বিদ্যাসাগর বিশ্ববিদ্যালয়

Vidyasagar University

Department of Physics

Syllabus for two years M. Sc in Physics (Semester System with CBCS)

Midnapore, 721102::(Ph- (03222) 298-405/ Centrex. 405) <u>From July 2018</u>

COURSE STRUCTURE OF M.Sc. in PHYSICS

SEMESTER	COURSE NO.	COURSE TITLES		Full Marks	Credit
I	PHS 101	PHS 101.1	METHODS OF MATHEMATICAL PHYSICS - I	50	4
		PHS 101.2	CLASSICAL MECHANICS		
	PHS 102	PHS 102.1	QUANTUM MECHANICS - I	50	4
		PHS 102.2	SOLID STATE – I		
	PHS 103	PHS 103.1	ELECTRODYNAMICS	50	4
		PHS 103.2	MATERIALS: PREPARATION AND CHARACTERIZATION		
	PHS 104	PHS 104.1	ANALOG ELECTRONICS - I	50	4
		PHS 104.1	DIGITAL ELECTRONICS - I		
	PHS 195	ELECTRONICS PRACTICAL –I		50	4
	PHS 196	COMPUTER PRACTICAL		50	4
		TOTAL		300	24
II	PHS 201	PHS 201.1	QUANTUM MECHANICS - II	50	4
		PHS 201.2	METHODS OF MATHEMATICAL PHYSICS - II		
	PHS 202	PHS 202.1	SOLID STATE II	50	4
		PHS 202.2	SEMICONDUCTOR PHYSICS		
	PHS 203	PHS 203.1	ANALOG ELECTRONICS - II	50	4
		PHS 203.2	DIGITAL ELECTRONICS - II		
	C-PHS 204	*CONCEPTS OF PHYSICS: INVENTIONS ANS APPLICATION(CBCS)*		50	4
	PHS 295	ELECTRONICS PRACTICAL – II		50	4
	PHS 296	ADVANCE PRACTICAL – I		50	4
		TOTAL		300	24
III	PHS 301	PHS 301.1	QUANTUM MECHANICS - III	50	4
		PHS 301.2	STATISTICAL MECHANICS - I		
	PHS 302	PHS 302.1	MOLECULAR SPECTROSCOPY & LASER PHYSICS	50	4
		PHS 302.2	NUCLEAR PHYSICS - I		
		SPECIAL PAPER (any one)			
	PHS 303	PHS 303A	SOLID STATE PHYSICS-I	50	4
		PHS 303B	APPLIED ELECTRONICS-I		
			PHS 303B.1 APPLIED ANALOG ELECTRONICS-I		
			PHS 303B.2 APPLIED DIGITAL ELECTRONICS-I		
		PHS 303C	APPLIED OPTICS AND OPTO-ELECTRONICS-I		
	C-PHS 304	*INTRODUCTORY ASTROPHYSICS (CBCS)*		50	4
	PHS 395	ADVANCE PRACTICAL-II		50	4
		SPECIAL BASED PRACTICAL			
	PHS 396	PHS 396A	SOLID STATE PHYSICS-I (practical)	50	4
		PHS 396B	APPLIED ELECTRONICS-I (practical)		
		PHS 396C	APPLIED OPTICS AND OPTO-ELECTRONICS-I(practical)		
		TOTAL		300	24
IV	PHS 401	PHS 401.1	PARTICLE PHYSICS	50	4
		PHS 401.2	STATISTICAL MECHANICS - II		
	PHS 402	PHS 402.2	NUCLEAR PHYSICS - II	**50**	4
		PHS 402.1	QUANTUM FIELD THEORY		
	PHS 403	PHS 403.1	SEMICONDUCTOR DEVICES	**50**	
		PHS 403.2	APPLIED OPTICS		
		SPECIAL PAPER (any one)			
	PHS 404	PHS 404A	SOLID STATE PHYSICS-II	50	4
		PHS 404B	APPLIED ELECTRONICS-II		
			PHS 404B.1 APPLIED ANALOG ELECTRONICS-II		
			PHS 404B.2 APPLIED DIGITAL ELECTRONICS-II		
		PHS 404C	APPLIED OPTICS AND OPTO-ELECTRONICS-II		
		SPECIAL BASED PRACTICAL			
	PHS 495	PHS 495A	SOLID STATE PHYSICS-II (practical)	50	4
		PHS 495B	APPLIED ELECTRONICS-II (practical)		
		PHS 495C	APPLIED OPTICS AND OPTO-ELECTRONICS-II(practical)		
	PHS 496	PROJECT, SEMINAR AND GRAND VIVA		50	4
		TOTAL		300	24
ALL TOTAL				1200	96

