COURSES SCHEME

&

SYLLABUS

FOR

M.SC.

PHYSICS

2015

M.Sc. (Physics) Program

ELIGIBILITY

Minimum 60% (55% for SC/ST) at graduation level in the relevant discipline of eligibility. Admissions shall be made by combining percentage of marks obtained at 10^{th}, $12^{th}$and graduation (aggregate marks upto second year/four semesters will be considered). Graduation must be done from a recognized University.

PROGRAM OBJECTIVES

The program has following three specializations:

- i. Nuclear Science and Technology
- ii. Electronics
- iii. Materials Technology

1. To understand the underlying physics in respective specializations, and, be able to teach and guide successfully.
2. To introduce advanced ideas and techniques that are applicable in respective fields.
3. To develop human resource with a solid foundation in theoretical and experimental aspects of respective specializations as a preparation for career in academia and industry.

COURSE SCHEME & SYLLABUS FOR M.SC. (PHYSICS)

SEMESTER – I

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PPH101	CLASSICAL MECHANICS	3	1	0	3.5
2	PPH102	STATISTICAL MECHANICS	3	1	0	3.5
3	PPH103	QUANTUM MECHANICS	3	1	0	3.5
4	PPH104	MATHEMATICAL PHYSICS	3	1	0	3.5
5	PMC104	FUNDAMENTALS OF COMPUTER SCIENCE AND C PROGRAMMING	3	0	4	5.0
6	PHU002	PROFESSIONAL COMMUNICATION	3	1	0	3.5
TOTAL			**18**	**5**	**4**	**22.5**

SEMESTER – II

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PPH201	CONDENSED MATTER PHYSICS	3	1	0	3.5
2	PPH203	ATOMIC AND MOLECULAR PHYSICS	3	1	0	3.5
3	PPH204	ELECTRODYNAMICS	3	1	0	3.5
4	PPH205	ELECTRONICS	3	1	0	3.5
5	PPH207	CONDENSED MATTER PHYSICS LAB	0	0	3	1.5
6	PPH312	ADVANCED QUANTUM MECHANICS	3	1	0	3.5
TOTAL			**15**	**5**	**3**	**19.0**

SUMMER INTERNSHIP 2.0 CR

SEMESTER – III

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PPH301	PARTICLE PHYSICS	3	1	0	3.5
2	PPH302	NUCLEAR PHYSICS	3	1	0	3.5
3	PPH303	SEMICONDUCTOR PHYSICS	3	1	0	3.5
4	PPH305	COMPUTATIONAL METHODS IN PHYSICS	3	1	3	5.0
5	PPH306	NUCLEAR PHYSICS LAB	0	0	3	1.5
6	PPH307	SEMICONDUCTOR PHYSICS LAB	0	0	3	1.5
7		ELECTIVE – I	3	1	3	5.0
8	PPH391	SEMINAR	-	-	-	2.0
TOTAL			**15**	**5**	**12**	**25.5**

SEMESTER – IV

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1		ELECTIVE II	3	1	0	3.5
2		ELECTIVE III	3	1	0	3.5
3	PPH491	DISSERTATION	-	-	-	6.0
TOTAL			**6**	**2**	**0**	**13.0**

ELECTIVE-I

NUCLEAR SCIENCE AND TECHNOLOGY

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PPH315	ACCELERATOR TECHNOLOGY	3	1	3*	5.0
2	PPH324	NUCLEAR REACTOR PHYSICS	3	1	3*	5.0

ELECTRONICS

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PPH325	DIGITAL ELECTRONICS AND MICROPROCESSORS	3	1	3	5.0
2	PPH316	OPTOELECTRONICS	3	1	3	5.0

MATERIALS TECHNOLOGY

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PPH326	STRUCTURE AND PROPERTIES OF MATERIALS	3	1	0	3.5
2	PPH327	ELECTROMAGNETIC PROPERTIES OF MATERIALS	3	1	0	3.5

***** VISITS TO SITES AND CASE STUDIES

MATERIALS TECHNOLOGY

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PPH318	NANOMATERIALS	3	1	3	5.0
2	PPH317	CHARACTERIZATION TECHNIQUES	3	1	3	5.0

ELECTIVE-II

NUCLEAR SCIENCE AND TECHNOLOGY

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PPH435	RADIATION TECHNOLOGY	3	1	0	3.5
2	PPH436	ADVANCED NUCLEAR PHYSICS	3	1	0	3.5

ELECTRONICS

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PPH437	MICROELECTRONICS	3	1	0	3.5
2	PPH438	MICROWAVE THEORY AND TECHNIQUES	3	1	0	3.5

MATERIALS TECHNOLOGY

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PPH439	ELECTRONIC AND OPTOELECTRONIC MATERIALS	3	1	0	3.5
2	PPH440	MATERIALS PROCESSING	3	1	0	3.5

ELECTIVE-III

NUCLEAR SCIENCE AND TECHNOLOGY

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PPH445	PLASMA PHYSICS AND FUSION REACTOR	3	1	0	3.5
2	PPH446	NUCLEAR MEDICINE	3	1	0	3.5

ELECTRONICS

SR. NO.	COURSE NO.	TITLE	L	T	P	CR
1	PPH447	NANOELECTRONICS	3	1	0	3.5
2	PPH448	OPTICAL FIBRE COMMUNICATION	3	1	0	3.5

TOTAL NUMBER OF CREDITS: 82.0

Program Outcomes: Students will have understanding of

1. Fundamentals and advancements in nuclear physics and their applications in the area of nuclear reactors, accelerators, and medicine.
2. Fundamentals and advancements in electronics, microprocessors, and their applications in electronic devices and microwave and optical fiber communications.
3. Fundamentals and electromagnetic properties of materials, their characterization techniques, as well as advancements in the area of nanomaterials.

PPH101: CLASSICAL MECHANICS

L	T	P	Cr
3	1	0	3.5

Course Objectives: To apprise the students of Lagrangian and Hamiltonian formulations and their applications.

Newtonian Mechanics: One and many particle system; conservation of linear and angular momentum, work energy theorem,

System of Particles: Constraints, D'Alembert principle, Principle of virtual work, Degree of freedom, generalized coordinates and momenta, Lagrange's equation and application of linear harmonic oscillator, Simple pendulum and central force problems, Cyclic coordinate, Symmetries and conservation laws, Hamiltonian, Lagrange's equation from Hamilton's Principle, Principle of least action derivation of equation of motion; variation and end points.

Central Force: Reduction of two body problem into single body problem. Definition and characteristics of central force; Closure and stability of circular orbits. General analysis of orbits: bounded and unbounded orbits, Kepler's law of motion, Scattering in centre of mass and laboratory frame of reference, Rutherford scattering.

Rigid Body Dynamics: Euclerian angle, Inertia tensor, principal moment of inertia. Euler's equation of motion of a rigid body, Force free motion of a symmetrical top.

Canonical Transformation: Canonical transformation, Legendre Transformation, Generating functions. Conditions for a transformation to be canonical, Hamilton-Jacobi equation, Hamilton's principle and characteristics functions, Action and action angle variables

Wave Motion: Small oscillations, Normal modes and normal coordinates. Examples: Two coupled pendulums and Vibration of linear tri-atomic molecule, Dispersion relation.

Course Learning Outcomes (CLO):

Students will have understanding of

1. necessity of Lagrangian and Hamiltonian formulations.
2. essential features of a problem (like motion under central force, rigid body dynamics, periodic motions), use them to set up and solve the appropriate mathematical equations, and make quick and easy checks on the answer to catch simple mistakes.
3. theory of small oscillations which is important in several areas of physics e.g., molecular spectra, acoustics, vibrations of atoms in solids, coupled mechanical oscillators and electrical circuits.

Recommended Books:

1. *Rana, N.C. and Joag, P.S., Classical Mechanics, Tata McGraw-Hill, (1991).*
2. *Goldstein, H., Classical Mechanics, Pearson Education, (2007).*

PPH102: STATISTICAL MECHANICS

L	T	P	Cr
3	1	0	3.5

Course Objectives: The objective of this course is to learn the properties of macroscopic systems using the knowledge of the properties of individual particles.

The Statistical Basis of Thermodynamics: The macroscopic and microscopic states, contact between statistics and thermodynamics, classical ideal gas, Gibbs paradox and its solution.

Ensemble Theory: Phase space and Liouville's Theorem, the microcanonical ensemble theory and its application to ideal gas of monatomic particles, Partition function, Classical ideal gas in canonical ensemble theory, Energy fluctuations, Equipartition and virial theorems, A system of harmonic oscillators as canonical ensemble, Thermodynamics of magnetic systems and negative temperatures, The grand canonical ensemble and significance of statistical quantities. Classical ideal gas in grand canonical ensemble theory. Density and energy fluctuations.

Ideal Bose Systems: Basic concepts and thermodynamic behavior of an ideal Bose gas, Bose-Einstein condensation, Discussion of gas of photons (the radiation fields) and phonons (The Debye field), Liquid helium and super fluidity.

Ideal Fermi Systems: Thermodynamic behavior of an ideal Fermi gas, Discussion of heat capacity of a free-electron gas at low temperatures, Pauli paramagnetism

Course Learning Outcomes (CLO):
Students will have understanding of:

1. connection between statistics and thermodynamics.
2. different ensemble theories to explain the behaviour of the systems.
3. difference between classical statistics and quantum statistics.
4. Statistical behaviour of ideal Bose and Fermi systems.

Recommended Books:

1. *Pathria, R.K., Statistical Mechanics, Butterworth-Heinemann (1996).*
2. *Reif, F., Fundamentals of Statistical and Thermal Physics, Waveland (2008).*

PPH103: QUANTUM MECHANICS

L	T	P	Cr
3	1	0	3.5

Course Objectives: To give exposure about the various tools employed to analyze the quantum mechanical problems.

Introduction to Quantum Mechanics: Experimental background and inadequacy of classical Physics, Complimentary principle**.**

Schrödinger Wave Equation: Development of wave equation, Schrödinger's time dependent and independent wave equation, Interpretation and normalization of wave function, Probability current density, Expectation value and Ehrenfest theorem. Wave packet.

