXT BOOKS

1. Keiser. G., *Optical Fiber Communications*, 4th Edition, McGraw-Hill, 2008.
2. Franz and Jain, *Optical Communication Systems and Components*, Narosa Publications, 2000.

REFERENCES

1. Agarwal.G.P., *Fiber Optic Communication Systems*, 2nd Edition, John Wiley and Sons, 1997.
2. Ghatak, Ajoy, and Thyagarajan.K, *An Introduction To Fiber Optics*, Cambridge university press, 1998.
3. Peterson.L and Davie. B S., *Computer Networks. A System Approach*, Margan and Kaufmann, 2000.
4. Mynbaev and Scheiner, *Fiber Optic Communication Technology* Pearson, 3rd Indian Reprint, 2003.

COURSE CODE	COURSE TITLE	L	T	P	Total of L+T+P	C
PPY14E05	CRYOGENICS	2	-	-	2	2
INSTRUCTIONAL OBJECTIVES						
1.	To define concept of energy and apply its principles.					
2.	To understand the fundamental principles of cryogenics involved with liquefaction cycles and study the behaviour of atoms/molecules at low/ultralow temperatures.					
3.	To increase the awareness of low temperature engineering systems and safety measures.					
4.	Apply sound engineering principles to cryogens, analyze cryogenic engineering systems, and undertake the design of simple cryogenic systems.					

UNIT I: CRYOGENIC ENGINEERING CONNECTIONS

Science Marches On - The Entrepreneurs - The Butchers - The Brewers - The Industrialists - The Scientists - The Engineers - The Rocket Scientists - The Physicists and Superconductivity - Vacuum Techniques - Vapor pressure - Measurement of partial pressures - Mean free path and viscosity - Gas flow - Vacuum pumps - Sorption pumps- Oil diffusion pumps – Turbo molecular pumps - Molecular drag pumps - Measurement of partial pressures.

UNIT II : THERMODYNAMICS OF SOLIDS AND CRYOGENS

Basic principles - Heat Transfer - Momentum Transfer - Heat Leak and Pressure Drop in Cryogenic Transfer Lines - Cool down- PVT Behavior Of A Pure Substance - Temperature - Enthalpy And Temperature- Entropy Diagrams Of Pure Substances - Cryogens - Liquid oxygen and hydrogen- Liquid nitrogen - Liquid helium- Properties and Uses of Cryogenic Fluids - Material selection criteria.

UNIT III : ULTRACOLD BEHAVIOR OF CRYOGENS

Cryofluids- - Lattice specific heat - Electronic specific heat in superconducting materials - Magnetic specific heat - Emissivity - Absorptivity - Reflectivity - Thermal expansion - Thermal conductivity of Phonons - Electron thermal conductivity - thermal gradient - Local heat dissipation - Helium physics properties - Helium vapor pressure and latent heat of evaporation - Helium specific heat - Transport properties of liquid ^4He - thermal conductivity and viscosity- Heat switches - Gas heat switches - Superconducting heat switches.

UNIT IV : REFRIGERATIONS

Designs - Recuperative Cycles - Liquefaction of Gases Refrigerator Efficiency - Useful Thermodynamic Relations - Refrigeration and Liquefaction Methods - Macro (Large) Systems - Regenerative Cycles - Magnetocaloric Refrigeration- Ultra Low-Temperature Refrigerators - Very Small Coolers - Superconductors and Their Cooling Requirements - Cryocoolers - cooling down to 0.3 K - Transport and storage vessels - other accessories - Large scale systems - Superconductors - Space cryogenics - MiniGRAIL.

UNIT V : THERMOMETRY AND SAFETY CONSIDERATIONS/MEASURES

Reference fixed points - The ITS 90 - Gas thermometry - Constant volume gas thermometry - Acoustic gas thermometry - Dielectric constant gas thermometry - Noise thermometry - Paramagnetic salt thermometry - Magnetic thermometry with nuclear paramagnets - General Safety Principles - Reliability- Availability- Maintainability and Inspectability considerations - Physiological Hazards - Suitability of Materials and Construction Techniques - Explosions and Flammability - Excessive Pressure Gas - Special Considerations for Hydrogen and for Oxygen.