Full Marks, 50 = END SEMESTER EXAMINATION (40) + INTERNAL ASSESSMENT (10)
25 = END SEMESTER EXAMINATION (20) + INTERNAL ASSESSMENT (5)

PROGRAMME OUTCOME

M.Sc Physics programme is based on total syllabus covering almost all the fields of Physics. The syllabus is based on CBCS and the students get good knowledge after completing the course. Thus in every year a significant number of students qualify national level examination like NET, GATE, SET, JEST. The programme design will ensure that students passing out will have completed the standard pre-requisites for them to take up doctoral programme in India and abroad. The multidisciplinary and interdisciplinary skills which they have acquired will be of tremendous value to them especially if they choose to enter such research areas as nano-scale physics, theoretical as well as experimental Solid State Physics, Optoelectronics, and Electronics.

SEMESTER- I

Course No: PHS 101.1: Methods of Mathematical Physics

Marks: 25 Credit: 2 Classes: 20

1. Vector spaces and matrices: Vector spaces of n dimensions, inner product, Schmidt's orthogonalisation, Schwarz and Bessel inequality.

2. Hermitian and unitary matrices, eigenvectors and elgenvalues, diagonalization, unitary transformation. Cayley Hamilton theorem.

3. Complex variable: Cauchy Reimann conditions, cauchys integral and residue theorem, singularities, poles, branch points, contour integration. Taylor & layrebt series expansion, Principle value of an integral Reimann Surface.

4. Special functions, regular and irregular singularities, series solution. Hermite & Legendre (only revision).Laguerre and Bessel functions / polynomials, Gamma, Beta and error functions.

Books Recommended

1. M. R. Spiegel (Schaum's outline series) – Theory and Problems of Complex Variables.
2. G. Arfken (Academic Press) – Mathematical Methods for Physicists.
3. J. Mathews and R. I. Walker (Benjamin) – Mathematical Methods of Physics.
4. P. Dennery and A. Krzywicki (Harper and Row) – Mathematics for Physicists.
5. Grewal-Higher Engineering Mathematics
6. Joshi – Group Theory for Physicists
7. Hamermesh- Group Theory
8. Tulsi Dass- Mathematical Methods Of Physics

COURSE OUTCOME:

The course - Mathematical Physics - provides a tool to realize the laws of physics and focused on a rigorous exposition to some of the principles of mathematical physics. Offers a sound knowledge of vector space and matrices. Provides a good knowledge of special functions and their various properties that are being extensively used in physics. Focuses on techniques of complex variables and tensor analysis. At the end of the course, students will be able to identify a range of mathematical methods that are essential for solving advanced problems in theoretical physics, interpret and illustrate the interactions between mathematics and the associated field and demonstrate the ability to apply mathematical concepts and techniques in to problems in that field, elaborate the understanding of basic concept of complex variables. The students should be able to formulate and express a physical law in terms of tensors, and simplify it by use of coordinate transforms. Also analyse the wide range of special functions and transformations of different series.

Describe various processes involved in understanding the behaviour of different systems through mathematics. Implement mathematical skills to solve problems in advanced physics.

