DEPARTMENT OF PHYSICS

SYLLABUS

MASTER OF SCIENCE (PHYSICS)

[2012-13]

SIKKIM MANIPAL UNIVERSITY

DEPARTMENT OF PHYSICS

PH2101 (4L hrs/week)

MATHEMATICAL PHYSICS

Max Marks: 100

No. of questions to be set: 4 from UNIT – I and 4 from UNIT – II of 20 marks each.
No. of questions to be answered: Any 5 questions selecting atleast two questions from each UNIT

Objectives: The course is focused on teaching different kind of mathematical techniques used in various kinds of physics problems.

Prerequisites: Students should have the knowledge of complex number system, basic various mathematical functions, different kind of coordinate systems, matrix operations, integration and differentiation.

Learning Outcomes: After the completion of the complete syllabus, the student will be capable of the following:

1. Students will learn complex analytical method to solve tedious integrals learn,
2. Fourier and Laplace techniques to solve differential equations.
3. Students will be able to deal with spatial function came across different physics problems in classical and quantum systems.
4. Basic understanding of tensors will be developed.
5. Learn Green's function method to solve nonhomogeneous differential equations.

UNIT-I

Complex analysis: Functions of complex variables, regular and singular points. Cauchy-Riemann equations. Cauchy's theorem and consequences, integral formulae. Expansion of functions about singular points. Residue theorem – its application in evaluating integrals. **(9 Hours)**

Integral transform: Fourier series, Fourier transforms, Laplace transform and their application. **(4 Hours)**

Differential equations and special functions: Series solutions of linear second order differential equations; Bessel, Legendre, Associated Legendre, Hermite, Laguerre equations and polynomials. Dirac's delta function; Gamma and Beta functions. **(8 Hours)**

Linear vector space and matrices: Definition of vector space; dimension, basis, subspace; inner product, orthogonality and completeness. Linear operators – representation of operators by matric. **(5 Hours)**

UNIT-II

Tensors: Covariant, contravariant and mixed tensors. Tensor algebra, contraction, quotient law. Kronecker delta, metric tensors. Christoffel symbols and covariant derivative of tensors. **(10 Hours)**

Group theory: Introduction, group multiplication table, discrete and continuous groups. Reducible and irreducible representation of groups, equivalent representation, representation by unitary matrices, orthogonality theorem, rotation groups, unitary groups and Lorentz homogeneous groups. **(8 Hours)**

Green's function: Nonhomogeneous boundary value problem and Green's function, Eigen function expansion of Green's function, application to physical problems. **(4 Hours)**

References:

1. Mathematical Methods for Physicists, G.B. Arfken & H.J. Weber, Prism Books Pvt. Ltd.
2. Vector Analysis, M.R Spiegel, Mc GRAW- Hill
3. Advanced Mathematics for Engineers & Sci., M.R Spiegel, Mc GRAW- Hill
   Mathematical Physics, P.K. Chattopadhyay, New Age International Pub.

DEPARTMENT OF PHYSICS

PH2102 (4L hrs/week)

FUNDAMENTALS OF ELECTRONICS

Max Marks: 100

No. of questions to be set: 4 from UNIT – I and 4 from UNIT – II of 20 marks each.
No. of questions to be answered: Any 5 questions selecting atleast two questions from each UNIT

Objectives: The course focuses at developing the basic knowledge of electronics in physics. It gives the fundamental knowledge of network analysis to make various electronics circuit. This course also make the strong theoretical base of different components used in electronics. The course is designed in such a way that it can cope up with modern technology.

Prerequisites: Student should have the basic knowledge of electronics. Familiarity with network analysis theorems and basics of diodes and transistors. They should have also done a course in mathematics involving calculus, simple differential equations, algebra, elementary number theory and trigonometry.

Learning Outcomes: After the completion of the complete syllabus, the student will be capable of the following:

1. Use Science Process and Thinking Skills.
2. Observe objects for patterns and record both qualitative and quantitative information.
3. When given a problem, plan and conduct experiments on the topic.
4. Plan procedures to control independent variable.
5. Analyze data and construct reasonable conclusions.
6. Communicate Effectively Using Science Language and Reasoning.
7. Provide relevant data to support their inferences and conclusions.
8. Use mathematical reasoning to communicate information.
9. To correlate the laws of physics for explaining facts and figures.
10. Development of any devices, appliances, instruments can be done only when the laws of the force governing their actions are understood properly.

UNIT-I

Introduction : Survey of network theorems and network analysis, Equivalent circuits of diodes , Simple diode circuits and characteristics, Half wave, Full wave rectifiers, Filter, clipping, clamping, Voltage multipliers (Doublers, Tripler), Fundamentals of BJT operation □ charge transport in a BJT, amplification with BJTs. Transistor action, CC, CE and CB connections and characteristics, load line analysis, operating point, Cut off and saturated points. **(6 hours)**

Diode devices: Optoelectronic devices, Light-emitting diodes, photo-diodes (solar cells), negative-resistance devices (Zener diodes used as voltage regulators) **(3 hours)**

Amplifiers: Faithful amplification, stabilization, thermal runaway, stability factor ,Single-stage transistor amplifier, Graphical method, Equivalent circuits using hybrid h-parameters and amplifier equations, RC Coupled amplifier. **(5 hours)**

Feedback in Amplifiers: Concept of feedback, advantages of negative feedback, amplifier circuits with current negative feedback, emitter follower. Basic differential amplifier circuit, Operational amplifier characteristics and applications, Simple analog computer. **(6 hours)**

UNIT-II

Oscillators: Sinusoidal oscillator, types, Oscillatory circuits, transistor oscillators- tuned Collector, Hartley, and Collpit's, Phase shift, Wien Bridge, Crystal oscillators, Principle of multivibrator. **(6 hours)**

JFET & MOSFET: Jjunction Field Effect Transistor (JFET) - Device structure, Pinch-off and saturation, Gate control, current-voltage characteristics. MOSFET - Device structure, operation with no gate voltage, creating a channel, Application of small V_{DS}, Derivation of i_D - V_{DS} relationship, p channel enhancement MOSFET, i_D - V_{DS} characteristics of enhancement MOSFET, Finite output resistance in saturation, and characteristics of the p-channel MOSFET, Complementary MOSFET (CMOS) **(8 hours)**

Digital Electronics - I: Combinational Logic: Logic fundamentals, Boolean Algebra- De Morgan's Theorem and Logic Gates, Sequential Logic: Flip-flops, T, D, RS, JK flip-flops. **(6 hours)**

References:

1. Integrated Electronics, Millman and Halkias, McGrawhill, New York, 1998.
2. Network & Systems, D. Roy Choudhury, New Age Int. Publisher.
3. Electronic Devices and Circuit, Allen Mottershead, Prentice Hall of India.
4. Networks, Lines and Fields, J.D. Ryder, Prentice Hall.
5. Electronics Principles, A.P. Malvino (6th Edition), Tata McGrawhill.
6. Digital Computer Electronics – A.P. Malvino, Tata McGraw Hill.
7. Basic Electronics: *Devices, Circuits & IT Fundamentals*: Santiram Kal, Prentice Hall of India, May 2008.

DEPARTMENT OF PHYSICS

PH2103 (4 hrs/week)

CLASSICAL MECHANICS

Max Marks: 100

No. of questions to be set: 4 from UNIT – I and 4 from UNIT – II of 20 marks each.
No. of questions to be answered: Any 5 questions selecting atleast two questions from each UNIT

Objective: The course aims to provide the students with an understanding of advanced methods in classical mechanics namely Lagrangian and Hamiltonian formulation as well as the basic parts of continuum mechanics. These formulations are vital in making the transition from classical mechanics to quantum theory, the Hamiltonian formulation being the backbone of quantum mechanics. The course provides a platform for the student to master most of the mathematical techniques necessary for quantum mechanics while still working in the familiar realm of classical mechanics. The students will also be introduced to the idea of the dynamics of systems near equilibrium and the normal modes of oscillation.

Pre- requisites: Knowledge of Mathematical Physics and elementary calculus.