TEXT BOOKS

1. Klaus D. Timmerhaus and Thomas M. Flynn, *Cryogenic Process Engineering*, International Cryogenics Monograph Series, Springer, 2013.
2. Guglielmo Ventura and Lara Risegari, *The Art of Cryogenics- Low-Temperature Experimental Techniques*, Elsevier, 2008.
3. Thomas M. Flynn, *Cryogenic Engineering*, 2nd Edition (Revised and Expanded), Marcel Dekker, 2005.

REFERENCES

1. Klaus D. Timmerhaus and Thomas M. Flynn, *Cryogenic Process Engineering*, International Cryogenics Monograph Series, Springer, 2013.
2. Serio L, *Cryogenic Handbook*, ITER cryogenics components, ITER Organization Headquarters, 2010.
3. Mamata Mukhopadhyay, *Fundamentals of Cryogenic Engineering*, PHI Learning Pvt. Ltd., 2010.
4. Richard. T. Jacobsen, Steven. Penoncello.G, and Eric. W. Lemmon, *Thermodynamic Properties of Cryogenic Fluids*, Plenum Press, 1997.
5. Randall F. Barron, *Cryogenics Systems*, 2nd Oxford University Press, Clarendon Press, 1985.
6. Dudley B. Chelton and Douglas B. Mann, *Cryogenic Data Book, National Bureau of Standards, Cryogenic Engineering Laboratory, Boulder, Colorado, 1956.*

COURSE CODE	COURSE TITLE	L	T	P	Total of L+T+P	C
PPY14E06	OPTICAL SYSTEMS DESIGN	2	-	-	2	2
INSTRUCTIONAL OBJECTIVES						
1.	To make the student understand the principles of optical systems design.					
2.	To make the student understand concepts of image formation.					
3.	To make the student understand aberrations in optical systems.					
4.	To allow the student to have a deep knowledge of the materials used in optical systems.					

UNIT I: IMAGE FORMATION

Cardinal Points of an Optical System - Image Position and Size - Refraction of a Light Ray at a Single Surface - The Paraxial Region - Paraxial Raytracing through Several Surfaces - Calculation of the Focal Points and Principal Points - The Thin Lens - Mirrors - Systems of Separated Components - The Optical Invariant - Matrix Optics - The y-ybar Diagram - The Scheimpflug Condition - The Summary of sign Conventions.

UNIT II: ABERRATIONS

The Aberration Polynomial and the Seidel Aberrations - Chromatic Aberrations - The Effect of Lens Shape and Stop Position on the Aberrations - Aberration Variation with Aperture and Field - Optical Path Difference (Wave Front Aberrations) - Aberration Correction and Residuals - Ray Intercept Curves and the Orders of Aberrations.

UNIT III: OPTICAL MATERIALS AND INTERFERENCE COATINGS

Reflection- Absorption- Dispersion - Optical Glass - Special Glasses - Crystalline Materials - Plastic Optical Materials - Absorption Filters - Diffusing Materials and Projection Screens - Polarizing Materials - Dielectric Reflection and Interference Filters - Reflectors - Reticles - Cements and Liquids.

UNIT IV: OPTICAL COMPUTATION AND IMAGE EVALUATION

Paraxial Rays - Meridional Rays - Skew Rays- Spherical Surfaces - Aspheric Surfaces - Coddington's Equations - Aberration Determination - Thin Lenses; Stop Shift Equations - Path Difference- Focus Shift - Optical Path Difference- Spherical Aberration - Aberration Tolerances - Image Energy Distribution (Geometric) - Spread Functions-Point and Line - Geometric Spot Sizes Due to Spherical Aberration - The Modulation Transfer Function - Computation of the Modulation Transfer Function - Diffraction-Limited Systems.

UNIT V: OPTICAL SYSTEMS AND DESIGN TECHNIQUE

The Simple Meniscus Camera Lens - The Symmetrical Principle - Achromatic Telescope Objectives (Thin Lens Theory) - Achromatic Telescope Objectives (Design Forms)-The Diffractive Surface in Lens Design - The Cooke Triplet Anastigmat - A Generalized (Nonautomatic- Old-Fashioned) Design Technique - Contents - Automatic Design by Electronic Computer - Practical Considerations - The Design of Optical Systems-Particular - Telescope Systems and Eyepieces - Microscope Objectives - Photographic Objectives - Condenser Systems - Reflecting Systems - The Rapid Estimation of Blur Sizes for Simple Optical Systems.