Course No: PHS 101.2: Classical Mechanics

Marks: 25 Credit: 2 Classes: 20

1. Recapitulation of Mechanics of System of particles, Lagrange and Hamiltonian of different systems. Lagrange & Hamiltonian for Non conservative system: Velocity dependent potential, dissipation function, charge particle is moving in an electro-magnetic field. Relativistic Lagrangian of a Particle, Relativistic Hamiltonian of a Particle.

2. Variational Principles, Hamilton's Principle from Newton's equation & D'Alemberts Principle, Lagrange's equation from Hamilton's Principle, Modified Hamilton's Principle, Hamiltons Canonical equations.

3. Gauge function for Lagrangian, Canonical Transformations, Legendre Transformation, Generating Functions, Infinitesimal Contact Transformations, Poisson Bracket, Lagrange Bracket.

4. Hamilton – Jacobi Theory, Hamilton – Jacobi equation for Hamilton's principal function, Physical significance of Hamilton's principal function, Hamilton – Jacobi equation for Hamilton's characteristic function, Physical significance of Hamilton's characteristic function Hamilton-Jacobi equation from Schrodinger equation, Action-angle variables.

5. Small Oscillations: One Dimensional Oscillator, Systems with many Degrees of Freedom: The Eigen value Equation and Normal Coordinates, Different examples.

Books Recommended:

1. Classical Mechanics, by H.Goldstein, Narosa Publishing Home, New Delhi.
2. Classical Dynamics of Particles and Systems, by Marion and Thornton, Third Edition, Horoloma Book Jovanovich College Publisher.
3. Classical Mechanics, by N. C. Rana and P. S. Joag, Tata Mc-Graw Hill Publishing Company Limited, New Delhi.
4. Introduction to Classical Mechanics, by R. G. Takawale and P. S. Puranik, Tata Mc-Graw HillPublishing Company Limited, New Delhi.
5. Classical Mechanics, by J. C. Upadhyaya, Himalaya Publishing House
6. Introduction to Classical Mechanics by David Morlin, Cambridge University Press

COURSE OUTCOME:

In the era of modern physics, this course in classical mechanics remained absolutely essential in the way it is designed. Firstly this course acts as the stepping stone for the

various branches of modern physics. e.g. the technique of action-angle variable is needed for older quantum mechanics, the Hamilton Jacobi formalism and the principle of least action paved the way to wave mechanics and the Poisson Bracket and canonical transformation leads to the justification of commutator formalisms and equation of motions. This course also provides an opportunity for students of physics to master many of the mathematical techniques.

Course No: PHS 102.1: Quantum Mechanics-I

Marks: 25 Credit: 2 Classes: 20

1. Recapitulation of :

   I. Chronological evolution of quantum mechanics, Wave particle dualism, Uncertainty principle, Wave packets in space and time.

   II. Formalism of Quantum Mechanics: Development of the wave equation, the Schrodinger wave equation, statistical interpretation of the wave function, probability density and probability current density, Ehrenfest's theorem, stationary states, energy eigen functions, one dimensional square well potential, parity.

   III. Some bound state problems: Linear harmonic oscillator, Spherically symmetric potential, the Hydrogen atom, Particle in a spherical cavity.

2. Operators and operator algebra, eigen functions and eigen values, expectation values, Dirac bra-kets, Completeness and closure property, Hilbert space of state vectors minimum uncertainty product, form of minimum packet. Coordinate and momentum representation, Unitary transformations
3. Schrodinger, Heisenberg and interaction pictures, Matrix theory of harmonic oscillator.