Learning outcomes: By the end of the course, the student will be able to:

1. set up the Lagrangian and Hamiltonian for the system under study,
2. analyze the relevant symmetries,
3. obtain the equations of motion, solve them in certain cases,
4. relate the Hamiltonian and Lagrangian approaches,
5. apply the concepts of:
   _ canonical transformations, and
   _ Poisson brackets,
6. solve the motion of mechanical systems applying the Hamilton-Jacobi technique,
7. analyze the dynamics of systems near equilibrium; find the normal modes of oscillation, and
8. apply the Lagrangian formulation for continuous system

UNIT-I

Types of Constraints on dynamical systems, Generalized Coordinates, Virtual Work, d'Alembert Principle, Lagrange's Equations, Simple applications of the lagrangian formulation. **(8 Hours)**

Calculus of variation, Hamilton's variational principle, lagrange's Equations from Hamilton's principle. Advantages of a variational principle formulation, Lagrangian and Hamiltonian for central forces, electromagnetic forces, coupled oscillators and other systems. Lagrangian formulation of relativistic mechanics. **(8 Hours)**

Legendre transformation and the Hamilton Equations of motion. Cyclic coordinates and conservation theorem. Derivation of Hamilton's equations from variational principle. The principle of least action. **(5 Hours)**

UNIT-II

Canonical transformation, Generating function, Examples of canonical transformation, Poisson Brackets, Liouville's Theorem. Symmetry, invariance and Noether's theorem. **(6 Hours)**

Hamilton-Jacobi theory, Action and angle variables, Harmonic Oscillator and Kepler problem. **(5 Hours)**

Mechanics of Small Oscillation and continuous systems: Stable and unstable equilibrium oscillators, Lagrange's equation of motion for small oscillations, Normal coordinate and its applications to chain molecules and other problems. **(6 Hours)**

Transition from from a discrete to a continuous system, Lagrangian formulation for Continuous system, Hamiltonian formulation. **(4 Hours)**

References:

1. Classical Mechanics. H. Goldstein, Addison Wesley.
2. Classical Mechanics of Particles & Rigid Bodies, Kiran O. Gupta, New Age International.
3. Classical Mechanics, N.C Rana and P.S Joag, Tata- Mc Graw Hill.
4. Classical Mechanics, A. K. Raychaudhury, Oxford University Press.
5. Classical Mechanics, John and Taylor, University Science Books.

DEPARTMENT OF PHYSICS

PH2104 (4L hrs/week)

QUANTUM MECHANICS-I

Max Marks: 100

No. of questions to be set: 4 from UNIT – I and 4 from UNIT – II of 20 marks each.
No. of questions to be answered: Any 5 questions selecting atleast two questions from each UNIT

Objective: Students develop appropriate competence and a working knowledge of quantum physics. It will help them to understand atomic and sub-atomic physics.
Students develop the ability to identify and apply the appropriate analytic, numerical, computational, and other mathematical tools necessary to solve quantum problems.
Students develop a familiarity with the current state of research in quantum physics, including the most significant research questions being pursued by today's physicists**.**

Scope: Students develop the ability to analyze scientific problems, generate logical hypotheses, evaluate evidence, and tolerate ambiguity.
Students develop the ability to apply knowledge of quantum physics in relevant areas to make appropriate intellectual connections and solve problems.

UNIT- I

Introduction and Review of Classical Mechanics: Quantization of Physical quantities, Radiation laws, wave aspect of Matter, Newton's Equations, Lagrangian Approach, Principle of Least Action, Hamiltonian Formalism. **(3 hours)**

Mathematical foundation of QM-I: Linear vector Space, Inner product, States, Dirac's kets & bra notation, compatible and incompatible observables, Linear Operators, Measurement, Position, Momentum, Angular Momentum Operators, projection operator, Eigen vectors and Eigen values, Infinite dimensional vector spaces, Dirac Delta function and its properties, Operators in infinite dimensions, Fourier Transform. **(7 Hours)**

Basics of Quantum Mechanics: Motivation, Inadequacies of Classical Mechanics, Postulates of QM, Expectation value, Uncertainty Principle, Ehrenfest, theorem, stationary state solutions, continuity Equation, Schrodinger picture and Heisenberg picture. **(6 Hours)**

Simple application of Schrödinger Equation- Free particle, Infinite Square Well, Finite Square well, Parity, Penetration of Barrier, Hydrogen Atom. **(5 hours)**

UNIT-II

Harmonic oscillator: Harmonic Oscillator in 1-Dimension, Creation & Annihilation operators, Matrix formulation, solution of Schrodinger Equation, Oscillator in higher dimension. **(3 hours)**
Symmetries and their consequences: Symmetries in Classical Mechanics, Symmetries in Quantum Mechanics, Groups, Parity, Rotations. **(4 Hours)**

Angular Momentum: Rotation in 3-dimension, Communication relations of Angular momentum operators, Ladder operators and their matrix representation. Addition of Angular momenta. Clebsch- Gordon coefficients. **(6 Hours)**

Conceptual & Philosophical problems of Quantum Mechanics: Determinism, Locality, Hidden variable theory, Bell's theorem, Quantum Mechanical puzzles and answers, the conservation of particle number in Quantum Mechanics, Problem of Reality, Quantum Physics and computation**.** **(8 Hours)**

References:

1. Quantum Mechanics, A. Ghatak and S. Loknathan, Macmillan India Ltd
2. Lectures on Quantum Mechanics, Ashok Das, Hindustan Book Agency
3. Principles of Quantum Mechanics, P.A.M. Dirac, Oxford University Press
4. Quantum Mechanics, E. Merzbacher 3rd Edition, John Wiley & Sons, INC
5. Quantum Mechanics An Introduction, W. Greiner, Springer –Verlag
6. Quantum Mechanics, Mathews and Venkateshan, Tata McGraw Hill
7. Elementary theory of Angular Momentum, M.E. Rose, Dover Publications
8. Quantum Mechanics, J.J. Sakurai, Addison Wesley Publishing House.

DEPARTMENT OF PHYSICS

PH2161

PHYSICS LAB - I

Max Marks: 100

There will be **TWO** laboratory class of 3 hours duration per week. There are **13 weeks** expected in a semester.

Note: Minimum of **SIX** experiments to be completed from each **UNIT.**

Objectives: This laboratory is considered to be General Physics laboratory. This course covers begins advanced level experiments of the theories covered in the UG level and theories offered in the first two semesters at PG level. Different experiments from thermodynamics, electromagnetic theory, condensed matter physics, atomic physics, nuclear physics and quantum mechanics will be covered to understand the some of the basic laws of physics in these areas.

Prerequisites: Student should have the basic knowledge of UG level experiments taught at B.Sc. (Hons/Pass) Physics. They should have adequate knowledge of basic laws of physics.

UNIT-I

1. To study the existence of different harmonics and measure their amplitude.
2. To determine the heat capacity of the given sample.
3. To determine the resistivity of the given sample using Four Probe method.
4. To determine the Curie temperature of the given Ferroelectric material.
5. To determine the dielectric constant of a given (i) solid and (ii) polar liquid.
6. To determine the compressibility of a given liquid using ultrasonic diffraction.
7. Study the
   (i) dispersion relation for the mono-atomic lattice and comparison with theory and
   (ii) determination of the cut-off frequency of the mono-atomic lattice.
8. To find the velocity of sound in the given (i) liquid and (ii) solid using Ultrasonic Interferometer.
9. To study the structure of NaCl monocrystals with different orientations.
   (i) Structure factor (ii) Atomic form factor (iii) Bragg Scattering (iv) Reciprocal Lattice (v) Miller Indices (vi) Crystal structures (vii) Energy levels (viii) Characteristics X-ray radiation.

UNIT-II

1. To determine the Hall coefficient of the given semiconductor and its charge carrier density.
2. To study the Hall Effect in metals and study
   (i) Normal Hall Effect (ii) Anomalous Hall Effect (iii) Charge carrier density (iv) Hall mobility (v) Electrons (vi) Defect Electrons
3. To find out the value of e/m and study
   (i) Cathode Rays (ii) Lorentz force (iii) Electron in crossed fields (iv) Electron Mass (v) Electron charge

4. To display the B-H hysteresis curve on CRO screen and to determine magnetic Permeability of free space.
5. To determine the capacitance of the given capacitor and to find the Permittivity of free space.
6. To study the various characteristic of P-N junction.
   (i) Determination of the reverse saturation current I_o and material constant ŋ.
   (ii) Determination of Temperature Coefficient of junction voltage and Energy Band gap.
7. To determine Passion's and Gaussian distribution of Radioactive decay and determine
   (i) Poisson Distribution (ii) Gaussian distribution (iii) Standard deviation (iv) Expected value of Pulse rate (v) Different symmetric of distribution (vi) Dead time (vii) Recovering time and resolution time of a counter tube.
8. To determine the Electron spin resonance and study
   (i) Zeeman effect (ii) Energy quantum (iii) Quantum number (iv) Resonance (v) G-factor (vi) Lande factor
9. To study Frank – Hertz experiment with Hg – tube and determine
   (i) Energy quantum (ii) Electron collision frequency (iii) Excitation energy
10. To study the superconductivity in solids and determine
    (i) Meissner-Ochesenfeld effect (ii) Measure the transition temperature of high temperature superconductor.

References:

1. General Physics Manual for M.Sc. Physics.
2. Advanced Practical Physics, B. L. Worsnop and H. T. Flint, Pub. Methuen & Co, Ltd., London

DEPARTMENT OF PHYSICS

PH1162

PHYSICS LAB – II (PHOTONICS & SPECTROSCOPY)

Max Marks: 100

There will be **TWO** laboratory class of 3 hours duration per week. There are **13 weeks** expected in a semester.