TEXT BOOKS

1. Warren J. Smith, *Modern Optical Engineering the Design of Optical Systems*, Mc. Graw Hill , 2000.
2. Herbert Gross, *Handbook of Optical Systems, Vol 1-6*, Wiley - VCH , 2005.
3. Robert E Fishcher, Biljana Tadic Galeb and Paul R Yoder, *Optical System Design*, 2nd Edition, SPIE Press, 2008.

REFERENCES

1. Pieter W. Hooijmans, *Coherent Optical System Design*, Wiley, 1994.
2. Kingslake, Rudolf, *Optical System Design*, Academic Press, 1983.
3. Mahajan, Virendra N. *Optical Imaging and Aberrations: Part 1. Ray Geometrical Optics*, Bellingham: SPIE, 1998.
4. Tou, Julius T, *Optical Design of Digital Control Systems*, Elsevier, 1963.
5. Guenther, Robert D., and Robert Guenther, *Modern Optics*. Vol. 1, Wiley, 1990.

COURSE CODE	COURSE TITLE	L	T	P	Total of L+T+P	C
PPY14306	MINI PROJECT*	-	-	3	3	2

**SEMESTER IV
CORE BASED ELECTIVES COURSES**

COURSE CODE	COURSE TITLE	L	T	P	Total of L+T+P	C
PPY14E21	NANO ELECTRONICS	3	-	-	3	3
INSTRUCTIONAL OBJECTIVES						
1.	To understand the concepts of transport in nanostructure.					
2.	To gain knowledge in nano device fabrication techniques.					
3.	To understand the working of various nanoelectronic devices.					
4.	To familiarize with molecular electronics and computational method.					

UNIT I: INTRODUCTION TO NANOELECTRONICS

Overview of progress of microelectronics - International technology roadmap characteristics- Need for new concepts in Electronics - Moore's Law - CMOS scaling Nanoscale MOSFET - Limits of CMOS technology. From microelectronics towards nanoelectronics - Novel approaches towards future devices - Applications in different fields.

UNIT II: TRANSPORT IN NANOSTRUCTURES

Semiconductors - Crystal lattices- bonding in crystals - Electron energy bands - Semiconductor heterostructures - Lattice-matched and pseudomorphic heterostructures - Organic semiconductors - Low dimensional structures- Quantum well- Quantum wire and quantum dots-Quantum behavior in nanodevices-Resonant tunneling phenomena - Ballistic transport-single electron effect - Coulomb Blockade - Magneto transport - Spin dependent tunneling - Spin transport in semiconductors - Kondo effect.

UNIT III: FABRICATION TECHNIQUES

Nanofabrication - Nanopatterning of Metallic - Semiconducting nanostructures - Nano lithography- E-beam and nano imprint lithography- Advanced nanolithography- High resolution Nanolithography- Dip-Pen lithography- AFM Lithography- Embossing and surface passivation- Dimensional - Subtraction and Addition- Multi step Processing of Micro-contact printing- Molding implications and applications of the conventional and advanced techniques Nanophase materials - Self-assembled Inorganic-Organic layers - Langmuir blodgett Method.

UNIT IV: SEMICONDUCTOR NANODEVICES AND SPINTRONICS

Resonant tunneling diodes - Field effect transistors - Single electron transfer devices - Potential effect transistors - Light emitting diodes and lasers - Nano-electromechanical system devices - Quantum dot cellular automata Quantum electronic devices - Introduction to Spintronics- Ferromagnetic metals - Materials for spin electronics- Giant Magneto Resistance (GMR) - Spin transistor torques-spin valve and spin tunnel devices in data storage - Magnetic RAM and sensors - Quantum computation.

UNIT V: MOLECULAR ELECTRONICS

Electronic and opto-electronic properties of molecular materials - Electrodes & contacts - Functions - Molecular electronic devices - Logic gates - Elementary circuits using organic molecules- Organic materials based rectifying diode and switches- Monte Carlo Simulations - Computational methods and Simulations from ab initio to multiscale Modeling - Modeling of Nanodevices.

TEXT BOOKS

1. Rainer Waser (Ed.), *Nanoelectronics and Information Technology: Advanced Electronic Materials and Novel Devices*, 2nd Edition, Wiley-VCH Verlag, 2005.
2. Gosser K., Glosekotter P., and Dienstuhl J., *Nanoelectronics and Nanosystems: From Transistors to Molecular Devices*, Springer, 2004.