Solution of Schrödinger Equation: Constant potential in one dimension: Potential Step, Rectangular Potential Barrier and tunneling, Linear Harmonic Oscillator, Rigid Rotator and Hydrogen atom.

Angular Momentum in Quantum Mechanics: General solution to the Eigen value problem of angular momentum J and the angular momentum matrices, Eigenvectors for spin ½ particles, Addition of two angular momenta, Clebsch-Gordan coefficient, System of identical particles, Indistinguishability principle, Symmetry of wave functions, Spin statistics.

Perturbation Theory: Time independent perturbation theory: (1) Non degenerate case: First order perturbation, Second order perturbation, Perturbation of an oscillator. (2) Degenerate case: Removal of degeneracy in second order, Zeeman effect without electron spin, First order Stark effect in Hydrogen.
Time dependent perturbation theory: The equation of motion in interaction picture, Transition probability and Fermi-Golden Rule, Selection Rules.

WKB Approximation: Method, the connection Formula, Tunneling through a barrier**.**

Introduction to Theory of Scattering: Total and Differential Scattering cross section, Partial wave and Phase shift, Optical Theorem, Born approximation and scattering by one dimensional Potential barrier, and Coulomb Field.

Course Learning Outcomes (CLO):
Students will have understanding of:
1. importance of quantum mechanics compared to classical mechanics at microscopic level.
2. various tools to calculate Eigen values and total angular momentum of particles.
3. application of approximation methods and scattering theories.

Recommended Books:

1. *Schiff, L.I., Quantum Mechanics, McGraw Hill (2008).*
2. *Ghatak, A. and Loknathan, S., Quantum Mechanics, MacMillan (2004).*
3. *Thankapan, V.K., Quantum Mechanics, New Age International (2004).*
4. *Sakurai, J.J., Advanced Quantum Mechanics, Pearson Education (2007).*

PPH104: MATHEMATICAL PHYSICS

L	T	P	Cr
3	1	0	3.5

Course Objectives: To impart knowledge about various mathematical tools employed to study physics problems.

Complex Variables: Introduction, Cauchy-Riemann conditions, Cauchy's Integral formula, Laurent expansion, Singularities, Calculus of residues.

Differential Equations: Ordinary Differential Equations, First order homogeneous and non-homogeneous equation with variable coefficients, Second order homogeneous and non-homogeneous equation with constant coefficients, Second order homogeneous and non-homogeneous equation with variable coefficients, Partial differential equations of theoretical physics, Separation of variables, Series solutions.

Special Function: Bessel functions of first and second kind, generating function, orthogonality; Legendre functions: generating function, Recurrence relations and special properties, Orthogonality; Hermite functions, Laguerre functions.

Fourier Series and Fourier Transforms: Fourier series, Dirichlet conditions, applications, Gibbs phenomenon, Fourier transforms, Development of the Fourier integral, Fourier transforms of derivatives.

Tensors: Scalar, Vector and tensor quantities, Contravariant and covariant tensors, Addition, multiplication and contraction of tensors, Application of tensors in coordinate transformations.

Group Theory: Concept of group, Character tables of discrete groups, Lie groups, generators, U (1), SU (2), SU (3).

Course Learning Outcomes (CLO):
Students will have understanding of
1. various techniques to solve differential equations
2. how to use special functions in various physics problems?

Recommended Books:

1. *Arfken G. and Weber H.J., Mathematical Methods for Physicists, Academic Press (2005).*
2. *Rajput B. S., Mathematical Physics, Pragati Prakashan (2002).*
3. *Boas M.L. Mathematical Methods in the Physical Sciences, John Wiley & Sons, New York (1983).*
4. *Harper C. Analytical Mathematics in Physics, Prentice Hall (1999).*

.

PMC104: FUNDAMENTALS OF COMPUTER SCIENCE AND C-PROGRAMMING

L	T	P	Cr
3	0	4	5

Course Objectives: To impart the basic knowledge of computers and C-programming.

Computer's General Concepts: Definition, Historical overview, Technological advancement in computers, Shape of today's computer, Computer as a system.

Hardware and Software: CPU, Primary memory, Secondary storage devices, input devices, Output devices, Significance of software in computer system, Categories of software – system software, Application software, Compiler, Interpreter, Utility program, Binary arithmetic for integer and fractional numbers, Operating system and its significance.

C Programming: Introduction to algorithm, Flow charts, Problem solving methods, Need of programming languages. C character set, Identifiers and keywords, Data types, Declarations, Statement and symbolic constants, Input-output statements, Preprocessor commands, Operators, expressions and library functions, Control statements: Conditional, Unconditional, Bi-directional, Multi-directional and loop control structures, Functions, Arrays, Strings, Introduction to Pointers, Structure and union, Files.

Laboratory Work:
Laboratory experiments will be set in consonance with the materials covered in theory.

Course Learning Outcomes (CLO):
Students will have understanding of
1. Basics of computer and its components.
2. C Programming.

Recommended Books:

1. *Norton, Peter, Introduction to Computers, Tata McGraw Hill, (2008).*
2. *Kerninghan, B.W. and Ritchie, D.M., The C programming language, ANSI C Version, (2008).*
3. *Kanetka, R Yashawant, Let us C, BPB, (2007).*
4. *Rajaraman, V., Fundamentals of Computers, Prentice-Hall of India, (2004).*

PHU002: PROFESSIONAL COMMUNICATION

L	T	P	Cr
3	1	0	3.5

Course Objective: To provide the students with essential skills required for effective communication, and to apprise them of business communication and its role in corporate environment.

Essentials of Communication: Meaning, Definition, process, feedback, emergence of communication as a key concept in the corporate and global world, impact of technological advancements on communication.

Channels of Communication: Formal and Informal: Vertical, horizontal, diagonal, and grapevine.

Methods and Modes of Communication: Verbal and nonverbal, Verbal Communication: Characteristics of verbal communication, Non-verbal Communication: Characteristics of non-verbal communication, kinesics, proxemics and chronemics.

Barriers to Communication: Physical, semantic, language, socio-cultural, psychological barriers, Ways to overcome these barriers.

Listening: Importance of listening skills, cultivating good listening skills.

Written Communication: Business letters, memos, minutes of meeting, notices, e-mails, agendas and circulars.

Technical Report Writing: Types of Reports, contents of reports. Formatting, writing styles and documentation.

Presentations: Principles of effective presentation, power-point presentation, video and satellite conferencing.

Interviews and Group Activities: Personal interviews, group discussion and panel discussion

Creative Writing: Paragraph and Essay writing, Book reviews, Movie Reviews, Editorials and articles.

Paper Writing: Styles of paper writing: Short Communication, Review papers and Research papers, Referencing styles: MLA, Chicago Style and APA.

Course Learning Outcomes (CLO):
Students will have understanding of:

1. the use proper writing techniques relevant to the present day technological demands, including anticipating audience reaction,
2. how to write effective and concise letters and memos,
3. how to prepare informal and formal reports,
4. how to proofread and edit copies of business correspondence

5. how to develop interpersonal skills that contribute to effective personal, social and professional relationships

Recommended Books:

1. *Lehman, C.M., DuFrene, D.D.,,and Walker, R, B-BCOM - An Innovative Approach to Learning and Teaching Business Communication. Cengage Learning New Delhi, (2011).*
2. *McMurrey, A.M and Buckley, J., Handbook for Technical Writing, Cengage Learning, New Delhi, (2008).*
3. *Lesikar, R.V and Flately, M.E., Basic Business Communication-Skills for Empowering the Internet Generation, Tata McGraw-Hill Publishing Company Limited. New Delhi, (2005).*

PPH201: CONDENSED MATTER PHYSICS

L	T	P	Cr
3	1	0	3.5

Course Objectives: To study some of the basic properties of the condensed phase of materials especially solids.

Crystal Structure: Fundamental types of lattices-two and three dimensional lattice types, SC, BCC and FCC unit cells, Miller indices, Diffraction of x-rays by crystals, Scattered wave Amplitude-Fourier analysis, Reciprocal lattice vectors, Diffraction conditions, Laue equations, Structure factor and Atomic form factors.

Electrical Conductivity and Free Electron Fermi Gas: Drude theory, DC conductivity, Hall effect and magneto-resistance, AC conductivity, thermal conductivity, Fermi-Dirac distribution, Free electron gas in three dimension, thermal properties of an electron gas, Wiedemann-Franz law.

Lattice Vibrations and Thermal Properties: Vibration of lattice with monoatomic and diatomic basis: Dispersion relation, optical and acoustical branches. Quantization of elastic waves: Phonon, Classical theory of Specific heat. Average energy of harmonic oscillator, Phonon Density of states. Einstein and Debye models of specific heat. Electronic contribution to specific heat. Anharmonic effect: thermal expansion, Phonon collision process, Thermal conductivity.

Concept of Energy Band: Nearly free electron model and origin of energy gap, magnitude of gap, Bloch function, Kronig-Penny model, Classification of metal, insulator and semiconductors. Wave equation of electron in periodic potential, Bloch theorem and crystal momentum.

Dielectrics: Dielectric properties of insulators, Types of polarizations, Local field, Claussius-Mossotti equation, Dielectric constant and loss.

Magnetism: Types of magnetism, Susceptibility, Permeability and their relation. Diamagnetism: Langevin Quantum theory of Diamagnetism. Paramagnetism: Quantum Theory, Paramagnetism of rare earth and iron group ions, Crystal field Splitting and quenching of orbital, Angular momentum. Paramagnetism of conduction electrons**.** Ferromagnetism, Ferrimagnetism and Antiferromagnetism: Curie point and exchange integral, saturation magnetization. Ferromagnetic Domains and their origin.

Superconductivity: Superconductivity, critical temperature, Meissner effect, Destruction of superconductivity by magnetic field, Type I and type II superconductors, Isotope effect, energy gap, London equation, London penetration depth, BCS theory of superconductivity, Coherence length.

Course Learning Outcomes (CLO):
Students will have understanding of:

1. Structures in solids and their determination using XRD.
2. Behavior of electrons in solids including the concept of energy bands and effect of the same on material properties.
3. Electrical, thermal, magnetic and dielectric properties of solids.