Note: Minimum of **SIX** experiments to be completed from each **UNIT.**

Objectives: The Physics Lab-II paper is designed to cover the areas of laser optics and study the effects of light on some materials. The students will be able to get a first-hand experience in the field of photonics and appreciate the various spectroscopic effects which are covered in the lectures of the program. It will also enable the students to apply analytical techniques, statistical analysis and graphical analysis to the experiments.

Prerequisites: The students must have completed a course of Modern Physics in the B. Sc. Program so that they have a preliminary knowledge of the basic principles of lasers, optics, fiber optics and spectroscopy.

UNIT I

1. To study the solar cell characteristics.
2. (i) To design a simple solar thermal system.

   (ii) To calculate effective power and collector efficiency.

   (iii) To study the effect of angle of incidence and irradiation intensity on effective power.
3. To study the characteristics of opto-electronic devices: (i) Light Emitting Diode (LED). (ii) Photo Diode. (iii) Photo Transistor. (iv)Light Dependent Resistor (LDR).
4. To determine Planck's constant '*h*' by measuring the radiation in a fixed spectral range.
5. To studythe laser beam characteristics:
   (i) To measure the divergence of the laser beam by the sized spots.

   (ii) To measure the divergence of laser beam by lens.

   (iii) To measure the beam diameter.

   (iv) To study the intensity distribution of laser beam.
6. (i) To measure the absorption coefficient of laser light (6328Å) through the filters of different colours.

   (ii) To study the photo cell characteristics.

   (iii) To determine the value of Planck's constant '*h*' by Photo cell (Photo-Electric Effect).
7. To study the optical fiber characteristic:

   (i) To measure the numerical aperture of an optical fiber.

   (ii) To measure the attenuation or propagation loss in an optical fiber.
8. To study the material properties:

   a) To determine of optical rotation of quartz disc.

   b) To examine of optic axis of lithium niobate disc.

c) To demonstrate the homogeneity of a rod of transparent material.

d) To observe the strain in glass by using cross polarizer.

UNIT II

1. To measure the wavelength of He-Ne laser beam using Fresnel Biprism.
2. (i) To determine the wavelength of the laser light by using transmission grating and the number of lines in transmission grating.

   (ii) To determine the particle size by diode laser.
3. To measure the Brewster angle of a glass plate and hence the refractive index of the glass.
4. To measure the thermal expansion coefficient of Quartz crystal (rod) using Michelson interferometer.
5. To study Zeeman Effect.
6. To study Hydrogen spectrum and determine Rydberg's constant.
7. To study fine structure of one-electron and two-electron spectra.

   (i) To calibrate spectrometer using He-spectrum and determination of grating element.

   (ii) To determine spectrum of Na

   (iii)To determine fine structure splitting

   (iv)To determine the most intense spectral lines of Hg, Cd and Zn.

8. To study Gamma ray –spectroscopy for (i) detecting gamma radiation with scintillation counter (ii) Recording and callibrating gamma ray spectrum (iii) Absorption of gamma rays.
9. To study the Nature of Polarization of Laser Light using Photocell and Quarter wave plate.

References:

1. Optics: Ajoy Ghatak, Tata McGraw Hill Education
2. An Introduction to Fiber Optics: Ajoy Ghatak, K. Thyagarajan, Cambridge University Press
3. Laser and Non Linear Optics, B. B. Laud, Wiley Eastern Limited
4. Basic Electronics: Devices, Circuits and its Fundamentals: Santiram Kal, PHI Learning Pvt. Ltd.

DEPARTMENT OF PHYSICS

PH2201 (4L hrs/week)

CLASSICAL & RELESTIVISTIC ELECTRODYNAMICS

Max Marks: 100

No. of questions to be set: 4 from UNIT – I and 4 from UNIT – II of 20 marks each.
No. of questions to be answered: Any 5 questions selecting atleast two questions from each UNIT

Objectives: The course focuses at developing the basic knowledge of electrodynamics in physics. It gives a understanding of fundamental principle and laws of electromagnetism to pursue research work in future that take into account electromagnetic propagation and radiation effects. Also it will get the students ready for advanced courses both theoretical and application oriented.

Prerequisites: Student should have the basic knowledge of electric field and magnetic field. Student should have the basic knowledge of mathematics. They should have also done a course in mathematics involving calculus, simple differential equations, algebra, elementary number theory and trigonometry. A proper understanding of vector calculus is desired.

Learning Outcomes: After the completion of the complete syllabus, the student will be capable of the following:

6. Use Science Process and Thinking Skills.
7. Understand laws of electromagnetic.
8. Use the basic electromagnetic laws to solve various problems.
9. Analyze transmission lines.
10. Analyze electromagnetic wave propagation in free space and material media.

UNIT – I

Review of electric field and magnetic field (in free space and matter): Coulomb's Law, electrical potential, equipotential surface, flux density, Gauss's law. Biot Savart Law, Ampere's law, Magnetic vector potential, magnetic flux and flux density, Numerical problems. **(5 hours)**

Electromagnetic wave: Maxwell's equation in free space and inside matter (lossy dielectric and conducting body), Boundary conditions and its applications. Scalar and vector potential, Gauge transformation, Wave equation. Plane waves in dielectric and conducting media, Skin effect, Polarization of electromagnetic wave. Poynting vector, Complex Poynting's theorem, Reflection and transmission of electromagnetic wave incident at media interface, Reflection from perfect conductor, standing wave, Numerical problems. **(10 hours)**

Propagation of Electromagnetic wave: propagation of electromagnetic wave, wave guide, rectangular and spherical wave guide, Basic theory of transmission line, equations of transmission line, characteristic impedance, impedance matching, SWR. **(6 hours)**

UNIT – II

Electromagnetic Radiation: Retarded potentials, radiation form an oscillating dipole, Lienard wiechert potential, Potential for a charge in uniform motion – Lorentz formula, Fields of an accelerated charge, Radiation from an accelerated charge. **(7 hours)**

Relativistic Electrodynamics: Galilean Transformation, Postulates of special Theory of Relativity, Lorentz transformation, charges and fields in different frames of reference, covariant formulation of electrodynamics, Electromagnetic Field Tensor, radiation form relativistic particles.

(8 hours)

Scattering and Dispersion: Scattering of Radiation by free charge, Scattering of Radiation by bound charge, Radiation Damping, Dispersion in dilute gases, Dispersion in liquids and solids.

(6 hours)

References:

1. Classical Electrodynamics, J.D Jackson, John Willey and sons.
2. Introduction to Electrodynamics, D.J Griffith, Prentice Hall of India Pvt. Ltd.
3. Electromagnetic with applications, Kraus & Fleisch, McGraw-Hill International.
4. Elements of electromagnetic, M.N.O Sadiku, Oxford University Press.
5. Electromagnetic, B.B Laud, New Age Int. Publications.
6. Classical theory of fields, Landau & Lifshitz, Pergamon press – Butterworth-Heinemann.

DEPARTMENT OF PHYSICS

PH2202 (4L hrs/week)

CONDENSED MATTER PHYSICS

Max Marks: 100

No. of questions to be set: 4 from UNIT – I and 4 from UNIT – II of 20 marks each.
No. of questions to be answered: Any 5 questions selecting atleast two questions from each UNIT

Objectives: The course focuses at developing the basic knowledge of condensed matter physics. It give a preliminary idea about the conduction in metals, crystal structure and thermal properties of solids in its unit – I. In unit-II it gives the fundamentals of dielectric properties and magnetic properties of materials along with the introduction of superconductivity and nano-materials. This course also emphasize in developing problem solving skills in related topics of it.

Prerequisites: St5udent should have the basic knowledge of solid state physics. Student should have the basic knowledge of mathematics the laws of physics in different areas of physics like waves, geometrical optics, atomic physics, states of matter and basic laws of heat and thermodynamics. They should have also done a course in mathematics involving calculus, simple differential equations, algebra, elementary number theory and trigonometry.