REFERENCES

1. Ziese M. and Thornton M.J. (Eds), *Spin Electronics*, Springer Verlag, 2001.
2. K.E. Drexler, *Nanosystems*, Wiley, 1992.
3. John H. Davies, *The Physics of Low-dimensional Semiconductors*, Cambridge University Press, 1998.
4. Petty M.C., *Molecular Electronics- From Principles to Practice*, John Wiley & Sons, 2007.
5. Mitin V., Kochelap V., and Stroscio M., *Quantum Hetrostructures*, Cambridge University Press, 2008.

COURSE CODE	COURSE TITLE	L	T	P	Total of L+T+P	C
PPY14E22	CRYSTAL GROWTH AND CHARACTERIZATION METHODS	3	-	-	3	3
INSTRUCTIONAL OBJECTIVES						
1.	To provide the students knowledge on various theoretical methods on the crystal growth process.					
2.	To impart the knowledge on the concept of birth of nucleus.					
3.	To make the students familiar with the growth of crystals from low temperature, melt and vapour growth techniques.					
4.	To equip the students with the experimental techniques to characterize the properties of crystals.					

UNIT I: BASICS OF CRYSTAL GROWTH AND NUCLEATION

Nucleation - Thermodynamics of nucleation - Different kinds of nucleation - Homogeneous and Heterogeneous Nucleation- Formation of critical nucleus - Energy formation of a nucleus - Spherical and cylindrical nucleus - Saturation and supersaturation-Degree of supersaturation-Induction Time -Crystal growth theories-Diffusion Theory-Surface energy theory-Adsorption Layer theory-Adsorption theory of nucleation.

UNIT II: LOW TEMPERATURE SOLUTION GROWTH TECHNIQUES

Low temperature solution growth - Solution - Solubility and supersolubility - Expression of supersaturation - Miers T-C diagram - Solution growth methods-constant temperature bath and crystallizer - Seed preparation and mounting - Slow cooling and solvent evaporation methods - Gel growth - various types - Structure of gel - Importance of gel technique - Chemical reaction method - Single and double diffusion method - Chemical reduction method - Complex and decomplexion method - Solubility reduction method - Advantages of gel method.

UNIT III: MELT GROWTH TECHNIQUES

Phase diagram and phase rules (basic concept) - Concepts of melt techniques - Bridgman technique - Basic Process - Various crucible designs - Importance of double wall crucible-Thermal consideration - Temperature profile - Vertical Bridgman technique - Experimental arrangement - Czochralski technique - Experimental arrangement - Growth process - Derivation of growth rate - Liquid Encapsulated Czochralski technique - Verneuil flame-Fusion growth method.

UNIT IV: CHEMICAL VAPOUR GROWTH TECHNIQUES

Principle of vapour growth technique-Transport agent-Properties of transport agents-chemical reaction involved in the vapour growth-Chemical vapour transport technique-Importance of temperature difference-Establishment of temperature profile between growth zone and source zone-Two zone and three zone technique-Chemical vapour deposition method-Advantages of the chemical vapour technique.

UNIT V: CHARACTERIZATION TECHNIQUES

Characterization using X-ray powder method - Single Crystal methods - Spectroscopic methods- Fourier transform method-Raman spectroscopic technique- Studies of surface morphology (SEM)- Energy Dispersive X-ray (EDX)- U-V Visible spectroscopy - Band gap energy calculation - Etching - Chemical etching - Thermal properties of crystals - Thermogravimetric analysis (TGA)- Differential thermogram and Differential Scanning Calorimetry (DSC).

TEXT BOOKS

1. Santhana Raghavan P. and Ramasamy P., *Crystal Growth Processes and Methods*, KRU Publications, 2001.
2. Heinz K. Henisch, *Crystals in Gels and Liesegang Rings*, Cambridge University Press, 2005.
3. Govindhan Dhanaraj, Kullaiiah Byrappa, Vishwanath Prasad, *Handbook of Crystal Growth*, Michael Dudley, Springer, 2010.

REFERENCES

1. Williard H. H., Merritt L. L., Dean J., and Settle F. A., *Instrumental Methods of Analysis*, 6th Edition, CBS Publishers & Distributors, 1986.
2. Goodman C. H. L., *Crystal Growth- Theory and Techniques*, Plenum Press, Pennsylvania State University, Cambridge University Press, 2005.
3. Brice J. C., *Crystal Growth Processes*, John Wiley and Sons, 1986.
4. Hans J. Scheel, Peter Capper, Peter Rudolph, *Crystal Growth Technology: Semiconductors and Dielectrics*, John Wiley & Sons, 2010.
5. Vere A.W., *Crystal Growth*, Plenum Press, 1987.