Recommended Books:

1. *Kittel, C., Introduction to Solid State Physics, John Willey, (2007).*
2. *Mayers, H.P., Introduction to Solid State Physics, Taylor & Francis, (1997).*
3. *Srivastava, J.P., Elements of Solid State Physics, Prentice Hall of India, (2008).*
4. *Ashcroft, N.W. and Mermin, N.D., Solid State Physics, Cengage Learning, (2008).*
5. *Dekker, A.J., Solid State Physics, Macmillan, (2003).*

PPH203: ATOMIC AND MOLECULAR PHYSICS

L	T	P	Cr
3	1	0	3.5

Course Objectives: Objective of this course is to learn atomic, molecular and spin resonance spectroscopy.

One Electron Atom: Vector model of a one electron atom, Quantum states of an electron in an atom, Hydrogen atom spectrum, Spin-orbit coupling, Relativistic correction, Hydrogen fine structure, Spectroscopic terms, Hyperfine structure.

Two valance Electron Atom: Vector model for two valance electrons atom, LS coupling, Pauli exclusion principle, Interaction energy for LS coupling, Lande interval rule, jj coupling, interaction energy for jj coupling.

Atom in Magnetic Field: Zeeman effect, Magnetic moment of a bound electron, Magnetic interaction energy in weak field. Paschen-Back effect, Magnetic interaction energy in strong field.

Molecular Spectroscopy: Rotational and vibrational spectra of diatomic molecule, Raman Spectra, Electronic spectra, Born-Oppenheimer approximation, Vibrational coarse structure, Franck-Condon principle, Rotational fine structure of electronic-vibration transitions.

Course Learning Outcomes (CLO):
Students will have understanding of:
1. atomic spectroscopy of one and two valance electron atoms.
2. the change in behavior of atoms in external applied electric and magnetic field.
3. rotational, vibrational, electronic and Raman spectra of molecules.
4. electron spin and nuclear magnetic resonance spectroscopy.

Recommended Books:

1. *White, H.E., Introduction to Atomic Spectra, McGraw Hill, (1934).*
2. *Banwell, C.N. and McCash, E.M., Fundamentals of molecular spectroscopy, Tata McGraw Hill, (2007).*

PPH204: ELECTRODYNAMICS

L	T	P	Cr
3	1	0	3.5

Course Objectives: To apprise the students regarding the concepts of electrodynamics and its use in various situations.

Boundary Value Problems: Uniqueness Theorem, Dirichlet or Neumann Boundary conditions, Formal solution of Electrostatic &Magnetostatic Boundary value problems.

Time Varying Fields and Maxwell Equations: Faraday's Law of induction, Displacement current, Maxwell equations, scalar and vector potentials, Gauge transformation, Lorentz and Coulomb gauges, Hertz potential, Conservation of energy, Complex Poynting's Theorem.

Electromagnetic Waves: Wave equation, Plane waves in free space and isotropic dielectrics, Polarization, Energy transmitted by a plane wave, waves in conducting media, Skin depth. Reflection and Refraction of electromagnetic waves at plane interface, Fresnel's amplitude relations. Reflection and transmission coefficients, Polarization by reflection. Brewster's angle, Total internal reflection, EM wave guides, TE, TM and TEM waves, Rectangular wave guides. Energy flow and attenuation in wave guides, Cavity resonators.

Radiation from Localized Time Varying Sources: Solution of the inhomogeneous wave equation in the absence of boundaries. Fields and Radiation of a localized oscillating source, Electric dipole and electric quadrupole fields, Centre fed linear antenna.

Charged Particle Dynamics: Non-relativistic motion in uniform constant fields and in a slowly varying magnetic field. Adiabatic invariance of flux through an orbit, Relativistic motion of a charged particle.

Course Learning Outcomes (CLO):
Students will have understanding of:
1. time-varying fields and Maxwell equations.
2. various concepts of electromagnetic waves.
3. radiation from localized time varying sources, and the charged particle dynamics.

Recommended Books:

1. *Jordan, E.C. and Balmain, K.G., Electromagnetic Wave and radiating systems, Prentice Hall of India, (2007).*
2. *Griffiths, D.J., Introduction to Electrodynamics, Dorling Kingsley, (1998).*
3. *Jackson, J.D., Classical Electrodynamics, Wiley Eastern, (1999).*
4. *Puri, S.P., Classical Electrodynamics, Tata McGraw Hill, (1999).*

PPH205: ELECTRONICS

L	T	P	Cr
3	**1**	**0**	**3.5**

Course Objectives: To introduce students to entire circuit designs, and to provide in-depth theoretical base of Digital Electronics.

Linear Wave Shaping: High Pass RC circuits: Its response to step, Pulse, Square wave, Ramp, exponential waveforms, Its application as a Differentiator. Low pass RC Circuit: Its response to step, pulse, Square wave, Ramp, Exponential wave forms, Its application as an integrator.

Clipping and Switching Circuits: Non Linear Wave Shapers, Diode Clippers, Positive and Negative Clippers, Combinational and Biased clippers, Transistor Clipper.

Clamping and Switching Circuits: Operation of Clamping Circuits, Clamping Circuit theorem, Practical Clamping Circuit theorem, Operation of Transistor as a switch.

Logic Systems: Basic Concepts of dc positive and negative logic systems, Dynamic logic systems, OR gate and AND gate, NOT gate, NAND gate, EX-OR gate, NOR gate & their applications, Response to input pulse operation. TTL (transistor transistor logic) and DTL (diode transistor logic)

Multivibrators: Solid state switching circuits, A bistablemultivibrator-basic concept of its operation. Symmetrical and Unsymmetrical triggering, Application (brief). MonostableMultivibrator, Basic concepts of its operation, quantitative discussion of Quasi stable state, Application, Astablemultivibrator - basic concepts of operation.

Analog Systems: Operational Amplifier, Differential Amplifier, Transfer Characteristics, Frequency Characteristics, IC Operational Amplifier, Compensation in Operational Amplifiers, Application of OP-AMP as adder, Multiplier, Differentiator, Integrator, Log and Antilog Amplifier, Application of

Course Learning Outcomes (CLO):

Students will have understanding of:

1. fundamental designing concepts of different types of Logic Gates, Minimization techniques etc.
2. designing of different types of the Digital circuits, and to give the computational details for Digital Circuits.
3. characteristics of devices like PNP, and NPN junction diode and truth tables of different logic gates.
4. basic elements and to measure their values with multimeter and their characteristic study.

Recommended Books:

1. *Millman, J. and Taub, H., Pulse Digital and Switching Wave forms, Tata McGraw Hill, (1991).*
2. *Boylestad, R.L. and Nashelsky, L., Electronic Devices and Circuit Theory, Prentice Hall of India, (2007).*
3. *Bell, D.A., Electronics Devices and Circuits, Oxford University, (2008).*

PPH207: CONDENSED MATTER PHYSICS LAB

L	T	P	Cr
0	0	3	1.5

Course Learning Objective(s):

To experimentally realize the structural, optical, magnetic and electric behavior of condensed matters.

1. Determination of lattice constant and crystal structure of given powder sample using X-ray diffraction method.
2. Dynamics of mono and diatomic lattices.
3. Studies on the Electric Spin Resonance spectrum of the given DPPH sample and determination of Lande*g* factor.
4. Investigation of Hall Voltage as a function of current and magnetic field and determination of Hall Coefficient and carrier concentration of the given sample of semiconductor.
5. Study of magneto resistance behavior of semiconductor/manganites.
6. Investigation of Four probe and two probe resistance measurement and determination of contact resistance.
7. Investigation of B-H curve: (i) to determine the value of permeability and coercivity of ferrite sample. (ii) to distinguish between soft and hard ferrites.
8. Investigation of ferroelectric behavior of $BaTiO_3$.
9. To determine the Curie temperature of given ferrite sample.
10. To determine the dielectric constant of PCB laminate.
11. To determine the Young's modulus of brass using ultrasonic interferometer.
12. Studies on the thermoluminescence of KCl/KBr single crystal sample and determination of activation energy and color centers.

Course Learning Outcomes (CLO):

Students will have understanding of:

1. How to determine the crystal structure, lattice parameter and crystallite size?
2. Measurement and analysis of various types of transport.
3. Optical characterization of solid.
4. Magnetic and dielectric behavior of solids.

PPH312: ADVANCED QUANTUM MECHANICS

L	T	P	Cr
3	1	0	3.5

Course Objectives: To impart knowledge of advanced quantum mechanics for solving relevant physical problems.

Relativistic Quantum Mechanics: Klein-Gordon equation, Dirac equation and its plane wave solutions, solution of Klein Gordan equation for a particle with Coulomb potential, significance of negative energy solutions, spin angular momentum of the Dirac particle. The non-relativistic limit of Dirac equation, Dirac equation for a particle in a central field, fine structure of hydrogen atom, Lamb shift.

Field Quantization: Classical field theory, Lagrangian and Hamiltonian formalism of a particle in an electromagnetic field, Second quantization, Concepts and illustrations with Schrödinger field.

Relativistic Quantum Field Theory: Quantization of a real scalar field and its application to one meson exchange potential. Quantization of a complex scalar field, Dirac field and e.m. field, Commutation relations.

Interaction: Yukawa interaction, Coupling of electron and electromagnetic field, Global and guage invariance Feynman diagrams, Feynman rules, Feynman graphs for Compton and e-e scattering, Path integration method: Wick's Theorem. Scattering matrix.

Course Learning Outcomes (CLO):
Students will have understanding of:
1. Importance of relativistic quantum mechanics compared to non-relativistic quantum mechanics.
2. Various tools to understand field quantization and related concepts.
3. Exposure to quantum field theory and universal interactions.

Recommended Books:

1. *Mathews, P.M. and Venkatesan K.A., Textbook of Quantum Mechanics, Tata McGraw Hill (2004).*
2. *Thankappan, V.K., Quantum Mechanics, New Age International (2004).*
3. *Sakurai, J.J., Advanced Quantum Mechanics, Pearson Education (2007).*
4. *Bethe, H.A. and Jackiew, R., Intermediate Quantum Mechanics, Perseus Book Group (1997).*

PPH301: PARTICLE PHYSICS

L	T	P	Cr
3	1	0	3.5

Course Objectives: To impart the knowledge of fundamental particles, fundamental interaction and the range and strength of these interactions with the concept of particle antiparticle or matter antimatter.