UNIT – I

Conduction in Metals: A simple model of a conductor, Energy distribution of electrons in a metal, The Fermi level in a metal, Conduction processes in metals, The Drude Lorentz theory, Allowed energy bands of electrons in solids **(4 hours)**

Crystal Structure: Lattice, basis and unit cell, crystal system, Point group and symmetry, centred lattices, Miller indices, Bragg and Laue's Treatment, reciprocal lattices, atomic and geometrical factor, experimental methods of X-ray diffraction. **(8 hours)**

Lattice Dynamics: Elastic vibrations in one-dimensional homogeneous line, one-dimensional line of atoms and the vibrational modes, the linear diatomic lattice. **(4 hours)**

Thermal Properties of Solids: Lattice specific heat- Classical theory, Einstein's Theory, Debye Theory and Born's Modification, Thermal conductivity, mean free path of phonons, thermal expansion and Gruneisen relation. **(6 hours)**

UNIT – II

Dielectric Properties of Insulators: Polarization, Microscopic models of polarization processes, the internal field in solids and liquids, the relationship between polarizability and permittivity, the relative permittivity of polar materials, Ferroelectrics, Piezoelectric, Dielectric in Alternating fields, Complex permittivity of lossy dielectric, loss angle and loss tangent. **(6 hours)**

Magnetic Properties of Materials: Magnetic permeability, Magnetization, Bohr Magnetron, Electron and nuclear spins and magnetic moments, Atomic interpretation of magnetic properties of materials, Permanent magnetic dipoles in matter, Theory of diamagnetism, Langevin's theory of Para magnetism, Curie-Weiss theory, Ferromagnetism, Spontaneous magnetization of ferromagnetic materials, Weiss Hypothesis, Anti ferromagnetism, Ferrimagnetism, Garnets, magnetic bubbles. **(8 hours)**

Superconductivity: Experimental facts, Theoretical approaches, Thermodynamics of superconductors, the two fluid model, London's equations, Brief idea of BCS Theory. Applications of superconductors. **(5 hours)**

Nano Materials: Introduction, nano challenges, science behind nanotechnology, applications of nanotechnology- Sensors, smart materials. **(3 hours)**

References:

1. Solid State Physics, S.O. Pillai, New Age International.
2. Solid State Physics, A. Rao, Asiatech Publication.
3. Introduction to Solid State Physics, C. Kittel, John Wiley and sons.
4. Solid state Physics, A.J. Dekker, MacMillan

DEPARTMENT OF PHYSIC

PH2203 (4L hrs/week)

COMPUTER FUNDAMENTALS AND PROGRAMMING

Max Marks: 100

No. of questions to be set: 4 from UNIT – I and 4 from UNIT – II of 20 marks each.
No. of questions to be answered: Any 5 questions selecting atleast two questions from each UNIT

UNIT – I

Computer Fundamentals: Introduction, Basic anatomy of computers, Evolution of computers – different generations, Evolution of programming languages, Concepts of algorithm and flowcharts. **(5 hours)**

'C' Fundamentals: The 'C' character set, identifiers and keywords, data types, Operators & Expressions: Arithmetic, relational and logical operators, increment and decrement operators, precedence & associativity of operators. **(6 hours)**

Input and Output: Standard and formatted input-output. **(3 hours)**

Flow of control: Statements and blocks, if-else, else-if, switch, loops, break and continue. **(8 hours)**

Functions: Types, storage class, and recursion function prototypes, the 'C' preprocessor. **(8 hours)**

UNIT – II

Arrays: One dimensional and multidimensional array. **(5 hours)**

Pointers: Its relation with functions, arrays and character strings, pointer arrays. **(10 hours)**

Structures and Unions: Concepts and applications **(10 hours)**

REFERENCES:

1. Programming in 'C', Balguruswamy, Tata McGraw Hill publication.
2. Programming with 'C', Byron S. Gottfried, Schaum's outline series.

DEPARTMENT OF PHYSICS

PH2204 (4L hrs/week)

QUANTUM MECHANICS-II

Max Marks: 100

No. of questions to be set: 4 from UNIT – I and 4 from UNIT – II of 20 marks each.
No. of questions to be answered: Any 5 questions selecting atleast two questions from each UNIT

Objective: Students develop appropriate competence and a working knowledge of quantum physics. It will help them to understand atomic and sub-atomic physics.
Students develop the ability to identify and apply the appropriate analytic, numerical, computational, and other mathematical tools necessary to solve quantum problems.
Students develop a familiarity with the current state of research in quantum physics, including the most significant research questions being pursued by today's physicists**.**

Scope: Students develop the ability to analyze scientific problems, generate logical hypotheses, evaluate evidence, and tolerate ambiguity.
Students develop the ability to apply knowledge of quantum physics in relevant areas to make appropriate intellectual connections and solve problems.

UNIT-I

Approximation Methods: Variational Method, Harmonic Oscillator, Hydrogen Atom, and Ground State of Helium, WKB Approximation, Connection formulae, Bohr-Sommerfeld quantization condition and its application, Penetration of Barrier, Applications of Tunneling, Time-independent perturbation theory, Non-degenerate, Near degenerate and Degenerate perturbation, Hydrogen Atom & the Stark Effect, Ground state of Helium, Doubly degenerate level and Resonance, Fine structure of Hydrogen levels. **(11 hours)**

Time-dependent Perturbation Theory: Interaction picture. Time-dependent perturbation theory. Constant and harmonic perturbations, Transition from discrete level to continuum, Fermi's Golden Rule, Ionization of Hydrogen, Adiabatic and sudden approximations. Dynamics of two-level systems – exact and approximate treatment. **(10 hours)**

UNIT-II

Scattering Theory: Quantum Theory of scattering, Resonance scattering, Inelastic scattering, Wave packet description of scattering, Generalized Optical theorem, Integral Equation for scattering, Green's function, Born approximation, Coulomb scattering, scattering of identical particles. **(10 hours)**

Relativistic Quantum Mechanics: Relativistic 1-particle equations, Klein Gordon Equation, Motivation for Dirac equation, Continuity Equation, Dirac's Hole theory, Properties of Dirac matrices, Plane wave solutions of Dirac equation, Spin and magnetic moment of the electron, Non relativistic reduction of the Dirac equation, Spin-orbit coupling, Energy levels in a Coulomb field. **(11 hours)**

References:

1. Quantum Mechanics Theory And Applications, A.K Ghatak, S.Lokanathan, MacMillan India Ltd, Madras, 5th edn.
2. Quantum Mechanics, John.C. Powell and Bernd Crasemann, Narosa Publication House, New Delhi.
3. Quantum Mechanics, Franz Schwabl, Narosa Publication House, New Delhi.
4. Quantum Mechanics, Merzbacher, John Wiley (wie), 3rd Edition.
5. Quantum Mechanics, J.J. Sakurai, Pearson Education (India)

DEPARTMENT OF PHYSICS

PH2261

PHYSICS LAB III (ELECTRONICS)

Max Marks: 100

There will be **TWO** laboratory class of 3 hours duration per week. There are **13 weeks** expected in a semester.

Note: Minimum of **SIX** experiments to be completed from each **UNIT.**

Objectives: The objective of the lab being learning, the course has been designed such that the students are able to apply the scientific method to experiments in the laboratory and verify the theoretical ideas and concepts covered in lecture by completing a host of experiments. It will also enable the students to apply analytical techniques, statistical analysis and graphical analysis to the experiments. In this laboratory, the course emphasis is on the understanding of basic principles of electronics: characteristic properties for semiconductor diodes and their application in filter circuits, transistor, MOSFET, JFET,OP-AMP, multivibrator etc.

Prerequisites: The students should have completed a course of Physics at Degree level and thereby has an understanding of the basic principles of electronic circuits with the behavior of its various active and passive components.

UNIT I

1. Design of different rectifiers circuits with and without filters.
2. Study of clipper, clamper and voltage multipliers using diodes.
3. Design of Amplifiers using transistors and to study the frequency response.
4. MOSFET Characteristics.
5. JFET Characteristics.
6. BJT characteristics. Determination of h-parameters in the CE configuration using the measured input and output characteristics of a BJT (e.g.2N 2218).
7. Multivibrators – Bistable, Monostable and Free Running multivibrators using BJT's (e.g.2N 2218).
8. 555 IC timer. Free Running and Monostable Multivibrators, Sawtooth wave generator.

UNIT II

1. Verify the typical transfer characteristics of the OP-AMP both inverting and non-inverting configuration.
2. OP-AMP as Buffer amplifier (voltage follower).
3. Study differentiator and integrator using OP-AMPS.
4. Study the analog addition and subtraction using OP-AMPs.
5. To study the representation of basic logic gates: AND, OR, INVERT, NAND and NOR functions by truth tables, logic diagrams and Boolean algebra.
6. To design a circuit diagram and study the voltage gain, input impedance, and power gain of an emitter follower.

7. To study OP-AMP as a function generator, i.e. as (a) square wave generator (b) triangular wave generator.
8. To construct a Wein-Bridge oscillator using OP-AMP and to study its output waveform and frequency for various RC values.

DEPARTMENT OF PHYSICS

PH2262

PHYSICS LAB – IV (COMPUTER PROGRAMMING)

Max Marks: 100

Note: 6 hours per week for lab. There are 13 weeks expected in a semester.

Familiarization and introduction of computers, Operating System: Windows & Linux

Simple Programs: To find simple & compound interest, factorial of a number, sorting of series, solving algebraic equations.

Conversion of binary to decimal numbers, octal, hexadecimal and vice versa Summation of arithmetic series, trigonometric series and generation of nth term of a series. Solving some simple physics/electronics problems. Problems based on understanding of various statements, macro substitution. Problems using various loops.

Functions: Programs for different types of function, programs using recursive functions.

Arrays, Matrices and Strings: Sorting of arrays, manipulation of one and multidimensional arrays.
Programs for sorting words, comparing words and manipulating string output.

Pointers: Simple problems using arrays to demonstrate its relation with function, arrays and strings. Arrays of pointers.