COURSE CODE	COURSE TITLE	L	T	P	Total of L+T+P	C
PPY14E23	NONLINEAR OPTICS	3	-	-	3	3
INSTRUCTIONAL OBJECTIVES						
1.	To make the student understand the principles of Nonlinear Optics.					
2.	To enable the student to explore the concept of wave equations for nonlinear optical medium.					
3.	To make the student understand the basic concepts in nonlinear susceptibility models.					
4.	To allow the student to have a deep knowledge of the fundamentals of electrooptic effect.					

UNIT I: NONLINEAR OPTICAL SUSCEPTIBILITY

Introduction to Nonlinear Optics - Descriptions of Nonlinear Optical Processes - Definition of the Nonlinear Susceptibility - Nonlinear Susceptibility of a Classical Anharmonic Oscillator - Properties of the Nonlinear Susceptibility -Time-Domain Description of Optical Nonlinearities - Kramers-Kronig Relations in Linear and Nonlinear Optics - Schrödinger Calculation of Nonlinear Optical Susceptibility.

UNIT II: WAVE EQUATION FOR NONLINEAR OPTICAL MEDIA

The Coupled Wave Equations for Sum Frequency Generation - Phase Matching - Quasi Phase Matching - The Manley Rowe Relations - Sum Frequency Generation - Second Harmonic Generation - Difference Frequency Generation and Parametric Amplification - Optical Parametric Oscillators - Nonlinear Optical Interactions with Focused Gaussian Beams - Nonlinear Optics at an Interface.

UNIT III: INTENSITY-DEPENDENT REFRACTIVE INDEX

Descriptions of the Intensity-Dependent Refractive Index - Tensor Nature of the Third-Order Susceptibility - Nonresonant Electronic Nonlinearities - Nonlinearities Due to Molecular Orientation - Thermal Nonlinear Optical Effects - Semiconductor Nonlinearities - Nonlinear Susceptibilities Calculated Using Time-Independent Perturbation Theory- Semiempirical Models of the Nonlinear Optical Susceptibility.

UNIT IV: SCATTERING AND ELECTROOPTIC AND PHOTOREFRACTIVE EFFECTS

Spontaneous Raman Effect - Spontaneous versus Stimulated Raman Scattering - Stimulated Raman Scattering Described by the Nonlinear Polarization - Stokes-Anti-Stokes Coupling in Stimulated- Raman Scattering - Coherent Anti-Stokes Raman Scattering - Stimulated Rayleigh-Wing Scattering - Introduction to the Electrooptic Effect - Linear Electrooptic Effect- Electrooptic Modulators - Introduction to the Photorefractive Effect - Two-Beam Coupling in Photorefractive Materials .

UNIT V: OPTICAL PROCESSES AND ULTRAFAST NONLINEAR OPTICS

Introduction to Optical Damage - Avalanche-Breakdown Model - Influence of Laser Pulse Duration - Direct Photoionization - Multiphoton Absorption and Multiphoton Ionization - Ultrashort Pulse Propagation Equation - Interpretation of the Ultrashort-Pulse Propagation Equation - Intense-Field Nonlinear Optics - Motion of a Free Electron in a Laser Field - High-Harmonic Generation - Nonlinear Optics of Plasmas and Relativistic Nonlinear Optics.

TEXT BOOKS

1. Laud B.B., *Lasers and Nonlinear Optics*, 2nd Edition, New Age International (P) Ltd., 1991.
2. Robert W. Boyd, *Nonlinear Optics*, 2nd Edition, Academic Press, 2003.

REFERENCES

1. Govind P. Agarwal, *Fiber-Optics Communication Systems*, 3rd Edition, John Wiley & Sons, 2003.
2. William T. Silvast, *Laser Fundamentals*, Cambridge University Press, 2003.
3. Mills D.L., *Nonlinear Optics - Basic Concepts*, Springer, 1998.
4. Richard L. Sutherland, *Handbook of Nonlinear Optics (Optical Science and Engineering)*, Marcel Dekker, Inc., 2003.
5. Shen Y. R., *The Principles of Nonlinear Optics*, Wiley-Interscience, 2003.