Introduction: Fermions and bosons, Particles and antiparticles, Quarks and leptons, Yukawa picture, Types of fundamental interactions - electromagnetic, weak, strong and gravitational, HEP Units, Bound states of quarks, Hadron, Mesons and Baryons.

Invariance Principles and Conservation Laws: Interactions and fields in particle physics, Classical and quantum pictures Invariance in classical mechanics and in quantum mechanics types of symmetries and their breaking, Parity, Pion parity, Charge conjugation, Time reversal invariance, CP violation, CPT theorem.

Hadron-Hadron Interactions: Cross section and decay rates, Pion spin, Isospin, Two-nucleon system, Pion-nucleon system, Strangeness and Isospin, and Hypercharge.

Static Quark model of Hadrons: The Eightfold way, Meson nonet, Baryon octet, Baryon Decuplet, hypothesis of quarks, SU (3) symmetry, Quark spin and color, Quark-antiquark combinations.

Weak Interactions: Classification of weak interactions, Fermi theory, Parity non-conservation in β-decay, Helicity of neutrino, Experimental verification of parity violation..

Course Learning Outcomes (CLO):

Students will have understanding of:

1. Need of standard model and its limitations and the properties of QCD.
2. Basic rules of Feynman diagrams and the quark model for hadrons
3. Properties of neutrons and protons in terms of a simple quark model.
4. Weak interaction between quarks and how that this is responsible for β decay.
5. Leptons and how the (electron) neutrinos and (electron) antineutrinos are produced during β+ and β- decays respectively.

Recommended Books:

1. *Perkins, D.H., Introduction to High Energy Physics, Cambridge University Press, (2000).*
2. *Hughes, I.S., Elementary Particles, Cambridge University Press, (1991).*
3. *Close, F.E., Introduction to Quarks and Partons, Academic Press, (1979).*
4. *Segre, E., Nuclei and Particles, Benjamin-Cummings, (1977).*
5. *Khanna, M.P., Introduction to Particle Physics, Prentice-Hall of India, (2004).*

PPH302: NUCLEAR PHYSICS

L	T	P	Cr
3	1	0	3.5

Course Objectives: To impart knowledge about basic nuclear physics properties and nuclear models for understanding of related reaction dynamics.

Nuclear Size and Shape: Scattering and electromagnetic methods for determining the nuclear radius, Wave mechanical properties of nucleus and statistics, Nuclear angular momentum and Parity, Electric and magnetic moments, nuclear shapes, Nuclear excited states.

Nuclear Forces: Types of nuclear potentials, Ground and excited states of deuteron, Exchange forces and mass formula, n-p scattering at low energies, Partial wave analysis, Scattering length, Spin dependence of n-p scattering, effective range theory in n-p scattering, p-p scattering at low energy, Meson theory of nuclear forces.

Nuclear Models: Liquid drop model, coupling of angular momenta, Extreme single particle model and analysis of its predictions, Spin-orbit coupling, Magnetic moment, Electric quadrupole moment, Collective picture, Single particle states in deformed Nucleus.

Nuclear decays & Nuclear Reactions: Type of reactions, reaction cross section, conservation laws, Q-values and its significance, Coulomb excitation, compound nucleus, energy of excitation, Breit-Wigner formula, Nuclear Resonance phenomena, Direct reactions

Course Learning Outcomes (CLO):
Students will have understanding of:

1. basic properties of nucleus and nuclear models to study the nuclear structure properties.
2. various aspects of nuclear reactions will give idea how nuclear power can be generated.

Recommended Books:

1. *Roy, R.R. and Nigam, B.P., Nuclear Physics, New Age International Ltd., (2001).*
2. *Tayal, D. C., Nuclear Physics, Himalaya Publication home, (2007).*
3. *Kaplan Irving, Nuclear Physics, Narosa Publishing House, (2000).*
4. *Krane, K.S. Nuclear Physics, Wiley India Pvt. Ltd., (2008).*

PPH303: SEMICONDUCTOR PHYSICS

L	T	P	Cr
3	1	0	3.5

Course Objectives: To give knowledge about Semiconductor physics and discus working and applications of basic devices, including p-n junctions, BJTs and FETs.

Semiconductors: Energy Band and Charge Carriers: Energy bands in semiconductors, Types of semiconductors, Charge carriers, Intrinsic and extrinsic materials. Carrier concentration: Fermi Level, Electron and hole concentration equilibrium, Temperature dependence of carrier concentration, Compensation and charge neutrality. Conductivity and mobility, Effect of temperature, Doping and high electric field.

Optical Excitation in Semiconductor: Optical absorption, carrier generation, Carrier life time, diffusion length and photo conductivity, Direct and indirect recombination and trapping, Photoconductive devices. Diffusion of carriers, Einstein relation, Continuity equation, Carrier injection, Diffusion length. Haynes-Shockley experiment.

Junctions: p-n junction and contact potential, Fermi levels, Space charge, Reverse and Forward bias, Zener and Avalanche breakdown. Capacitance of p-n junction, Schottky barriers; Schottky barrier height, C-V characteristics, current flow across Schottky barrier: thermionic emission, Rectifying contact and Ohmic contact.

Field Effect Transistors: JEFT amplifying and switching, Pinch off and saturation, Gate control, I-V characteristics. MOSFET, Operation, MOS capacitor, Debye screening length, Effect of real surfaces; Work function difference, Interface charge, Threshold voltage and its control, MOS C-V analysis and time dependent capacitance. Output and transfer characteristics of MOSFET.

Bipolar Junction Transistors (BJT): Fundamentals of BJT operation. Minority carrier distribution, Solution of diffusion equation in base region, Terminal current, Current transfer ratio, Ebers-Moll equations, Charge control analysis. BJT switching: Cut off, Saturation, Switching cycle.

Photonics: LED: Radiative transition, Emission spectra, Luminous efficiency and LED materials, Solar cell and photodetectors: Ideal conversion efficiency, Fill factor, Equivalent circuit, V_{oc}, I_{sc} and Load resistance, Spectral response. Reverse saturation current in photodetector.

Course Learning Outcomes (CLO):

Students will have understanding of:

1. basic properties of semiconductors including the band gap, charge carrier concentration, doping and charge carrier injection/excitation.
2. properties of the semiconductors to understand the working and applications of various semiconducting devices including photo conductors, p-n junctions, BJTs and FETs.

Recommended Books:

1. *Streetman, B. and Banerjee, S., Solid State Electronics, Prentice Hall India, (2006).*
2. *Sze, S.M., Physics of Semiconductor Devices***,** *John Wiley, (1981).*
3. *Tyagi, M.S., Introduction to semiconductor materials and devices, John Wiley, (2000).*
4. *Mishra, Umesh K. and Singh, Jaspreet, Semiconductor Device Physics and Design, Springer, (2008).*
5. *Pierret, R.F., Semiconductor Device Fundamentals, Pearson Education Inc., (2006).*

PPH305: COMPUTATIONAL METHODS IN PHYSICS

L	T	P	Cr
3	1	3	5.0

Course Objectives: To give exposure about various computational techniques to solve physics using advance computer programming languages.

Fortran 90 Programming: Operating systems, Flow charts, Integer and Floating point arithmetic, built-in functions, Executable and non-executable statements, Assignment, Control and input/output commands, Subroutines and functions, Operation with files, Debugging and testing.

Numerical Algebraic and Transcendental Equations: Methods for determination of zeroes of linear and nonlinear algebraic and transcendental equations, Convergence of solutions, Solution of simultaneous linear equations.

Interpolation and Approximation: Introduction to interpolation, Lagrange approximation, Newton polynomials, Curve fitting by least squares, Polynomial least squares and cubic splines fitting.

Numerical Differentiation and Integration: Numerical differentiation, Quadrature, Simpson's rule, Gauss's quadrature formula, Newton – Cotes formula.

Random Variables and Monte Carlo Methods: Random numbers, Pseudo-random numbers, Monte Carlo integration: Moment of inertia, Monte Carlo Simulations: Buffen's needle experiment, Importance of sampling.

Differential Equations: Euler's method, RungeKutta methods, Finite difference method, Finite difference equations for partial differential equations and their solution.

Laboratory Assignments:

1. To find mean, standard deviation and frequency distribution of an actual data set from any physics experiment.
2. To determine Wien's constant using bisection method and false position method.
3. To solve Kepler's equation by Newton-Raphson method.
4. To solve van der Waals gas equation for volume of a real gas by the method of successive approximation.
5. To interpolate a real data set from an experiment using the Lagrange's method, and Newton's method of forward differences and cubic splines.
6. To fit the Einstein's photoelectric equation to a realistic data set and hence calculate Planck's constant.
7. To find the area of a unit circle by Monte Carlo integration.
8. To simulate the random walk.
9. To study the motion of an artificial satellite by solving Newton's equation for its orbit using Euler method.

10. To study the growth and decay of current in RL circuit containing (a) DC source and (b) AC using RungeKutta method, and to draw graphs between current and time in each case.

Course Learning Outcomes (CLO):
Students will have understanding of:

1. various computational methods like Euler, Newton-Raphson and RangaKutta useful to solve research problems.
2. various simulation techniques which can be used in future by students to analyse the data.

Recommended Books:

1. *Mathews, J.H., Numerical Methods for Mathematics, Science and Engineering, Prentice-Hall, (2000).*
2. *Rajaraman, V., Computer programming in Fortran 90 and 95, Prentice-Hall of India, (2008).*
3. *Salaria, R.S., Programming in Fortran, Khanna Publishing, (2008).*

PPH306: NUCLEAR PHYSICS LAB

L	T	P	Cr
0	0	3	1.5

Course Objectives: Aim of Nuclear Physics Lab is to train the students for advanced techniques in nuclear physics so that they can investigate various relevant aspects and be confident to handle sophisticated instruments of nuclear physics.