Structures and Unions: Concepts and applications

DEPARTMENT OF PHYSICS

PH2301 (4L hrs/week)

STATISTICAL MECHANICS

Max Marks: 100

No. of questions to be set: 4 from UNIT – I and 4 from UNIT – II of 20 marks each.
No. of questions to be answered: Any 5 questions selecting atleast two questions from each UNIT

UNIT-I

Classical Ensemble Theory: Phase space, Liouville's equation, Micro-canonical, canonical and grand-canonical ensembles. Boltzmann relation for entropy. Application to classical system of interacting particles. **(10 hours)**

Quantum Ensemble Theory: Density operator, Quantum Liouville's equation. Density operator for equilibrium micro-canonical, canonical and grand canonical ensembles. Calculation of grand partition function and distribution function. **(15 hours)**

UNIT-II

Introductory Quantum Statistics: Bose-Einstein transition and nature of discontinuity of specific heat. Pauli paramagnetism. Landau's theory of liquid Helium II. Phonon-roton spectrum **(8 hours)**

General Theory of Phase Transitions: Order parameter. Landau's theory. Critical exponents. Order parameter fluctuations in Gaussian approximation. Scale invariance. Critical dimensionality. Concept of universality of phase transitions. Ising and Heisenberg models. Bethe approximation. Introduction to irreversible processes and their applications. **(17 hours)**

References:

1. Statistical Physics, Landau & Liftsutz
2. Statistical Physics, Berkeley Physics course
3. Statistical Mechanics, R.K. Pathria, B.H.Publication
4. Statistical Mechanics, K. Huang, Wiley Eastern Pub
5. Statistical Physics, J.K. Bhattacharya
6. Statistical and Thermal Physics, Reif, Mc Graw Hill
7. Statistical and Thermal Physics, Abhijit Lahiri
8. Fundamentals of Statistical Mechanics by BB Laud, New Age International
9. Introduction to Statistical Physics, Silvio R.A. Salinas, Springer
10. Introduction to Statistical Mechanics, Rogev Bowling & Mariana Sanchez, Oxford Sc

DEPARTMENT OF PHYSICS

PH2302 (4L hrs/week)

NUCLEAR AND PARTICLE PHYSICS

Max Marks: 100

No. of questions to be set: 4 from UNIT – I and 4 from UNIT – II of 20 marks each.

No. of questions to be answered: Any 5 questions selecting atleast two questions from each UNIT

Objectives: The course focuses at developing the basic knowledge of nuclear and particle physics, aspiring to pursue a carrier in physics. The main emphasis has been is the field of low energy nuclear physics, the basic discussion on elementary particles are also highlighted. Overall the course aims at developing the basic knowledge and numerical proficiency that will be required for learning nuclear physics.

Prerequisites: Student should have the basic knowledge of nuclear physics at undergraduate level. Student should also have the basic knowledge of mathematics and the basic laws of physics. They should have also done a course in mathematics involving calculus, simple differential equations, algebra, elementary number theory and other common mathematical operations. Basic knowledge of quantum physics is essential.

Learning Outcomes: After the completion of the complete syllabus, the student will be capable of the following:

11. Identify basic nuclear properties and outline their theoretical descriptions.
12. Understand the differences between various decay modes, state selection rules, and determine whether a given decay can take place
13. Calculate Q-values for alpha and beta decays and for nuclear reaction.
14. Apply conservation laws to nuclear reactions and transform quantities between laboratory and centre-of-mass frames
15. compare and construct different reaction mechanisms in relation to cross-sections.
16. manage to solve problems and develop critical thinking and independent learning .

UNIT-I

Static properties of Nuclei: Nuclear mass & binding energy, nuclear size and its determination from electron scattering, nuclear form-factors. Nuclear magnetic and electric moments. Angular momentum of the nucleus, spin and moments of nuclei. **(6 hours)**

Nuclear forces and two Nucleon system: Ground state of deuteron, Low energy neutron-proton scattering, spin dependence of n-p scattering, Non-central forces, S-wave effective range theory. Qualitative discussion on Proton-proton scattering, Evidence for hardcore potential. **(7 hours)**

Nuclear Models: Liquid Drop Model, The Shell Model, Nilsson's Unified Model. **(8 hours)**

UNIT-II

Nuclear Decays: Gamow's theory of alpha decay, alpha ray energies and fine structure of alpha rays, decay schemes, Fermi theory of beta decay, Kurie plot. Fermi and Gamow-Teller transitions. Parity violation in beta-decay, Electromagnetic decays: Selection rules, Electromagnetic interaction with nuclei. **(8 hours)**

Nuclear Reactions: Conservation laws, reaction energetics, relativistic and non-relativistic Q-value equation, Induced radioactivity, cross-section of nuclear reactions (theoretical considerations) theories of nuclear reaction, Breit Wigner formula. **(7 hours)**

Elementary Particles: Classification of fundamental forces, Spin and parity assignments, isospin, strangeness; Gell-Mann-Nishijima formula; C, P, and T invariance and applications of symmetry arguments to particle reactions, Properties of quarks and their classification. Elementary ideas of SU (2) and SU (3) symmetry groups and hadron classification. Introduction to the standard model. Electroweak interaction-W & Z Bosons**.** **(6 hours)**

References:

1. Nuclear Physics, S.N. Ghoshal, S. Chand and Company.
2. Nuclear Physics by I. Kaplan, Narosa.
3. Nuclear Physics by RR Roy and BP Nigam, Wiley Eastern Ltd.
4. Nuclear Physics, D.C. Tayal, Himalaya Publishing House.
5. Introductory Nuclear Physics, Kenneth S. Krane, Wiley India Pvt. Ltd.

DEPARTMENT OF PHYSICS

PH2303 (4L hrs/week)

NUMERICAL TECHNIQUES

Max Marks: 100

No. of questions to be set: 4 from UNIT – I and 4 from UNIT – II of 20 marks each.
No. of questions to be answered: Any 5 questions selecting atleast two questions from each UNIT

Objectives: The course focuses at developing the basic knowledge of solving mathematical problems numerically which cannot be solved using analytical methods. This subject also is intended to develop the skill to formulate algorithms to solve problems using computers.

Prerequisites: Basic knowledge of mathematics at undergraduate level is essential. Knowledge of differentiation, integration, ordinary and partial differential equation, matrices, infinite series etc. is necessary.

Learning Outcomes: After the completion of the complete syllabus, the student will be capable of the following:

1. Develop the skill of numerically solving the problems which cannot be solved analytically.
2. Develop the skill to formulate algorithms to be used in computers to solve problems.
3. Understands the significance of errors and its propagation in numerical calculations and how to minimize the errors, hence improving the accuracy.

UNIT – I

Introduction: Computer arithmetic, floating point representation of numbers, arithmetic operations, errors, accuracy and stability. **(4 hours)**

Roots of equation: Bisection, false position, Newton-Raphson method, secant method. **(4 hours)**

Simultaneous linear equation: Gauss elimination method, iterative method. **(3 hours)**

Interpolation and extrapolation: Lagrange interpolation, Newton-Gregory interpolation. **(3 hours)**

Least square curve fitting: Linear, polynomial regression, fitting exponential, trigonometric functions. **(3 hours)**

Numerical differentiation & Integration of a function: Differentiation, Trapezoidal rule, Simpson's rule, Gaussian quadrature formula, **(4 hours)**

UNIT-II

Solution of O.D.E: Taylor series method, Runge-Kutta method, Predictor-corrector method **(6 hours)**

Solution of P.D.E: Difference method, accuracy, stability, Lax method, Two-step Lax-Wendroff method, FTCS application to wave equation, Adective equation, Diffusion equation, Poisson equation, fast Fourier transforms. **(8 hours)**

Random numbers: Properties of random numbers, generation of random numbers. **(4 hours)**

Monte Carlo Techniques: Introduction, Monte Carlo Evaluation of integrals, Use of Monte Carlo techniques in Physics. **(4 hours)**

References:

3. Computer oriented numerical methods, V. Rajaraman, PHI
4. Numerical Analysis, S. S. Sastry, PHI
5. Numerical Methods for Scientific and Engineer Computation, M. K. Jain, S.R.K. Iyengar & R. K. Jain, Wiley Eastern, Indian Journal of Physics
6. Numerical Recepies in C, W.H Press, S.A. Tenkolsky, W.Vetterling and B.P Flannery, Cambridge University Press

DEPARTMENT OF PHYSICS

PH2331 (4L hrs/week)

PARTICLE PHYSICS I (ELECTIVES-I)

Max Marks: 100

No. of questions to be set: 4 from UNIT – I and 4 from UNIT – II of 20 marks each.

No. of questions to be answered: Any 5 questions selecting atleast two questions from each UNIT

Objectives: The course focuses at developing the basic knowledge of Particle Physics and Quantum Field Theory. It helps students to understand the basic constituents of all the matters in the Universe and the interaction among themselves.