COURSE CODE	COURSE TITLE	L	T	P	Total of L+T+P	C
PPY14E24	FUNDAMENTALS OF ATMOSPHERIC PHYSICS	3	-	-	3	3
INSTRUCTIONAL OBJECTIVES						
1.	To acquire the basic knowledge about the earth's atmosphere.					
2.	To understand the physical processes in earth atmosphere interactions.					
3.	To understand the radiation concepts of the atmosphere.					
4.	To understand the role of aerosols and clouds in precipitation processes.					

UNIT I: GLOBAL VIEW OF ATMOSPHERE

Introduction to the Atmosphere - Descriptions of Atmospheric Behavior - Mechanisms Influencing Atmospheric Behavior - Composition and Structure - Description of Air - Stratification of Mass - Thermal and Dynamical Structure - Trace Constituents - Carbon Dioxide - Water Vapor - Ozone - Methane - Chlorofluorocarbons - Nitrogen Compounds - Atmospheric Aerosol - Clouds. Radiative Equilibrium of the Planet - The Global Energy Budget - Global-Mean Energy Balance and Horizontal Distribution of Radiative Transfer - The General Circulation.

UNIT II: TRANSFORMATIONS OF MOIST AIR

Description of Moist Air - Properties of the Gas Phase and Saturation Properties - Implications for the Distribution of Water Vapor - State Variables of the Two Component System - Unsaturated and Saturated Behavior; Thermodynamic Behavior Accompanying Vertical Motion - Condensation and the Release of Latent Heat- the Pseudo-Adiabatic Process and the Saturated Adiabatic Lapse Rate. The Pseudo-Adiabatic Chart - Surface Relative Humidity- Surface Potential Temperature- Surface Dew Point- Cumulus Cloud Base- Equivalent Potential Temperature at the Surface- Freezing Level of Surface Air- Liquid Water Content at the Freezing Level- Temperature inside Cloud at 650 mb- Mixing Ratio inside Cloud at 650 mb.

UNIT III: HYDROSTATIC EQUILIBRIUM AND HYDROSTATIC STABILITY

Effective Gravity- Geopotential Coordinates and Hydrostatic Balance- Stratification - Idealized Stratification - Layer of Constant Lapse Rate- Isothermal Layer and Adiabatic Layer; Lagrangian Interpretation of Stratification - Adiabatic and Diabatic Stratification. Reaction to vertical displacement- stability in terms of temperature- potential temperature and moisture dependence.

UNIT IV: ATMOSPHERIC RADIATION

Shortwave and Longwave Radiation - Spectra of Observed SW and LW Radiation; Description of Radiative Transfer - Radiometric Quantities- Absorption - Lambert's Law- Emission - Planck's Law- Wien's Displacement Law- The Stefan-Boltzmann Law and Kirchhoff's Law; Scattering - The Equation of Radiative Transfer; Absorption Characteristics of Gases - Interactions between Radiation and Molecules- Line Broadening; Radiative Transfer in a Plane Parallel Atmosphere - Transmission Function and Two-Stream Approximation; Thermal Equilibrium - Radiative Equilibrium in a Gray Atmosphere- Radiative-Convective Equilibrium- Radiative Heating- Thermal Relaxation- The Greenhouse Effect.

UNIT V: AEROSOLS AND CLOUDS

Morphology of Atmospheric Aerosol - Continental- Marine and Stratospheric Aerosol; Microphysics of Clouds - Droplet Growth by Condensation- Droplet Growth by Collision and Growth of Ice Particles; Macroscopic Characteristics of Clouds - Formation and Classification of Clouds- Microphysical Properties of Clouds and Cloud Dissipation; Radiative Transfer in Aerosol and Cloud - Scattering by Molecules and Particles - Rayleigh Scattering and Mie Scattering- Radiative Transfer in a Cloudy Atmosphere; Roles of Clouds and Aerosol in Climate - Involvement in the Global Energy Budget - Influence of Cloud Cover and Aerosol. Involvement in Chemical Processes.

TEXT BOOKS

1. Chandrasekhar A., *Basics of Atmospheric Science*, PHI Learning Private Limited, 2010.
2. Murry Salby, *Fundamentals of Atmospheric Physics*, 1st Edition, Academic Press, 1996.