Books Recommended:

1. 'Quantum Physics' by Robert Eisberg and Robert Resnick (John Wiley and sons).
2. Quantum Mechanics' by L. I. Schiff (McGraw-Hill Book, New York).
3. Quantum Mechanics' by F Schwabl (Narosa).
4. 'Quantum Theory' by D. Bohm (Prentice-Hall).
5. 'Quantum Mechanics: Theory and Applications' by A. K. Ghatak and S. Lokanathan (Macmillan India Ltd.).
6. 'Quantum Mechanics' by Cohen and Tanandji

COURSE OUTCOME:

Quantum mechanics is the body of scientific laws that describe the wacky behavior of photons, electrons and the other particles that make up the universe. Quantum mechanics is the branch of physics relating to the very small. It results in what may appear to be some very strange conclusions about the physical world. Quantum mechanics was once mostly of

interest to physicists, chemists and other basic scientists. Now the concepts and techniques of quantum mechanics are essential in many areas of engineering and science such as materials science, nanotechnology, electronic devices, and photonics. This course is a substantial introduction to advanced quantum mechanics and how to use it. It is specifically designed to be accessible not only to physicists but also to students and technical professionals over a wide range of applied science. At the end of the course, students will be able to identify and understand the kinds of experimental results which are incompatible with classical physics and which required the development of a quantum theory of matter and light, to interpret the wave function and apply operators to it to obtain information about a particle's physical properties such as position, momentum and energy, solve the Schrodinger equation to obtain wave functions for some basic, physically important types of potential in one dimension, and estimate the shape of the wave function based on the shape of the potential, Hydrogen atom problem and Harmonic Oscillator problem, to apply the technique of separation of variables to solve problems in more than one dimension and to understand the role of degeneracy in the occurrence of electron shell structure in atoms. The problems can be solved in different pictures to calculate correlation function used in applied science.

Course No: PHS 102.2: Solid State-1 Marks: 25 Credit: 2 Classes: 20

1. Crystal structure: Bravis Lattice, Symmetry elements, Point group, Space group, Polycrystalline, single crystalline and amorphous materials.

2. X-ray diffraction & reciprocal lattice: Scattering of X-ray by a crystal and Derivation of Laue equation, reciprocal lattice vectors, Brillouin Zone, Atomic form factor, Structure factor and experimental diffraction methods, Debye Waller effect.

3. Vibrations of monoatomic and diatomic linear lattice(qualitative), Equivalence of vibrational mode and simple harmonic oscillator, Phonons, Anharmonic crystal interactions, thermal expansion

4. Energy Bands: Physical origin of the energy gap, Bloch function, essential features of Kronig penny model, extended, reduced and periodic zone schemes, effective mass, distinction of metal, insulator and semiconductor.

Books recommended

1. Woolfson : X ray crystallography
2. Kittel: Solid State Physics
3. Dekker: Solid State Physics.
4. Christmaan-solid state physics (academic press)

5. Warren- X-ray Diffraction

COURSE OUTCOME:

The course gives good idea to students related to structure and symmetry of solid. The course also gives light to the structural analysis of the materials and introduce new particle phonon in solid.The course deals with Band Theory of Solid which is an important tool for material study and research.

Course No: PHS 103.1: Electrodynamics **Marks: 25 Credit: 2 Classes: 20**

1. Radiation loss of energy by the free charges of plasma: Radiation by excited atoms and ions. Cyclotron or Betatron radiation, Bremsstrahlung, Recombination radiation, Transport of radiation.
2. Fundamental concepts about plasma: Mean free path and collision cross section. Effect of magnetic field on mobility of ions and electrons, Diffusion of ions and electrons; Ambipolar diffusion, Electron and ion temperature. Plasma parameters
3. Elements of Plasma Kinetic theory : Phase space, Distribution function, the Boltzman equation, The Vlasov Equation
4. Field of moving charges and radiations: Retarded potentials, Lienard Wichert potentials, Field produced by arbitrarily moving charged particle & uniformly moving charged particle, radiation from an accelerated charged particle at low velocity and at high velocity, angular distribution of radiated power. Radiation from an oscillating dipole, radiation from a linear antenna
5. Radiation in material media: Cherenkov effect, Thomson and Rayleigh Scattering, dispersion and absorption, Kramer Kronig dispersion relation.
6. Relativistic electrodynamics: Transformation equations for field vectors and. Covariance of Maxwell equations in 4 vector form, Covariance of Maxwell equations in 4-tensor forms; Covariance and transformation law of Lorentz force. Self energy of electron