Prerequisites: Knowledge in Quantum Mechanic-I (Non-relativistic), Quantum Mechanics-II (Relativistic), Classical Mechanics, Classical electrodynamics, Mathematical Methods in Physics are essential.

Learning Outcomes: After the completion of the complete syllabus, the student will be capable of the following:

1. Understand the basics of Particle Physics.
2. Understand the macroscopic physics in terms of physics at most fundamental, microscopic level.

UNIT-I

Introduction: A preview of Particle Physics, Introduction to elementary particles, Nature of interactions, Characteristic lifetimes and strengths, The Eightfold way, Quark Model, Cosmology and particle physics. **(8 hours)**

Relativistic Dynamics: Review of Relativistic Quantum Mechanics, Elementary Particle Dynamics, Scalar, Dirac, Electromagnetic fields, invariance principles, Lorentz invariance of free fields, Noether's theorem and its applications, Quantization of free fields. **(16 hours)**

UNIT-II

Symmetries: Symmetries, Groups and Conservation laws, Conservation laws in Quantum Mechanics, Symmetry and degeneracy, Parity, Charge Conjugation and time Reversal, CPT-theorem, CP violation, Properties of Bilinear covariants under C, P, T. Permutation Symmetry, Unitary Symmetry, SU (2) of spin, SU (3) of flavour and SU (6) Groups, Isospin, G-parity, Strange particles (Gell-Mann Nishijima Scheme), Quark Model of Hadrons. **(16 hours)**

The Standard Model: Electroweak interaction, Inclusion of Hadrons, Quantum Chromodynamics. **(4 hours)**

References:

1. Introduction to High Energy Physics, D. H. Perkins
2. Introduction to Particle Physics, Griffith , Wiley
3. Quarks and Leptons, Halzen &Martin, Wiley
4. Introduction to Particle Physics, W. S. C. Williums
5. Quantum Field Theory, Mandl & Shaw, John Wiley & Sons

DEPARTMENT OF PHYSICS

PH2332 (4L hrs/week)

PLASMA PHYSICS-I (ELECTIVE I)

Max Marks: 100

No. of questions to be set: 4 from UNIT – I and 4 from UNIT – II of 20 marks each.
No. of questions to be answered: Any 5 questions selecting atleast two questions from each UNIT

Objectives: The course is focused on realization of new state of matter which is plasma. It gives idea of interdisciplinary subject.

Prerequisites: Students should have the basic knowledge of gas, solid and liquid state of matter. The wave nature and its propagation in the medium.

Learning Outcomes: After the completion of the complete syllabus, the student will be capable of the following:

1. Students will gain basic concept of phases of matter.
2. Students will be able to deal with mode study in any medium.
3. Basic understanding of stability and instability of a system will be develop.
4. Application of Fourier method.

UNIT-I

Introduction: Definition of plasma, Debye shielding, plasma parameters, criteria for plasma. **(3 hours)**

Single particle motions: Under E×B fields, nonuniform B field, nonuniform E field, time varying E field, time varying B field. **(7 hours)**

Fluid model of plasma: Concept of fluid element, fluid equations, Fluid drift perpendicular to B and parallel to B, plasma approximation. **(3 hours)**

Linear Waves in plasmas: Plasma oscillation, electron plasma wave, ion waves, electrostatic and e-m waves without/with magnetic field. Hydromagnetic waves, Magnetosonic waves and Alfven waves. **(13 hours)**

UNIT-II

Plasma Diffusion: Ambipolar, resistivity , MHD equations. Generalized Ohm's law, classical, Bohm diffusions. **(5 hours)**

Kinetic theory of plasma: Statistical description of plasma, Boltzmann-Vlasov equation. Boltzmann and Landau collision integral, Fokker-Plank term. Solution of Boltzmann equation. Landau damping**.** **(6 hours)**

Stability of plasma: Classification of plasma instabilities. Methods of stability analysis, Two-stream instability. Rayleigh-Tayler and Kelvin Helmholtz instabilities. Pinch and Kink instabilities**.** **(9 hours)**

References:

1. Introduction to plasma physics and controlled fusion, F.F. Chen, Second edition, Plenum Press.
2. Principles of plasma physics, N.A. Krall and A.W. Trivelpiece, McGraw Hill, (1973).
3. Plasma Kinetic Theory, D.C. Montgomery and D.A. Tidman, McGraw Hill (1964).
4. The Theory of plasma Waves, T.H. Stix, McGraw Hill (1962).
5. Introduction to unmagnetized plasma, C. Uberoi, PHI (1988).

DEPARTMENT OF PHYSICS

PH2333 (4L hrs/week)

ELECTRONICS-I (ELECTIVE II)

Max Marks: 100
No. of questions to be set: 4 from UNIT – I and 4 from UNIT – II of 20 marks each.
No. of questions to be answered: Any 5 questions selecting atleast two questions from each UNIT

Objectives: The course focuses at developing the basic knowledge of Very-large-scale integration (VLSI) technology. It gives a preliminary idea about the fabrication of integrated circuits (IC) and materializes the circuit design along with the requirement of miniaturization. It also introduces two unparallel examples of IC, Operational amplifier and Microprocessor. The characteristics of Operational amplifier and its use in analog circuits for different applications have been emphasized. The basic architecture of 8085, the associated programming language and its use in solving problems of real life applications will also be discussed.

Prerequisites: Students should have the basic knowledge of physics of semiconductor devices. Students should understand the operation of analog circuits containing active and passive components. They should have also done a course in mathematics involving calculus, simple differential equations, algebra and elementary number theory.

Learning Outcomes: After the completion of the complete syllabus, the student will be capable of the following:

1. Students will have basic idea about the fabrication processes used in the manufacturing of VLSI based devices.
2. Students will be able to design the basic MOS devices which are the building blocks for VLSI circuits.
3. Students will be able to design the analog circuits using OPAMP for various real life applications.
4. Students will have basic idea about the microprocessor and will be able to program it according to the requirements.

UNIT-I

Integrated Circuit Fabrication: The monolithic integrated circuit technology, the planar processes, Bipolar transistor fabrication, fabrication of FET, CMOS technology, monolithic diodes; integrated-circuit resistors, capacitor and packaging; characteristics of IC components, microelectronic circuit layout. **(5 hours)**

CMOS fabrication: p and n well processes, twin tub process, thermal aspects, Bi-CMOS technology, and production of E-beam masks**.** **(3 hours)**

MOS and BiCMOS circuit design processes: MOS layers, stick diagram, design rule and layouts, a brief introduction of layout diagrams. **(5 hours)**

Basic Circuit Concepts: Sheet resistance, area capacitance of layers, standard unit of capacitance, delay unit, inverter delays, Driving large capacitive loads, propagation delays, wiring capacitance, choice of layers. **(5 hours)**

Scaling of MOS circuits: Scaling models and scaling factors. Scaling factors for device parameters. Limitations of scaling. **(3 hours)**

UNIT- II

Operational Amplifier (without internal circuit): characteristics of an ideal op-amp, as well as practical op-amp. Open-loop op-amp configuration: Differential, inverting and non- inverting amplifier. Close-loop op-amp configuration (with negative feedback): voltage- series feedback, voltage- shunt feedback, differential with one op-amp. **(5 hours)**

Applications of Op-Amp: AC Amplifier; summing, scaling and averaging amp., V to I and I to V converter, log, anti-log amp., multiplier and divider, differentiator, integrator. Comparator, square and triangular wave generator, V/F and F/V converter. **(5 hours)**

Introduction to Microprocessor Architecture: 8085 CPU Architecture, register organization, Memory Interfacing, 8085 instruction set, addressing modes, programming using 8085 instruction set, instruction cycle, machine cycles, timing diagram. **(5 hours)**

Interfacing devices: Basic Interfacing concepts, Interfacing output displays, Input devices memory-mapped I/O, Tristate devices, buffers, latches. **(4 hours)**

References:

2. Microelectronics by Jacob Millman and Arvin Grabel, Mcgraw-Hill College; 2 Sub edition (1987).
3. Microelectronic Circuits by Sedra and Smith Oxford Series.
4. Basic VLSI design by Douglas A. Puncknell and Kamran Eshragjhian, PHI.
5. Basic Electronics: *Devices, Circuits & IT Fundamentals*: Santiram Kal, Prentice Hall of India, (2008).
6. Microprocessor Architecture, Programming and Applications with the 8085—Ramesh S. Gaonkar, Penram International Publishing (India).

DEPARTMENT OF PHYSICS

PH2334

ELECTRONICS LAB I (ELECTIVE II)

Max Marks: 100

There will be **TWO** laboratory class of 3 hours duration per week. There are **13 weeks** expected in a semester.

Note: Minimum of **SIX** experiments to be completed from each **UNIT.**

Objectives: The objective of UNIT I is to build simple OPAMP circuits to examine some of the basic characteristics and compare observed behavior with the theoretical one. Afterwards application of OPAMP will be studied to perform specific operations e.g. data conversion, solving of equation etc. The objective of UNIT II is to introduce the assembly language program of 8085. Employing commonly used instructions elementary programming technique and their applications will be explored.