List of Experiments:

1. Dead time of a Geiger Muller (GM) Counter (Two source method)
2. Dead time of a Geiger Muller (GM) Counter (Absorber method)
3. To determine the operating voltage of a PMT and to find the photopeak efficiency of a NaI (Tl) crystal of given dimension for ϒ rays of different energies.
4. To calibrate a ϒ ray spectrometer and to determine the energy of a given gamma ray source
5. Pulse height ϒ ray spectrum of withmulti channel analyser.
6. Energy resolution of a NaI(Tl) detector.
7. To verify the inverse square law with ^{137}Cs source.
8. To study the Compton scattering using ϒ rays of suitable energy.
9. To study the time resolution of a coincidence setup.
10. To determine ϒ ray attenuation coefficient for different metals.
11. To study the relationship between thickness of absorber and backscattering using GM counter.
12. To study the shielding effect of radiation penetrability.
13. To study anisotropy of ϒ ray cascade emission in ^{60}Co source.
14. To determine the half-life of a radioactive sample.

Course Learning Outcomes (CLO):

Students will have understanding of:

1. how to operate a GM counter?
2. how to find the absorption coefficient of different materials?
3. how to handle nuclear materials and nuclear safely management

PPH307: SEMICONDUCTOR PHYSICS LAB

L	T	P	Cr
0	0	3	1.5

Course Objectives: To study/perform some experiments in Semiconductor physics.

1. To determine the resistivity and the band-gap of the given semiconductor sample using four probe technique.
2. Determine the Hall coefficient for given semiconductor and determine the dopant density and mobility for majority charge carriers.
3. Determine the band-gap of the given p-n junction using reverse saturation current.
4. Study the forward and reverse characteristics of given p-n junctions (atleast 2) and determine materials constants, bandgap, variation of junction capacitance and the nature of the junction (abrupt/linearly graded).
5. Study the characteristics of a Zener diode, LDR and VDR.
6. Static characteristics and 90^0 phase control of a Silicon Controlled Rectifier (SCR)
7. To study the input and the output characteristics of the given bipolar junction transistor (CE, CB and CC).
8. To study the switching characteristics of a transistor (NPN & PNP).
9. Study the static drain and transfer characteristics (dynamic resitance of drain, mutual conductance and amplification factor) of a JFET at a given operating point.
10. To study MOSFET as output power amplifier and plot the static drain characteristics.
11. Study the spectral output of the given lamp and use it to determine the intensity and spectral response of the given solar cell.
12. Study the I-V characteristics of the given solarcell.
13. Study the characteristics of the given photodiode and phototransistor.

Course Learning Outcomes (CLO):
Students will have understanding of
1. basic concepts of semiconductors
2. behavior of p-n junctions
3. behavior FETs and BJTs
4. working of phototransistors, photodiodes and solar cells
5. theoretical concepts learned in the class with hands on experiments
6. how to analyze and interpret experimental data using graphs

PPH315: ACCELERATOR TECHNOLOGY

L	T	P	Cr
3	1	3	5.0

Course Objectives: Aim is to expose students to different theoretical design and usage of various particle accelerators.

Charged Particle Dynamics: Particle motion in electric and magnetic fields, Beam transport system, Beam pulsing and bunching techniques, microbeams, Particle and ion sources, secondary beams, Measurement of beam parameters.

Radiofrequency Accelerators: Linear accelerators - Resonance acceleration and phase stability, electron and proton Linacs. Circular accelerators- Cyclotron, Frequency Modulated Synchrocyclotron, AVF Cyclotron, Alternating-gradient accelerators.

Electrostatic and Heavy Ion Accelerators: Van de Graff voltage generator, Cockcroft-Walton voltage generator, insulating column, voltage measurement, Acceleration of heavy ions, Tandem electrostatic accelerator, Production of heavy negative ions, Pelletron and Tandetron, Cluster beams, Superconducting Heavy Ion Linear Accelerators.

Synchrotron Radiation Sources: Electromagnetic radiation from relativistic electronbeams, Electron synchrotron, dipole magnet, multipole wiggler, noncoherent and coherent, Undulator, Characteristics of synchrotron radiation.

Radioactive ion Beams: Production of Radioactive ion beams, Polarized beams, Protonsynchrotron, Colliding accelerators.

Case Studies: Use of accelerators for AMS and Ion-beam Analysis Techniques, Relativistic heavy ion accelerator, Large hadron collider, Stanford linear accelerator, J-Parc, Fair facilities.

Laboratory Assignments: Visits to various accelerator sites and related case studies

Course Learning Outcomes (CLO):
Students will have understanding of:

1. various theoretical techniques to accelerate particles
2. technical details of accelerator technology
3. the latest accelerator available around the world

Recommended Books:

1. *Wiedman, H.J., Particle Accelerator Physics, Vol I and II, Springer Verlag, (1998).*
2. *Livingston, M.S., and Blewel, J.P., Particle Accelerators, McGraw-Hill Book Press, (1962).*
3. *Cerny, J., Nuclear Spectroscopy and Reactions Part-A, Academic Press, (1974).*
4. *Lee, S.Y., Accelerator Physics, World Scientific, Singapore, (2004).*

.

PPH324: NUCLEAR REACTOR PHYSICS

L	T	P	Cr
3	1	3	5.0

Course Objectives: To impart primary but wide theoretical knowledge about nuclear reactor and related topics.

Review of Physics of Nucleus: Characteristics of atomic nucleus, Binding energy, Nuclear fission.

Nuclear Reaction: Neutron sources, Types of Nuclear Reaction, Macroscopic & Microscopic Cross-section, Interaction of neutrons with nuclei, Absorption & Scattering Cross-sections.

Neutron Moderation: Inelastic scattering, Elastic collisions, moderating ratio, Slowing down Density, Resonance escape, Moderatos.

Fission Process and Diffusion Theory: Prompt neutrons, Fast fission, Fission energy, Thermal utilization, Fission products, Chain reaction, Multiplication factor, Leakage of neutrons, Critical size, Diffusion and slowing down theory, Homogenous and heterogeneous reactors.

Materials for Nuclear Reactors: Fuel materials, Moderator and Reflectors, Cladding materials, Coolants and control Rods.

Type of Power Reactors: Boiling water reactors, Pressurized water reactors, Pressurized heavy water reactors, Light water cooled graphite moderated reactors, Gas cooled reactors, Advanced gas cooled reactors, High temperature gas cooled reactors and liquid metal cooled reactors and Fast breeder reactors.

Fuel and Waste Management: Fuel management schemes, Fuel composition, Fuel cycle cost and waste management.

Laboratory Assignments: Visits to fission reactor sites and related case studies for generation of nuclear energy.

Course Learning Outcomes (CLO):
Students will have understanding of:
1. detailed primary aspects of nuclear reactors.
2. the related safety aspects.
3. how to manage the nuclear fuel and waste?

Recommended Books:

1. *Glasstons, Sammuel and Sesonske, Alexander, Nuclear reactor Engineer, CBS Publishers & Distributors, (1986).*
2. *Lamarshs, J.R., Introduction to Nuclear Reactor Theory, Addison-Wesley Publishing Co., (1966).*

PPH3025: DIGITAL ELECTRONICS AND MICROPROCESSORS

L	T	P	Cr
3	1	3	5.0

Course Objectives: To provide theoretical knowledge and develop practical skill in digital systems, logic systems and Microprocessor. electronic systems and microprocessor

Digital Systems: Standard gate assemblies. Binary Address, Parallel and Serial operations, Half Adder, Full Adder, J-K Flip-flop, Shift Register, Up and Down Counters, Synchronous and Asynchronous counters, Bipolar and MOS digital systems and their comparison, Decoder, Multiplexer, Encoder, Read Only Memory, Random Access Memory, Applications of ROM and RAM, Digital Display, Seven segment display, Sequence generator. Memory Storage cell (both Bipolar and MOS RAM), Read, Write and Address operations (both Bipolar and MOS RAM), Digital to Analog Converters, Weighted resistor and 2R Ladder type, Analog to digital Converters.

Microprocessors: An Introduction to Microprocessor, Microcomputers and assembly language. Bus interfacing, Bus organized computers, SAP-1, SAP-2 and SAP-3, Machine language, ASCII code. 8085 Microprocessor architecture, Microprocessor initiated operations. Internal data operations, 8085 registers, Externally initiated operations, Memory mapping and memory classification. Simple microcomputer system, Microprocessor communication and bus timings.8085 machine cycles. Memory interfacing with 8085.Interfacing I/O devices, Introduction to 8085 assembly language programming. 8085 instructions. General purpose programmable Peripheral devices. Microprocessor Applications, Recent trends in Microprocessor Technology. Introduction to 8086 microprocessors and 8051 microcontroller.

Laboratory Assignments:

1. To construct logic gates AND, NOT, EX-NOR and EX-OR using NANAD gates and verify their truth tables.
2. To design and construct multiplexer and demultiplexer and verify their truth tables.
3. To study the fundamentals of basic memory units and to become familiar with various types of flip-flops and verifying the Truth tables of Flip- Flops.
4. To study BCD to binary decoder and encoder
5. To study binary to seven segment decoder.
6. To design various flip-flops (R-S, D-, T-, J-K, J_K master slave) using gates and verify their truth tables.
7. To design and construct Half/Full adder and subtractor circuits.
8. To study the working of a 4-bit comparator and adder/subtractor chips.
9. To construct and study various ripple counters using J-K flip-flops.
10. To construct and study various synchronous counters using J-K flip-flops.

11. To construct and study various registers using J-K flip-flops.
12. To study 4-bit and 8-bit DAC for various V_{ref}.
13. To study and understand the working of the given 4-bit ADC.
14. To perform various mathematical, logical and jump operations for 8 bit numbers using 8085 microprocessor
15. To perform various mathematical, logical operations and jump operations for 16 bit numbers using 8085 microprocessor
16. To write a program to arrange an array of data in ascending/descending order using 8085 microprocessor

Course Learning Outcomes (CLO):

Students will have understanding of:

1. logic circuits, digital systems and microprocessor and their peripheral devices.
2. operating and designing digital systems.
3. how to solve problems in design and/ or implementation of digital

Recommended Books:

1. *Tocci R. J., Digital Systems-Principles and Applications, Prentice Hall of India, (2002).*
2. *Gaonkar R. S., Microprocessor Architecture, Programming and Applications, Prentice-Hall (2000).*
3. *Malvino A.P. and Brown A., Digital Computer Electronics, Prentice-Hall, (1999).*
4. *Mathur A.P., Introduction to Microprocessors, McGraw-Hill Publishing Co., (1980).*

PPH316: OPTOELECTRONICS

L	T	P	Cr.
3	1	3	5.0

Course Objectives: The course aims at imparting knowledge about modulation of light, LEDs, Lasers, and Photodetectors important for fiber-optic communication

Introduction: Energy bands in solids, Electrical conductivity, Semiconductors, carrier concentrations, Work function, Excess carrier in semiconductors, Junctions, Heterojunctions, Metal-semiconductor junctions.