Books Recommended:

1. Marion- Classical Electrodynamics
2. Jackson- Classical Electrodynamics
3. Panofsky & Phillips- Classical Electrodynamics
4. Griffith-Electrodynamics Chakraborty- Plasma Physics
5. Von Engle- Partially ionized gas

COURSE OUTCOME:

The aim and objective of the course on Electrodynamics is to familiarize the students of M.Sc. class to know the fundamental concepts about plasma, the mechanism of radiation by free charges of plasma, and excited atoms and ions; and their current transport. To evaluate fields and forces in Electrodynamics and Magneto dynamics using basic scientific

method. To provide concepts of Retarded phenomena and radiation by different material media and corresponding scattering dispersion relations. The students will have an understanding the relativistic electrodynamics. The students will be able to analyze s radiation systems in which the electric dipole, magnetic dipole or electric quadruple dominate. The students will have an understanding of the covariant formulation of electrodynamics and the concept of retarded time for charges undergoing acceleration.

Course No: PHS 103.2: Materials: Preparation and Characterization

Marks: 25 Credit: 2 Classes: 20

1. Concepts of various types of Materials: Materials Preparation Techniques: Various methods of crystal growth, Preparation of Amorphous Materials, Thin films preparation (Poly-Crystalline & Amorphous), Glass and Glass Transition. Synthesis of low dimensional materials. Top-down and bottom-up approach, Lithography, Arc Discharge, Thermal Evaporation, Sputtering, Chemical Vapour Deposition, Pulsed Laser Deposition, Molecular Beam Epitaxy, Atomic layer deposition, Solution phase synthesis; Electrodeposition and Sol-Gel technique, Solvothermal technique;

2. Material Characterization : X-ray Diffraction (XRD), XPS, Introduction to Microscopy: Advantages and disadvantages of electron microscopy over optical microscopy, Scanning electron Microscopy, Transmission Electron Microscopy, Scanning Tunneling Microscopy, Atomic Force Microscopy, Electron Spectroscopy for Chemical Analysis (ESCA), Introduction to thermal analysis: Phase changes, crystalline and amorphous fractions – DSC Thermo-gravimetric methods – TGA, DTA, Vibrating sample magnetometer,
   Energy Dispersive Analysis by X-ray (EDX). Neutron scattering and neutron diffraction, NMR

3. Different optical measurements: Optical Absorption & Transmission study by UV-VIS Spectro-Photometer, Photo Luminescence (PL), FTIR, Raman spectroscopy. Electrical measurements; Studies on various Conduction Mechanisms in 2D (thin films) and Low-dimensional Systems: Arrhenius type Thermally Activated Conduction, Variable Range Hopping Conduction and Polaron Conduction.

4. Concept of Ultra High Vacuum techniques, production and measurement of low pressure, Pirani and Penning gauges, rotary and oil diffusion, Turbo, Ion, cryo-pumps; Elements of instruments, Concepts of low temperature and high temperature measurement, Sensor and transducer materials.

Books recommended:

1. James F Shackelford, " Introduction to Materials Science for Engineers", 7th Edition,Pearson Prentice Hall, 2009

2. Callister W D, "Materials Science and Engineering : An Introduction", 7th Edition, John Wiley & Sons, Inc., 2007
3. Rao V V, Ghosh T B and Chopra K L, "Vacuum Science and Technology', Allied publishers Ltd., 1998.
4. Bharat Bhushan, "Springer Handbook of Nanotechnology", 2004.
5. Michael Kohler, Wolfgang and Fritzsche, "Nanotechnology: Introduction to Nanostructuring Techniques", Wiley –VcH, 2004.
6. Introduction to Nanoscience and Nanotechnology, K. K. Chattopadhyay and A. N. Banerjee (PHI)
7. Measurement, Instrumentation and Experimental Design in Physics and Engineering, Micheal Sayer and Abhai Mansingh (PHI)