Prerequisites: Students should understand the operation of analog circuits containing active and passive components. They must know the basic architecture of 8085, specially the programing registers. They should have a clear understanding about the decimal, binary and hexadecimal number systems.

UNIT I

1. Determine the slew rate of a given OP-AMP, at various frequencies and amplitude.
2. Determine the common mode rejection ratio (CMRR) and measure the input bias current and offset voltage of an OP-AMP.
3. Frequency response of the amplifier in the inverting configuration and study the phase shift with frequency.
4. Design and construct of RC phase shift oscillator using OP-AMP.
5. Design and construct the A/D converter using OP-AMP.
6. Design and construct the D/A converter using OP-AMP.
7. Find log and antilog of a given number using OP-AMP.
8. Solve two simultaneous equations using OP-AMP.
9. Design and construct current to voltage converter using OP-AMP.
10. Design and construct voltage to current converter using OP-AMP.

UNIT II

Experiments using microprocessor 8085

1. Addition of two 8 bit numbers.
2. Subtraction of two 8 bit numbers.
3. Addition of two 16 bit numbers.
4. Subtraction of two 16 bit numbers.
5. Multiplication of two 8 bit numbers.
6. Division of two 8 bit numbers.
7. Multiplication of two 16 bit numbers.
8. Division of two 16 bit numbers.
9. Selection of the largest number from an array of numbers.
10. Selection of the smallest number from an array of numbers.

11. Find the square of a given number.
12. Find the square root of a given number.

References:

1. Op-Amps and Linear Integrated Circuits, Ramakant. A. Gayakwad, PHI Learning.
2. Microprocessor Architecture, Programming and Applications with the 8085—Ramesh S. Goankar. Prentice Hall.

DEPARTMENT OF PHYSICS

PH2401 (4L hrs/week)

EXPERIMENTAL TECHNIQUES AND DATA ANALYSIS

Max Marks: 100

No. of questions to be set: 4 from UNIT – I and 4 from UNIT – II of 20 marks each.
No. of questions to be answered: Any 5 questions selecting atleast two questions from each UNIT

Objectives: The course focuses at developing the basic knowledge of interaction of the radiation with the mater and mechanism to detect the radiation. And also develop the basic knowledge regarding the digital electronics circuits.

Prerequisites: Basic knowledge of atomic physics, nuclear physics, electrical circuits and mathematics at undergraduate is essential.

Learning Outcomes: After the completion of the complete syllabus, the student will be capable of the following:

1. Develop the understanding of interaction of the radiation, dose and exposure which are used in medical applications.
2. Develop the ideas to discover the new particles.
3. Develop the idea on digital circuits which is to be used in computers and other electronic system.

UNIT – I

Radiation sources: Units and Definitions, Fast Electron Sources, Heavy Charged Particle Sources, Sources of electromagnetic Radiation, Neutron sources. **(4 hours)**

Interaction of radiations with matter: Interaction of Charged Particles, Fast Electrons, Gamma rays, Neutrons, Radiation Exposure and Dose. **(4 hours)**

Counting Statistics and Data Analysis: Precision and accuracy, Data interpretation and analysis using Statistical Models (Binomial, Poisson and Gaussian/Normal distribution), Optimization of Counting experiments. **(6 hours)**

Detectors: General properties of detectors, Gas Detectors: (Ionization Chambers, Proportional Counters, GM Counters), Scintillation Detectors, Silicon Surface Barrier Detector, Photomultiplier tubes, Cherenkov Detectors. **(9 hours)**

UNIT-II

Digital Electronics II: A/D and D/A converters, Digital techniques and applications (registers, counters, comparators and similar circuits); Introduction to 8085 Microprocessor architecture. **(12 hours)**

Data acquisition and signal processing: Introduction to transducers, Signal conditioning and recovery, Measurement and control, Impedance matching, filtering and noise reduction, shielding and grounding, Single channel data acquisition system, Multi-channel. Data acquisition system. **(8 hours)**

References:

1. Techniques for Nuclear and Particle Physics experiments, *W.R. Leo* (Springer, Berlin and Heidelberg, (1987).
2. Radiation Detection and Measurement, Glen F. Knoll, John Wiley & Sons.
3. Digital Computer Electronics, A.P. Malvino, Tata McGraw Hill.
4. Instrumentation Devices and Systems, C.S. Rangan, G. R. Sarma, V.S.V. Mani, Tata McGraw Hill.
5. Basic Electronics: Devices, Circuits & IT Fundamentals: Santiram Kal, Prentice Hall of India, (2008).
6. Microprocessor Architecture, Programming and Applications with the 8085—Ramesh S. Gaonkar, Penram International Publishing (India).

DEPARTMENT OF PHYSICS

PH2402 (4L hrs/week)

ATOMIC AND MOLECULAR PHYSICS

Max Marks: 100
No. of questions to be set: 4 from UNIT – I and 4 from UNIT – II of 20 marks each.
No. of questions to be answered: Any 5 questions selecting atleast two questions from each UNIT

Objectives: The course focuses to explain the fine structure and hyper fine structure of the atomic spectrum which cannot be explained by using the simple Bohr quantum model. This subject also is intended to explain the molecular spectra and principle of laser light.

Prerequisites: Basic knowledge of mathematics and statistical mechanics at undergraduate and graduate level is essential. Very good knowledge of quantum mechanics, nuclear physics and special theory of relativity is required.

Learning Outcomes: After the completion of the complete syllabus, the student will be capable of the following:

1. Develop the understanding of quantum mechanics as well as learn the power of quantum mechanics to explain the origin and nature of the spectra of the hydrogen – like atoms and of the alkali atoms.

2. Develop the idea of molecular physics which helps the understanding of the properties of the matter.

3. Get the idea of laser light.

UNIT – I

Atomic Physics: Fine structure of hydrogenic atoms, Mass correction, spin-orbit term, Darwin term. Intensity of fine structure lines. The ground state of two-electron atoms-perturbation theory and variation method. Many electron atoms-LS and jj coupling schemes, Lande interval rule, Hund's rule. The idea of Hartee-Fock equations. The spectra of alkalis using quantum defect theory. Zeeman, Paschen Back & Stark effect. Electron spin resonance. Nuclear magnetic resonance, chemical shift. **(16 hours)**

Molecular Physics: Molecular structure: Born-Oppenheimer separation for diatomic molecules, Rotation, vibration and electronic structure of diatomic molecules. Valence-bond and Molecular orbital theory: Applications to H_2^+ and H_2. **(8 hours)**

UNIT-II

Molecular Spectra: Rotation, vibration-rotation and electronic spectra of diatomic molecules. Raman spectra of diatomic molecules. The Franck-Condon principle. The electron spin and Hund's cases. Idea of symmetry elements and point groups for simple molecules. **(10 hours)**

Lasers: Spontaneous and stimulated emission, Einstein A & B coefficients, Multilevel rate equations and saturation, Laser pumping and population inversion, Gas, Liquid and Solid state

Lasers: Ruby Laser, He-Ne Laser, Free-electron laser, Non-linear phenomenon. Harmonic generation, Self focusing of light, Laser accelerator. **(8 hours)**

References:

1. Physics of Atoms and Molecules, BH Bransden and CJ Joachain, Pearson Education.
2. Atomic Physics, S.N. Ghoshal, S. Chand Publishers.
3. Lasers and Nonlinear Optics,.B B. Laud, New Age International.
4. Fundamentals of Molecular Spectroscopy , CN Banwell, Tata McGraw Hill.
5. Introduction to Atomic Spectra, HE White, McGraw Hill.

DEPARTMENT OF PHYSICS

PH2461

COMPUTATIONAL PHYSICS LAB

Max Marks: 100
Note: 6 hours per week for lab. There are 13 weeks expected in a semester.

1. Programming to plot a function

2. Root finding of polynomials (Bisection, N.R.)

3. Interpolation (Lagrange, Newton – Gregory)

4. Curve fitting by least square method (Linear and quadratic, trigonometric)

5. Integration of functions using different techniques (Trapezoidal and Sympson's method)

6. Differentiation of functions different techniques.

7. Solving Ordinary Differential equation (R.K. 2 and R. K. 4)

8. Use of Monte Carlo technique to solve simple problems.

DEPARTMENT OF PHYSICS

PH2431 (4L hrs/week)

PARTICLE PHYSICS II (ELECTIVES-I)

Max Marks: 100

No. of questions to be set: 4 from UNIT – I and 4 from UNIT – II of 20 marks each.
No. of questions to be answered: Any 5 questions selecting atleast two questions from each UNIT

Objectives: The course focuses at developing the basic knowledge of Particle Physics and Quantum Field Theory. It helps students to understand the basic constituents of all the matters in the Universe and the interaction among themselves.