Modulation of Light: Birefringence, Optical activity, Electro-optic effect, Materials exhibiting electro-optic effect, Kerr modulators, Magneto-optic devices – Faraday effect; Acousto-optic effect – Raman-Nath and Bragg effects, Nonlinear optics.

Display Devices: Introduction, Luminescence – Photoluminescence, Cathodoluminescence, Electroluminescence; Injection luminescence and light emitting diode – Radiative recombination processes: Interband transitions, Impurity center recombination, Exciton recombination; LED materials, LED construction, Plasma displays, Liquid crystal displays, Numeric displays.

Lasers: introduction, Threshold conditions, Laser losses; Lineshape function, Doppler broadening, Collision broadening, Natural broadening, Population inversion and pumping threshold conditions, Laser modes, Doped insulator lasers, Semiconductor lasers, Mode locking, Q-switching, Laser applications, Holography and its applications.

Photodetectors: Introduction, Thermal detectors – Thermoelectric detectors, Bolometer, Pneumatic devices, Pyroelectric detectors; Photon devices – Photoemissive devices, photodiodes, Photomultipliers, Photon cutting techniques, Image intensifiers, Photoconductive detectors, Junction arrays, Detector performance parameters.

Laboratory Assignments:

1. To determine the numerical aperture of a given multimode fiber
2. To determine the mode field diameter of the fundamental mode in a single-mode fiber
3. To measure the near-field intensity profile of a multimode fiber and hence its refractive index
4. To measure the power loss at a splice between the multimode fibers, and study the variation of splice loss with transverse, longitudinal and angular offsets
5. To study a simple intensity modulated fiber-optic pressure sensor based on microbending loss in a multimode fiber
6. To set up a Mach-Zehnder interferometer with single-mode fiber

PPH326: STRUCTURE AND PROPERTIES OF MATERIALS

L	T	P	Cr
3	1	0	3.5

Course Objective(s): To give comprehensive exposure to the students regarding various engineering materials; crystalline, non- crystalline materials, crystal structure and their defects; the concept of phase and different type of phase diagrams.

Materials Classification: Engineering materials and their classification: metals/ceramics/composites, Intrinsic and extrinsic, Structure sensitive and Structure insensitive properties. Structure-property-processing co-relationship as a theme of materials science.

Non-crystalline Structures: General features and classification, Structure models for amorphous materials-microcrystalline chain and ring model, Molecular model. Structure and properties of metallic glass and amorphous semiconductors.

Crsytal Imperfections: Point imperfections, Burger vector, Dislocations (edge and screw) Properties of dislocation, Generation of dislocation, Partial dislocation, stacking faults, Motion of dislocations (climb, cross-slip), Strain hardening and recovery, and Surface imperfections, Structure of high, Low angle and twin boundaries.

Diffusion: Diffusion mechanisms, Fick's rules of diffusion, Factors that influence diffusion

Phase diagrams: Phase rule and phase diagrams, Unary and binary systems, Solid solutions, Hume Rothery rules, Intermediate phases and compounds, Isomorphous and eutectic systems, Lever rule, Various phase reactions, Introduction to different phase diagrams, Ternary system, cooling curve and its use for drawing phase diagrams, Zone refining.

Mechanical Behaviour of Materials: Elastic, inelastic viscoelastic properties, stress-strain relation

Failure of Materials: Brittle and ductile fracture, Creep failure, Fatigue, Development of creep and fatigue resistant materials, Brittle failures in ceramics, Glasses and polymers.

Strengthening Mechanisms: Characteristics of dislocations, stress field around a dislocation, generation of dislocation, dislocation movement, slip systems, strengthening.

Course Learning Outcomes (CLO):

Students will have understanding of:

1. different type of materials, and their structure
2. structural dependence of various thermal, optical and mechanical properties

Recommended Books:

1. *Smallman, R.E., and Bishop, R.J., Metals and Materials, Butterworth-Heinemann, Oxford University Press, (1995).*
2. *Raghvan, V., Materials Science & Engineering, Prentice-Hall of India, (1998).*
3. *Callister, W.D., Materials Science & Engineering: An Introduction, Wiley & Sons, (2001).*
4. *Smith, W., Principles of Materials Science and Engineering., McGraw Hill, (1990).*

PPH327: ELECTROMAGNETIC PROPERTIES OF MATERIALS

L	T	P	Cr
3	1	-	3.5

Course Objectives: The course aims at to introduce the behaviour of materials in external electric and magnetic field to the students.

Introduction: Interaction of free electrons with lattice, Brillouin zones, Nearly free electron model, Tight binding and other electronic structure models.

Conducting Materials: Electrical resistivity of metals and alloys, Mattheissen rule, Nordheims Rule, Kondo effect, Ionic and superionic conductors, Properties and their applications.

Dielectric and Insulating Materials: Polarization, ClausiusMosotti equation, Dielectric permittivity and loss, Dielectric break down in materials, High K dielectric materials, Non-linear dielectrics, Ferroelectricity, Piezoelectricity, Pyroelectricity, Actuators and Smart materials.

Magnetic Materials: Classification, Ferromagnetism and Exchange interactions, Ferromagnetic domains, Magnetic anisotropy, Magnetic behaviour of polycrystalline materials, Hard and soft magnetic metallic and Intermetallic materials and their characteristics, Their properties and applications, Magnetism and superconductivity, Magnetostriction.

Course Learning Outcomes (CLO):
Students will have understanding of:
1. process of electrical conduction in different types of conductors.
2. behaviour of insulators in external electric field.
3. origin of magnetism in materials.

Recommended Books:

1. *Kittel, C, Introduction to Solid State Physics, John Wiley & Sons, Inc., (1996).*
2. *Ashcroft, N.W., and Mermin, N.D., Solid State Physics, Thomson, (2007).*
3. *L. Solymar and Walsh, Lectures on Electrical Properties of Materials, Oxford University Press, (2004).*
4. *Hummel, R.E., Electronic Properties of Materials, Springer Verlag, (2004).*

PPH318: NANOMATERIALS

L	T	P	Cr
3	1	3	5.0

Course Objectives: Aims at making the students to understand the various concepts of nanosized materials, their morphology, nomenclature and classifications along with different physical and chemical approaches used for their synthesis as well as their applications.

Introduction to Nanomaterials: Features of nanosystems, Characteristic length scales of materials and their properties, Density of states in 1-D, 2-D and 3-D bands, Variation of density of states and band gap with size of crystal.

Quantum Size Effect: Electron confinement in infinitely deep square well, Confinement in one dimensional well, Idea of quantum well structure, Formation of quantum well, Quantum dots and quantum wires.

Synthesis Methodologies: Sol-gel., Micromulsion, CVD, Molecular beam epitaxy, Vapor (solution)-liquid-solid growth, (VLS or SLS), Spary Pyrolysis, Lithography.

Effect of Nanoscale on Properties: Novel properties of nanomaterials-size and shape dependent optical, electronic, photonic, mechanical, magnetic catalytic properties.

Nanostructures: Carbon fullerenes and Carbon nanotubes, Self-assembly of nanostructures, Core-shell nanostructures, Nano composites nanocoatings, Thin film chemical sensors, biosensors, Photonic crystals, Smart materials, Fuel and solar cells, Drug deliveries and optoelectronic devices.

Laboratory Assignments: Familiarizing regarding various synthesis and characterization techniques for nanostructures.

Course Learning Outcomes (CLO):
Students will have understanding of:

1 different type of nanomaterials, and their synthesis techniques
2 size dependence of various properties
3 various applications and perspectives of nanotechnology in the development of value added new products and devices

Recommended Books:

1. *Bimerg, D., Grundmann, M., and Ledentsov, N.N., Quantum Dot Heterostructures, John Wiley (1999).*
2. *Jain, K.P., Physics of Semiconductor Nanostructures, Narosa (1997).*
3. *Fendler, J.H., Nano particles and Nano-structured Films, John Wiley &Sons (1998).*
4. *Timp, G., Nanotechnology, Springer-Verlag (1999).*

PPH317: CHARACTERIZATION TECHNIQUES

L	T	P	Cr
3	1	3	5.0

Course Objective(s): To introduce the students to the principles of optical and electron microscopy, X-ray diffraction and various spectroscopic techniques.

Introduction: Need of materials characterization and available techniques.

Optical Microscopy: Optical microscope - Basic principles and components, Different examination modes (Bright field illumination, Oblique illumination, Dark field illumination, Phase contrast, Polarised light, Hot stage, Interference techniques), Stereomicroscopy, Photomicroscopy, Colour metallography, Specimen preparation, Applications.

Electron Microscopy: Interaction of electrons with solids, scanning electron microscopy Transmission electron microscopy and specimen preparation techniques, Scanning transmission electron microscopy, Energy dispersive spectroscopy, Wavelength dispersive spectroscopy.

Diffraction Methods: Fundamental crystallography, Generation and detection of X-rays, Diffraction of X-rays, X-ray diffraction techniques, Electron diffraction.

Surface Analysis: Atomic force microscopy, scanning tunneling microscopy, X-ray photoelectron spectroscopy.

Spectroscopy: Atomic absorption spectroscopy, UV/Visible spectroscopy, Fourier transform infrared spectroscopy, Raman spectroscopy.

Thermal Analysis: Thermogravimetric analysis, Differential thermal analysis, Differential Scanning calorimetry, Thermomechanical analysis and dilatometry.