COURSE OUTCOME:

The course is typically a bridge between a physicist and a material scientist and the course is framed to enable students to understand the

1. **expanding world of functional materials**
2. **state of the art facts and techniques involved in materials preparation**
3. **comprehensive awareness of use of different instruments for material study.**
4. **development of the various aspects of material characterization.**
5. **use of different experimental techniques, challenges and prospects materials science**

Course No: PHS 104.1: Analog Electronics-I

Marks: 25 Credit: 2 Classes: 20

1. Operational Amplifiers: Revision of Op-amp circuits, Differential amplifier, OP-AMP architecture, Constant current sources, Input stage of an Op-Amp, OP-AMP characteristics and parameters.

2. Elements of Communication: Principle of amplitude modulation (AM) and frequency modulation (FM), AM spectrum and FM spectrum, channel band width and signal band width, side band frequency, Generation of transmitted carrier and suppressed carrier type AM signals with necessary circuits, Principles of detection of different types of modulated signals (TC and SC types), principle of generation of F.M. wave with necessary circuits, Detection of F.M. wave-Discriminators.

   Modulation techniques in some practical communication systems: Superheterodyne AM and FM radio receivers, FM stereo receiver principle, VSB AM and QAM technique in TV broadcasting.

3. Radio wave propagation: Ground wave, Ionospheric wave and space wave and their characteristics, reflection and refraction of radio waves in ionosphere, critical frequency, skip distance, Maximum usable frequency, fading, Secant law, duet propagation.

4. Antenna: Dipole antenna, half wave antenna, antenna with two half elements, N elements array, induction field and radiation field, radiation resistance of an antenna.

5. Radar: Radar range equation, Basic pulsed radar system-Modulators, duplexers, indicators, radar antenna, CW radar, MTI radar, FM radar, Doppler radar.

6. Amplifiers: MOSFET Characteristics and applications, FET and MOSFET Amplifiers.

Books Recommended:

1. J.D.Ryder, Electronics fundamental and application(PHI).
2. Gaykwad, Operational Amplifier.
3. Roddy and Coolen, Electronic Communication systems. (PHI)
4. Chattopadhyay and Rakshit, Electronics circuit analysis.
5. Millman and Grable, Microelectronics. Tata mcGraw Hill.
6. Frazier- Telecommunications.
7. Electronic and Radio Engineering – F. E Terman.

COURSE OUTCOME:

At the end of the course, students will be able to

1. impart basic knowledge on Analog and Digital Electronics.

2. clarify and exemplify the previous knowledge of electronics in B.Sc. courses.

3. learn the basics of Op-Amp circuits and Analog communication systems.

4. gain knowledge on Radar, Antenna and MOSFET circuits.

Course No: PHS 104.2: Digital Electronics-I

Marks: 25 Credit: 2 Classes: 20

1. Review of logic gates: Combinational logic gates: Karnaugh mapping : Methods of minimization (reduction) of Product of Sum (POS) and Sum of Products (SOP) expressions of 2, 3 4and 5 variables Boolean expression, Logical implementations,
2. Sequential Circuit: Revision of Flip-Flops, Conversion of Flip-Flops.

3. Registers: Shift Register, Serial in Serial out, Parallel in Serial out, Parallel in parallel out registers, Bi-directional and Universal registers.

4. Counter: Synchronous and Asynchronous counter, modulo-Counter, decade counter, ring counter and twisted ring counter, Up/Down Counter.

5. Multivibrators: Astable and monostable (principles, Circuits and operation), Internal circuit of IC 555, Timer circuit with 555. Digital display: Seven segment display system, developing of display system for decimal, octal number system.