Prerequisites: Knowledge in Quantum Mechanic-I (Non-relativistic), Quantum Mechanics-II (Relativistic), Classical Mechanics, Classical electrodynamics, Mathematical Methods in Physics, Particle Physics-I are essential.

Learning Outcomes: After the completion of the complete syllabus, the student will be capable of the following:

1. Understand the basics of Particle Physics.
2. Understand the macroscopic physics in terms of physics at most fundamental, microscopic level.

UNIT-I

Weak Interaction: Theory of beta-decay, Pion and muon-decay, lepton conservation, types of neutrinos, conserved vector current hypothesis and related topics. **(16 hours)**

Gauge-invariance: Abelian Transformation: U(1) Gauge symmetry, global and local gauge invariance, Electrodynamics of a Dirac Field, Non-Abelian Transformations. **(8 hours)**

Concepts of spontaneous symmetry breaking: Goldstone theorem, Higgs mechanism.**(6 hours)**

UNIT-II

Standard model- electroweak theory: Choice of the group SU (2) X U (1), two component left handed fermions, weak isospin and hypercharge assignment. SU (2) X U(1) symmetry breaking via the Higgs mechanism. Masses of vector bosons. Weak charged and neutral currents. Coupling of W and Z-bosons with leptons and quarks. Gauge vs. mass-eigen states. Calculations of processes like W decays etc. **(22 hours)**

References:

1. Introduction to Particle Physics, Griffith, Wiley
2. Quarks and Leptons, Halzen &Martin, Wiley
3. Introduction to Particle Physics, W. S. C. Willium

DEPARTMENT OF PHYSICS

PH2432 (4L hrs/week)

PLASMA PHYSICS-II (ELECTIVE I)

Max Marks: 100
No. of questions to be set: 1 compulsory question from the entire syllabus. 4 each from Unit-I and Unit-II of 20 mark each.
No. of questions to be answered: The COMPULSORY plus TWO from each Unit.

Objectives: The course is focused on realization of nonlinear phenomena in a system specially plasma. To get basic concept of diagnosis of material. To realize industrial applications of plasma.

Prerequisites: Students should have the basic knowledge of plasma, fluid model, interaction of conducting fluid and electromagnetic force. Current flow in a medium.

Learning Outcomes: After the completion of the complete syllabus, the student will be learn following:

1. Students will gain basic knowledge of nonlinear waves, parametric instability in plasma.
2. Students will learn electrical and spectroscopic diagnostic techniques.
3. Plasma production techniques.
4. Thermonuclear power generation techniques.
5. MHD power generation.

UNIT-I

Nonlinear phenomena: Introduction, Sheath, Ion Acoustic Shock Waves, Solitons, Pondermotive force, Parametric Instabilities, Plasma Echoes, Nonlinear Landau Damping. **(11 hours)**

Plasma Diagnostics: Electric Probes, Single probe and double probe methods. Microwave method. Spectroscopic method. X-ray diagnostics. **(10 hours)**

Introduction: radiations from plasma. **(2 hours)**

UNIT-II

Plasma Production: Ionization of gas by collision, Townsend's theory of ionization, break down potential, cold-cathode discharge, thermionic arc discharge, RF-discharge, dense plasma focus, laser produced plasma. **(7 hours)**

Thermonuclear Power reactor: Introduction to thermonuclear fusion, criteria for a reactor, Plasma production, heating of plasma, Tokamak, Magnetic mirror, Stellarator. **(8 hours)**

MHD power generator: Basic theory, principle of working, configuration. **(7 hours)**

References:

1. Plasma Physics, S.N. Sen, Pragati Prakashan.
2. Principles of Plasma Physics, N.A. Krall and A.W. Trivelpiece, McGraw-Hill.
3. Introduction to Plasma Physics, F.F. Chen, Vol. 1, Plenum Press.
4. Plasma Diagnostics, W. Lochte-Holtgreven, North-Holland Pub.
5. Plasma Technology, B. Gross, B. Gryez and K. Miklossy, Iliffe Books Ltd.

DEPARTMENT OF PHYSICS

PH2433 (4L hrs/week)

ELECTRONICS-II (ELECTIVE II)

Max Marks: 100
No. of questions to be set: 4 from UNIT – I and 4 from UNIT – II of 20 marks each.
No. of questions to be answered: Any 5 questions selecting atleast two questions from each UNIT

Objectives: The course focuses at developing the basic knowledge of electronic communication systems. It gives a preliminary idea about the analog and digital communication and materializes the circuit design for the generation, modulation and demodulation of the different communications schemes. It also introduces the effect of transmission medium on the transmitted/received signal, termed as Noise. The merits and demerits of different communications schemes will also be discussed.

Prerequisites: Students should have the knowledge of basic electronic principles and an understanding of mathematics through trigonometry.

Learning Outcomes: After the completion of the complete syllabus, the students will be capable of the following:

1. Students will have basic idea about electronic communication.
2. Students will be able to compare and contrast different communication schemes.
3. Students will be able to identify the process required to generate, modulation and demodulation of different communication schemes.
4. Evaluate the quality of transmitted or received information.
5. Recognize the role of the transmission medium in communication system.

UNIT-I

Introduction: Communications system, Modulation and Demodulation, Transmission Frequencies: Bandwidth requirement and information capacity, Transmission modes, Introduction to optical communication. **(7 hours)**

Noise: External noise, Internal noise: Thermal agitation noise, Shot noise etc., Noise calculations, Noise figure, Noise temperature. **(3 hours)**

Amplitude Modulation: Principles of amplitude modulation and demodulation, The AM envelope, AM Frequency spectrum and bandwidth. Phasor representation, Coefficient of modulation and Percent modulation, Voltage and Power distributions, Time-Domain Analysis, Generation of AM, Basic requirements, Grid-modulated class C amplifier, Plate modulated class C amplifier. Evolution and Description of SSB. **(10 hours)**

UNIT-II

Angle Modulation: Theory of frequency and phase modulation and demodulation, Mathematical representation of FM, Frequency spectrum of the FM wave, Bandwidth and required spectra, Phase modulation, Phasor representation of an Angle-modulated wave, Average power of an Angle-modulated wave. **(10 hours)**

Pulse Communications: Pulse modulation, Sampling theorem. Types: Pulse amplitude modulation, Pulse width modulation, Pulse position modulation, Generation and Demodulation, Pulse-Code modulation, Quantizing noise, Companding, Amplitude shift keying, Frequency shift keying, Phase shift keying. **(10 hours)**

References:

1. Electronic Communication Systems, George Kennedy, Tata McGraw Hill.
2. Optical Fiber Communications: Principles and Practice, John M. Senior: Prentice Hall, New Jersey (1985).
3. Analog and Digital Communication Systems, Martin S. Roden, Prentice Hall, New Jersey, 2nd ed.(1985).
4. Principles of Communication Engineering, Anokh Singh, S.Chand & Co. Ltd.
5. Electronic Communications Systems, Wayne Tomasi, Pearson Education Asia.

DEPARTMENT OF PHYSICS

PH2434

ELECTRONICS LAB II (ELECTIVE II)

Max Marks: 100

There will be **TWO** laboratory class of 3 hours duration per week. There are **13 weeks** expected in a semester.

Note: Minimum of **SIX** experiments to be completed from **UNIT I** and Minimum of **FOUR** experiments to be completed from **UNIT II** along with the Compulsory Experiments**.**

Objectives: Primarily objective of this lab is to provide hands on experience of different modulation techniques. Later on design and implementation of different types of filters will be conducted to study their output characteristic. Finally PSPICE language will be introduced to design different analog circuits.

Prerequisites: Students should have the knowledge of basic electronic principles and OPAMP characteristic. To design the filters an understanding of basic mathematical analysis is required.

Compulsory experiments:

1. Study of Amplitude modulation & demodulation.
2. Study of Frequency modulation & demodulation.
3. Study of Pulse amplitude modulation, pulse width modulation and demodulation.
4. Study of Digital modulation and demodulation.

UNIT I

1. Design and construct first order active low pass filter.
2. Design and construct first order active high pass filter.
3. Design and construct second order active low pass filter.
4. Design and construct second order active high pass filter.
5. Design and construct first order active wide band pass filter.
6. Design and construct first order active narrow band pass filter.
7. Design and construct first order active wide band reject filter.
8. Design and construct first order active narrow band reject filter.
9. Design and construct first order active all pass filter.

UNIT II

1. Simulate a circuit consisting of R, L and C using PSPICE.
2. Simulate diode and transistor characteristics using PSPICE.
3. Simulate voltage doublers, tripler and quadruple using PSPICE.
4. Simulate clipper and clamper using PSPICE.
5. Simulate an amplifier using PSPICE.
6. Simulate an oscillator using PSPICE.

References:

1. Op-Amps and Linear Integrated Circuits, Ramakant. A. Gayakwad, PHI Learning.

2. SPICE for Circuits and Electronics Using PSPICE, Muha