Laboratory Assignments:
Metallographic preparation and grain size measurement of metallic sample. Determination of crystal structure and lattice parameters using X-rays diffraction technique, Determination of crystal structure and lattice parameter from electron diffractions, Study of the UV visible absorption spectra of inorganic substance, Thermal analysis of alloys, to study the thermal expansion coefficient of various specimen using dilatometer, Determination of functional group and nature of bonding by FTIR, Study of surface roughness and morphology of thin films by using AFM.

Course Learning Outcomes (CLO):
Students will be able to:

1. apply appropriate characterization techniques for microstructure examination at different magnification level
2. understand the crystal structure determination and phase analysis of the materials
3. able to examine the electronic structure, and the thermal behavior of the materials

Recommended Books:

1. *Li, Lin, Ashok Kumar Materials Characterization Techniques Sam Zhang; CRC Press, (2008).*
2. *Cullity, B.D., and Stock, R.S., "Elements of X-Ray Diffraction," Prentice-Hall, (2001).*
3. *Murphy, Douglas B, Fundamentals of Light Microscopy and Electronic Imaging, Wiley-Liss, Inc. USA, (2001).*
4. *Tyagi, A.K., Roy, Mainak, Kulshreshtha, S.K., and Banerjee, S., Advanced Techniques for Materials Characterization, Materials Science Foundations (monograph series), Volumes 49 – 51, (2009).*
5. *Wendlandt, W.W., Thermal Analysis, John Wiley & Sons, (1986).*
6. *Wachtman, J.B., Kalman, Z.H., Characterization of Materials, Butterworth-Heinemann, (1993).*

PPH435: RADIATION TECHNOLOGY

L	T	P	Cr
3	1	0	3.5

Course Objectives: To impart knowledge in depth about nuclear radiation, its detection, nuclear spectrometry and related aspects

Interactions of Nuclear Radiations: Origin and energy spectra, Brief discussion of interactions of gamma rays, Electron and heavy charged particles with matter, Different types of neutron sources, Interaction of neutron with matter, Neutron detectors.

Nuclear Radiation Detector: Gas filled detectors; Ionization chamber, Proportional counter and GM counter, Scintillation detector, semiconductor detector, Radiation exposure & monitoring.

Nuclear Spectrometry and Applications: Measurement of nuclear energy levels, spins, parities, moments, internal conversion coefficients, Angular correlation, Perturbed angular correlation, measurement of g-factor and hyperfine fields.

Mossbauer Effect: Positron annihilation, particle and photon induced x-ray emission, Elemental concentration analysis by charged particles and neutron activation analysis, Diagnostic nuclear medicine, Therapeutic nuclear medicine.

Safety Aspects: Radiation dose unit, Safety limits, Dose calculations, Design consideration of simple shields.

Course Learning Outcomes (CLO):
Students will have understanding of:

1. nuclear radiation and its detection procedure, nuclear spectrometry.
2. applications of nuclear spectrometry.
3. how to solve problems related to safety aspect of nuclear radiation

Recommended Books:

1. *Knoll G. F., Radiation Detection and Measurement, John Wiley & Sons, (1989).*
2. *Singuru R. M., Introduction to experimental nuclear physics, Wiley Eastern Publications, (1987).*
3. *Muraleedhara V. Nuclear radiation Detection, measurement and Analysis, Narosa Publishing House, (2009).*

PPH436: ADVANCED NUCLEAR PHYSICS

L	T	P	Cr
3	1	0	3.5

Course Objectives: To impart knowledge about nuclear deformations, properties and nuclear models for understanding of related reaction dynamics. Beside this student will be exposed to heavy ion physics and nuclear astrophysics.

Nuclear Deformations: Effect of quadrupole deformations and higher multipole deformations, Nuclear orientation effect, deformed magic shells and related nuclear aspects, Importance of Exotic nuclear systems, halo shapes and bubble effect.

Collective Model of Nucleus: Collective model Hamiltonian, nuclear wave function for even-even nuclei and odd-A nuclei, Rotation-vibrational coupling, Nilsson model, Cranking shell model.

Heavy-Ion Physics: Total Hamiltonian function, scattering of deformed nuclei, Fusion fission dynamics, Radioactive ion beams, tightly and loosely bound interactions, Nuclear isomers, Nuclear Molecules, Nuclear Dynamics at Intermediate and high energies, Relativistic heavy ion collisions

Nuclear Astrophysics: Hot big bang cosmology, Stellar nucleosynthesis, energy production in stars, pp chain, CNO cycle.

Course Learning Outcomes (CLO):
Students will have understanding of:

1. basic properties of deformed shapes of nuclei and related nuclear models to study the nuclear structure properties.
2. various aspects of heavy ion collisions, nuclear astrophysics and related applications will be covered in this syllabus.

Recommended Books:

1. *Pal, M.K., Theory of Nuclear Structure, East-West Press Delhi, (1983).*
2. *Preston M. A. and Bhaduri R. K., Structure of Nucleus Addison-Wesley, (2000).*
3. *Lilley J.S., Nuclear physics principles and applications John Wiley & sons Ltd., (2007).*
4. *Krane K.S. Nuclear Physics, Wiley India Pvt. Ltd., (2008).*

PPH437: MICROELECTRONICS

L	T	P	Cr
3	**1**	**0**	**3.5**

Course Objectives: To build up the concept integrated circuits and its application in the electronics and communications.

Operational Amplifiers. Basic information of Op-Amp Ideal Operational Amplifier, Feedback in operational amplifiers: Inverting and noninverting amplifiers. DC and AC characteristics of Op-Amp. Slew Rate and CMRR of Op-Amp.

Operational Amplifier Applications: Adder, subtractor and differential amplifier; Current to voltage and voltage to current converter, Sample and hold circuit, Log and antilog amplifiers, multiplier and divider, Differentiator and integrator. Comparator and Waveform generator: Comparator, Schmitt trigger, Square wave generator, Monostablemultivibrator, Triangular and Sine wave generator.

Timer: Monostable and astable operation of 555 timer. Applications of monostable mode: Missing pulse detector, Linear ramp generator, frequency divider and pulse width modulation.

Phase Locked Loops: Basic principles of 565 PLL, Phase detector /comparator, Voltage controlled oscillator, Low Pass filter, Applications of Phase locked loop: Frequency multiplication and division, frequency translation.

D/A and A/D converters: Basic digital to analog conversion techniques, Analog to digital converters.

Course Learning Outcomes (CLO):

Students will have understanding of:

1. operational amplifiers and its applications.
2. knowledge of comparator and wave form generator.
3. construction, working and applications of 555 timer & 565 phase locked loop integrated circuits. Moreover, they will also acquire the knowledge of digital to analog and analog to digital techniques.

Recommended Books:

1. *Millman, J. and Halkias, C.C., Integrated Electronics, Tata McGraw Hills*
2. *Gaikwad, Ramakant, Opamps and Linear Integrated Circuits, Prentice-Hall of India.*
3. *Choudhury, D. Roy and Jain, S, Linear Integrated Circuits, New Age Publishers, India.*

PPH438: MICROWAVE THEORY AND TECHNIQUES

L	T	P	Cr
3	1	0	3.5

Course Learning Objectives: To build up the concept from basics of microwave communications to modern applications

Microwave Transmission. Basics, Concept of Mode: TEM, TE and TM Modes and their characteristic, Losses and concept and microwave impeadance.

Microwave Transmission Lines. Coaxial Line, Rectangular Waveguide, Circular waveguide, Striplineand Microstrip Line.

Microwave Network Analysis and Measurements: Equivalent Voltages and currents for non-TEM lines, Network parameters and Scattering Parameters for microwave Circuits. Power, Frequency and impedance measurement, Network Analyser and measurement of scattering parameters.

Microwave Devices. Active component: Diodes, transistors, oscillators and mixers. Passive component: Directional coupler, Power divider, Magic tree, attenuator and resonator. Low power microwave devices: Gun diodes.High power microwave devices: Travelling wave tubes (TWT), Magnetron and klystron.

Microwave Systems and Applications: Radar, Cellular Phone., Satellite Communication, Electromagnetic interference / Electromagnetic Compatibility (EMI / EMC) as modern application.

Course Learning Outcomes (CLO):
Students will have understanding of:
1. microwave transmission modes and transmission lines.
2. microwave network analysis, parameter and their measurements.
3. the concepts of various microwave devices
4. modern day applications of microwaves.

Recommended Books:

1. *David, M. Pozar, Microwave Engineering, Wiley India.*
2. *Ramo, S., Whinnery, J.R., and Duzer, T.V., Fields and Waves in Communication Electronics, Wiley India.*
3. *Collin, R.E., Foundations for Microwave Engineering, IEEE Press.*

PPH439: ELECTRONIC AND OPTOELECTRONIC MATERIALS

L	T	P	Cr
3	1	0	3.5

Course Objectives: The course aims at to introduce the behavior of different types of semiconducting materials to the students.

Semiconductors: Element and compound semiconductors, Conduction mechanisms, Amorphous semiconductors, Oxide and magnetic semiconductors.

Junction Devices: Contact potential, Metal-semiconductor contact and its properties, P-N junction, Potential barrier and barrier width, Forward and reverse saturation current, junction capacitance.

Optoelectronic Materials: Luminescence from quantum well, Photo luminescence and phosphorescence, Phototransistors electro luminescence process, Light emitting materials, Materials of LEDs, Polymer LEDs, Organic semiconductors and molecular electronics, Semiconductor lasers.

Materials for Optical Communication: Electro-optic effect, Kerr and Pockels effect, liquid crystal displays and display materials, TN and STN effect.

Course Learning Outcomes (CLO):
Students will have understanding of

1. the mechanism of charge transport in semiconductors
2. absorption and emission of light from semiconductors and related devices
3. the use of materials for optical communication

Recommended Books:

1. *Sze, S.M., Physics of Semiconductor Devices, Wiley, (2007).*
2. *Bhattacharya, P., SemiconductorOpto-electronic Devices, Prentice-Hall of India, (2006).*
3. *Wilson, J., and Hawkes, J.F.B., Optoelectronics, Prentice-Hall of India, (1988).*
4. *Singh, J., Semiconductor Devices, John Wiley & Sons, (2001).*

PPH440: MATERIALS PROCESSING

L	T	P	Cr
3	1	0	3.5

Course Objectives: The course aims at imparting understanding to the students of metals and ceramics processing as well as regarding the influence of different processing parameters on microstructures.