REFERENCES

1. Donald Ahrens.C, *Essentials of Meteorology*, Brooks/Cole Gengage Learning, 2008.
2. Kirill ya kondratyev, *Atmospheric Aerosol Properties*, Praxiz Publishing House, 2006.
3. David G Andrews, *An Introduction to Atmospheric Physics*, 2nd Edition, Cambridge University Press, 2010.
4. John T Houghton, *The Physics of the Atmospheres*, Cambridge University Press, 2009.
5. Thomas D Potter and Bradley R Colman, *Handbook of Weather, Climate and Water*, Wiley Interscience, 2003.

COURSE CODE	COURSE TITLE	L	T	P	Total of L+T+P	C
PPY14E25	RADIATION THERAPY & MEDICAL DIAGNOSIS	3	-	-	3	3
INSTRUCTIONAL OBJECTIVES						
1.	To understand the general concepts in radiation and its interaction and dose measurement.					
2.	To apply the Physics concepts in Clinical Trials.					
3.	To educate scientifically the principles of radiation and its effect in the medical field.					
4.	To emphasize the significance of various medical techniques and therapy.					

UNIT I: IONIZING RADIATION: GENERATORS, DOSE AND EXPOSURE

Clinical radiation generators-Grenz Therapy- Orthovoltage(or) Deep Therapy-Supervoltage Therapy-MegavoltageTherapy-Machines using radionuclides-Cobalt 60 (^{60}C) Unit-Interaction of Ionizing Radiation-Photon Beam Description-Photon Beam attenuation-Coefficients-Attenuation coefficient-Energy Transfer Coefficient and Energy Absorption coefficient-Measurement of Ionizing radiation-Roentgen-Free air Ionizing chamber-Measurement of absorbed dose-Radiation absorbed dose-Relationship between Kerma,Exposure and Absorbed dose(Relationship Between Various Dosimetry Units).

UNIT II: CLASSICAL RADIATION THERAPY

Dose Distribution and Scatter Analysis-Phantoms-Depth Dose Distribution-Percentage Depth Dose-Tissue Air Ratio-Scatter/Air ratio- Tissue/Phantom ratio - Isodose Curves -Electron Beam Therapy-Electron Interactions-Rate of Energy loss and Electron Scattering-Electron ARC Therapy-Brachytherapy-Source-Calibration-Calculation of Dose Distribution-Dose Specification-Cancer of the Cervix-Radiation Protection-Dose Equivalent-Effective Dose Equivalent-Background Radiation-Total Body Irradiation-Techniques and Equipment.

UNIT III: COMPUTED TOMOGRAPHY

Conventional X-ray tomography - Data Accumulation-Scanning motions -Principle of Helical CT Scan and Scan Parameters and scan configurations-X-ray tubes-Collimators-Detectors-Scintillation crystal and Xenon Gas Ionization chamber-Image reconstruction-Algorithms for Image reconstruction-Back projection-Iterative method and Analytical methods-CT Numbers- Image display-quality and Resolution-Spatial and contrast resolution-Patient exposure-3D Imaging -Surface reconstruction and Volumetric reconstruction.

UNIT IV: MAGNETIC RESONANCE IMAGING (MRI)

Magnetic Resonance image - proton density- relaxation time T1 and T2 images - Image characteristics - MRI system components - Magnets-Magnetic fields- Gradients-Magnetic field shielding-Radio Frequency systems - Computerfunctions - Imaging process - Image artifacts - MRI safety.

UNIT V: ULTRASOUND IMAGING AND THERMOGRAPHY

Interaction of sound waves with body tissues-Production of ultrasound - transducers - acoustic coupling - image formation - modes of image display - colour-Doppler -Thermography - Liquid Crystal thermography - Microwave thermography.

TEXT BOOKS

1. Fiaz.M.Khan, *The Physics of Radiation Therapy*, Lippincott Williams &Wilkins, 4th Edition, 2010.
2. Khandpur .R.S., *Hand Book of Biomedical Instrumentation*, Tata McGraw Hill Publishing Co., Ltd, 2005.

REFERENCES

1. Paul suetens, *Fundamentals of Medical Imaging*, 2nd Edition, Cambridge university press,2009.
2. Meredith/Massey, *Fundamental Physics of Radiology*, 3rd Edition, John Wright & Sons Ltd, 1977.
3. F.A.Smith, *A Primer in applied Radiation Physics*, WorldScientific Ltd,2000.
4. WilliamR. Hendo, Ceoffrey S. Ibbot and EricC .Hende, *Radiation Therapy Physics*, 3rd Edition, JohnWiley & Sons.Inc., 2005.
5. M.Arumugam, *Biomedical Instrumentation*, Anuradha Publishing Co., 2002.