Solidification from Liquid and Vapour Phase: Nucleation and growth, Homogeneous and heterogeneous nucleation, Interface stability, Development of micro structure, Faceted and non-faceted structure, Super cooling, Equilibrium phase diagrams, Eutectic and peritectic solidifications and their microstructures, Foundry techniques such as sand casting, Permanent mould casting, Investment casting and die casting, Casting defects and their inspection.

Forming Processes: Fundamentals of metal forming, Hot working process; Rolling, Forging, Extrusion, Piercing, Cold working processes; Bending, Shearing, Squizing etc.

Metals Processing: Welding, Brazing, and soldering: Conventional and Laser techniques and their application

Ceramic Processing / Powder Processing: Synthesis of common ceramic powders such as Al_2O_3, ZrO_2, Si_3N_4, and SiC, Powder characterization, Binders, Lubricants, Deflocculants and flocculants as processing aids, shaping techniques such as powder compaction, Extrusion, Injection moldings, Slip casting, Solid state and liquid phase sintering, machining of ceramic components, Common applications such as cutting tools, Ferrites and piezoelectric.

Course Learning Outcomes (CLO):
Students will have understanding of:
1. how to adopt proper working conditions for a particular material to be used in different engineering components;
2. different ceramic powders and bulk by different processing techniques.

Recommended Books:

1. *Chalmner, B., Principles of Solidification, Wiley, (1977).*
2. *Degarmo, E.P., Black, J.T. Kosher R.A, Materials and Processing in Manufacturing, Prentice-Hall of India, (1986).*
3. *Martin, D.H. & Jones, Polymer Processing, Chapman and Hall, (1989).*
4. *Fleming, M.C., Solidification Processing, McGraw Hill, (1974).*
5. *Richerson, B.W., Modern Ceramic Engineering: Properties, Processing and Use in Design, Marcel Dekker, (1983).*

PPH445: PLASMA PHYSICS AND FUSION REACTOR

L	T	P
3	1	0

Course Objective: To expose the students to theory related to motion of charge particle in inhomogeneous field, production of plasma and usage of plasma.

Introduction: Plasma state, plasma parameters, applications of plasmas.

Single Particle Orbit Theory: Drift of charge particle under different combinations of electric and magnetic field, crossed electric and magnetic fields, homogenous electric and magnetic fields, spatially and time varying electric and magnetic fields,

The Boltzmann Equation - Simplified magneto-hydrodynamic equations - Electron plasma oscillations, Debye shielding phenomenon and criteria for plasma, Electric field drift, curvature drift, adiabatic invariants; fundamental equations of magneto-hydrodynamics(MHD), magnetic confinement.

Production of Plasma in Laboratory: Physics of glow discharge, electron emission, ionization breakdown of gases, Paschen's law and different regimes of E/ρ in a discharge.

Plasma Diagnostic: Probes, energy analysers and optical diagnostics.

Fusion Reactor: Potential of fusion energy, controlled thermonuclear reactions, fusion power generation, energy balance for fusion systems, ignition criterion, gain factor, plasma heating, inertial confinement fusion.

Course Learning Outcomes (CLO):
Students will have understanding of:
1. what are theoretical method to study the charge particle motion
2. how to generate plasma in the laboratory?
3. how plasma production is helpful to make fusion reactors

Recommended Books:

1. *Chen, F.F., Introduction to Plasma Physics, Springer, (1984).*
2. *Sturrock, P.A., Plasma Astrophysics, Cambridge University Press, (1994)*
3. *Choudhuri, A.R., The Physics of Fluids and Plasmas, Cambridge University Press, (1998).*
4. *Nicholson, D. R., Introduction to Plasma theory, Wiley, (1983).*

PPH446: NUCLEAR MEDICINE

L	T	P	Cr
3	1	0	3.5

Course objectives: To train student on theoretical aspects of various nuclear techniques to scan and cure the diseases in the human body.

Rectilinear Scanner and Photography: Collimation, scattering and attenuation, block diagram, principle of working, effect of scanning speed, dot factor, time constant, line spacing, film density, photo recording display, contrast enhancement and clinical applications.

Gamma Camera: Basic principles of gamma camera, collimators - parallel hole, divergent, convergent pinhole, fan beam, slant hole collimator, NaI (Tl) detector.

Single Photon Emission Computerized Tomography: Theory aspects, rotating gamma camera and the couch, single or multiple section devices multi detector SPECT, matrix selection, rotating arc selection. Image reconstruction techniques.

Imaging: Renal, Bone, Gastrointestinal and Lung imaging static blood pool imaging, Rest/stress myocardial imaging, infarct imaging, MUGA, gated blood pool study, first pass study (shunt detection), 201Tl imaging Central nervous study- cerebral blood flow dynamic studies, static brain imaging.

Bone Marrow: Radiopharmaceuticals and imaging techniques studies- red-cell mass estimation, RBC survival and sequestration studies.

Course Learning Outcomes (CLO):
Students will have understanding of:
1. different techniques use radiation to scan human body
2. how to use nuclear technology to treat the deceases.

Recommended Books:
1. *Saha, Gopal B., Physics and Radio Biology of Nuclear Medicine, Springer,*
2. *Trapp, J.U. and Kron, T, An Introduction to Radiation Protection in Medicine, Taylor & Francis, (2008).*
3. *Saha, Gopal B., Fundamentals of Nuclear Pharmacy, Springer, (2010).*
4. *Hondee, W.R. and Ritondur, E.R., Medical Imaging Physics, New York: Wiley-Liss, (2002).*

PPH447: NANOELECTRONICS

L	T	P	Cr
3	1	0	3.5

Course Objectives: The course aims at imparting knowledge of nanoscience applications in the field of electronics.

Fundamental of Nanoelectronics: Basics of nanoelectronics– physical fundamentals of nanoelectronics – basics of information theory – the tools for micro and nanofabrication – basics of lithographic techniques for nanoelectronics –microlithography- nanolithography- tools for nanolithography

MOSFETS: Silicon MOSFETS- fundamentals of MOSFET devices-NanoFETS-single electron MOS transistor –split gate transistor – Electron wave transistor – Electron spin transistor – advanced MOSFET concepts – Principles of Single Electron Transistor (SET) – SET circuit design – comparison between FET and SET circuit design-

Quantum Electron Devices: Classical to quantum physics – electrons in mesoscopic structure – Nanoelectronics with tunneling devices and superconducting devices – tunneling element technology – Resonant tunneling Devices single electron devices- single electron devices for logic and gate applications- Carbon Nanotube based logic gates, optical devices. Quantum dots, quantum wires, and quantum wire.

Memory Devices and Sensors: Nanoferroelectrics – Ferroelectric random access memory – Fe-RAM circuit design – ferroelectric thin film properties and integration – calorimetric sensors – electrochemical cells– resistive semiconductor gas sensors –electronic noses – identification of hazardous solvents and gases – semiconductor sensor array.

Course Learning Outcomes (CLO):

The students will be able to:

1. know basics of nanoelectronics and its fabrication.
2. understand fundamentals of ´MOSFETS and design of circuits
3. understand the concept quantum mechanics in electronics
4. learn molecular devices and its synthesis techniques
5. understand nanoferroelectronics using Fe-RAM, sensors

Recommended Books:

1. *W.R. Fahrner, Nanotechnology and Nanoelectronics: Materials, Devices, Measurement Techniques, Springer, (2010).*
2. *K. Goser, P. Glosekotter, J. Dienstuhl, Nanoelectronic and Nanosystems – From Transistors to Molecular Quantum Devices, Springer, (2004).*
3. *Rainer Waser, Nanoelectronics and Information Technology: Advanced Electronic Materials Novel and Devices, Wiley VCH, (2005).*
4. *Mick Wilson, KamaliKannangara, Geoff smith, Nanotechnology: Basic Science and Emerging Technologies, Overseas press, (2005).*

PPH448: OPTICAL FIBER COMMUNICATION

L	T	P	Cr
3	1	0	3.5

Course Objectives: The course aims at imparting in-depth knowledge of optical fiber communication

Optical Fibers and Fabrication: Introduction, light propagation through optical fiber, fiber materials, fiber fabrication, mechanical properties of fibers.

Signal Degradation in Optical Fibers: Attenuation, signal distortion in optical waveguides, pulse broadening in graded index waveguides, mode coupling, design optimization of single-mode fibers.

Power Launching and Coupling: Source-to-fiber launching, fiber-to-fiber joints, LED coupling to single-mode fibers, fiber splicing, optical fiber connectors.

Photodetectors: The pin photodetector, avalanche photodiodes, photodetector noise, detector response time, structures for InGaAs APDs, temperature effect on avalanche gain.

Optical Amplifiers and Optical Receiver: Fundamental receiver operation, pre-amplifier types. optical amplifiers, semiconductor optical amplifiers, erbium-doped fiber amplifiers, amplifier noise, system applications.

Optical Networks: Basic networks, SONET/SDH, WDM Networks, nonlinear effects on network performance, performance of WDM + EDFA systems, solitons, optical CDMA, ultrahigh capacity networks.

Measurements: Measurement standards, test equipment, attenuation measurements, OTDR field applications, eye patterns, optical spectrum analyzer applications.

Course Learning Outcomes (CLO):
Students will have understanding of:

1. optical fiber communication vis a vis other modes of communication
2. the requisite inputs for optical fiber communication
3. how light beam is modulated, propagated, and demodulated
4. how to measure attenuation and dispersion in optical fibers, as well as measurement of fiber-fault location

Recommended Books:

1. *Keiser, G., Optical Fiber Communications, McGraw-Hill International, (2000).*
2. *Seniors, J.M., Optical Fiber Communications – Principles and Practice, Prentice-Hall of India, (1996).*
3. *Cherin, A.H., An Introduction to Optical Fibers, McGraw Hill Book Company, (1983).*
4. *Yariv, A., Quantum Electronics, Wiley, (1989).*