COURSE CODE	COURSE TITLE	L	T	P	Total of L+T+P	C
PPY14E26	PHOTONICS	3	-	-	3	3
INSTRUCTIONAL OBJECTIVES						
1.	To understand the general concepts in optics.					
2.	To learn the basic concepts of the origin and exploitability of intensity-induced optical effects.					
3.	To understand the concepts of light interaction with Biosystems.					
4.	To emphasize the significance of optoelectronic display devices.					

UNIT I: INTRODUCTION TO PHOTONICS

Nature of Light - Wave and light terminology- Maxwell equation- light spectra and sources- Absorption and emission- Black body radiation-Geometric Optics - Light as a ray- law of reflection including plane mirrors- Law of refraction including optical fiber applications- Prisms and thin lenses including Lensmaker's equation- Internal reflection and evanescent waves- Plasmons and surface plasmon resonance (SPR)- Attenuated total reflection- Grating SPR coupling- Optical waveguide SPR coupling.

UNIT II: NANOPHOTONICS

Fundamentals - Photons and electrons-confinement of photons and electrons, tunneling- Bandgap - Cooperative effects- Nanoscale optical interactions- Nanoscale confinement of electronic interactions-Quantum confinement and Plasmonics: Quatum wells- Quantum wires- Quantum dots- Quantum rings- Quantum confined Stark effect - Super lattices.

Near-Field Optics- Aperture near-Field optics- Apertureless near-Field optics- Near field scanning optical microscopy (NSOM or SNOM)- SNOM in nanolithography.

UNIT III: BIOPHOTONICS

Interaction of light with biological matter - Absorption spectroscopy of biopolymers - study of conformational dynamics- Optical activity and circular dichroism - Non-linear optical processes with intense laser beams-Photo-induced effects in biological systems - Fluorescence detection and quantification of nucleic acids- Proteins and cells-Optical trapping and manipulation of single molecules.

UNIT IV: OPTOELECTRONICS

Electronic properties of semi conductors - Effect of pressure and temperature on band gap-Consequence of heavy doping-Conduction processes in semiconductors- Electron-hole pair formation and recombination- PN junction-Carrier recombination and diffusion- Injection efficiency- Heterojunction- Internal quantum efficiency- Double heterojunction.

UNIT V: PHOTONIC CRYSTALS

Important features of photonic crystals- Presence of photonic bandgap-Anomalous Group Velocity Dispersion- Microcavity-Effects in Photonic Crystals-Fabrication of photonic crystals- Transfer matrix method-Plane wave expansion method-Finite difference time domain method-Dielectric mirrors and interference filters- Photonic crystal fibres- Applications-Photonic Crystal Laser- PC based LEDs- Photonic crystal fibers (PCFs)- Photonic crystal sensing.

TEXT BOOKS

1. Masuhara H., Kawata S. and Tokunaga F., *Nano Biophotonics*, Elsevier Science, 2007.
2. Gupta S C, *Optoelectronic Devices and Systems*, Prentice Hall India, 2005.
3. Saleh B.E.A., *Fundamentals of Photonics*, 2nd Edition, Wiley India Pvt Ltd; September 2012.

REFERENCES

1. Pearsall T.P., *Photonics Essentials: An introduction with experiments*, McGraw-Hill, 2002.
2. Yariv Amnon, *Photonics: Optical Electronics in Modern Communications*, 6th Edition, Oxford University Press 2009.
3. Ralf Menzel, *Photonics: Linear and Nonlinear Interactions of Laser Light and Matter*, 2nd Edition, Springer, 2007.
4. Shalaev V.M. and Kawata S., *Nanophotonics with Surface Plasmons, Advances in Nano-Optics and Nano-Photonics*, 2007.
5. Prasad P.N., *Introduction to Biophotonics*, John Wiley & Sons, 2003.

COURSE CODE	COURSE TITLE	L	T	P	Total of L+T+P	C
PPY14401	SEMINAR*	-	-	2	2	1

COURSE CODE	COURSE TITLE	L	T	P	Total of L+T+P	C
PPY14402	CAREER COMPREHENSIVE COURSE	2	-	-	2	2

Courses covered under the syllabus from First Semester to Fourth Semester (including electives) will form the basis for Career Comprehensive Course.

COURSE CODE	COURSE TITLE	L	T	P	Total of L+T+P	C
PPY14403	PROJECT WORK	-	-	12	12	12