Books Recommended:

1. R P Jain, Modern digital electronics, Tata McGraw Hill.
2. Anand Kumar, Fundamentals of Digital Circuits, PHI
3. Millman and Halkias- Microelectronics. Tata McGraw Hill.

4. M. Senthil Sivakumar- Fundamental of Digital Design, S. Chand
5. Digital Circuits and Design, D. P. Kothari and J. S. Dhillon (Pearson)
6. Digital Logic and Computer Design, Moris Mano
7. Digital Systems ; Principles and Applications, R. J. Tocci, N. S. Widmer, G. L. Moss (10^{th} Edition)

COURSE OUTCOME:

At the end of the course, students will be able to

1. gain basic knowledge of application of Digital Logic gates.

2. learn the structure and use of flip flops, counters, registers etc

Course No: PHS 195: Electronics Practical-I Credit 4 Marks: 50

1. To develop a LC filter (L type and π type) circuit having different cut-off frequencies and to find out frequency response characteristics.
2. To study the drain characteristics & transfer characteristics ($I_{D\ sat}$ vs V_{gs} with V_{DS} as parameter) of a FET/MOSFET and to find out the drain resistance, mutual conductance and amplification factor.
3. To study a transformer and to find its various parameters.
4. To construct and design a regulated power supply using Op-Amp as comparator and power transistor as pass element and to find out its ripple factor and percentage of regulation.
5. To obtain the frequency response characteristic of an inverting operational amplifier and to find out its band width.
6. To obtain the frequency response characteristic of a non-inverting operational amplifier and to find out its band width.
7. To design a J-K master – slave flip-flop and to verify its truth table.
8. To design 4 bit shift register in SISO and SIPO mode.
9. Design and study of 2 bit binary comparator.

COURSE OUTCOME:

With this course, students will be able to design and fabricate various digital and analog electronic circuits, e.g. Op-Amp amplifiers, oscillator circuits.

Course No: PHS 196: Computer Programming Credit 4 Marks: 50

Computer Programming in FORTRAN

Use of various software's like, Mathematica, Origin, Microsoft office.

COURSE OUTCOME:

The students get good training in computer programming. The programming knowledge will help them in Higher Study and Research.

SEMESTER- II

Course No: PHS 201.1: Quantum Mechanics-II

Marks: 25 Credit: 2 Classes: 20

1. Symmetry and Conservation laws, Space and time displacement, rotations, angular momentum matrices, Addition of angular momentum, CG coefficients. Spin matrices and eigen functions

2. Approximation methods for bound states: Stationary perturbation theory- non degenerate and degenerate cases, Stark effect, Zeeman effect; Variation method, ground state of Helium atom, WKB approximation,

3. Relativistic wave mechanics: Klein-Gordon equation for a free particle, solution of the KG equation, A spin zero particle in EM field, Coulomb field. fine structure, Dirac's equation for a free particle, Dirac equation in covariant form, Anti commutation relations of the Dirac matrices, Spin of Dirac particle, Magnetic moment of the electron, spin orbit interaction in the Dirac equation Dirac equation in EM field and Coulomb field.

COURSE OUTCOME:

At the end of the course, students will be able to apply the postulates of Quantum Mechanics to rotational motion Student uses the commutation relations to understand the link between the angular momentum operator and the generator of rotations. Student can compute the eigen systems of $\hat{L}^2$ and $\hat{L}_z$. Student understands the interpretation of these eigen systems. Student can compute the coefficients of the expansion of the angular part of a wave function in terms of spherical harmonics. Student can find the matrix elements of the operators corresponding to the addition of angular momenta in both the uncoupled and the coupled basis. Understand the concept of spin, Pauli spin matrices. Addition of angular momenta, Clebsch-Gordon coefficients and their properties, recursion relations. Knowledge of Matrix elements for rotated state, irreducible tensor operator. Understand the application of non-relativistic Hamiltonian for an electron with spin included. C.G. coefficients of addition for j==1/2, 1/2; 1/2, 1; 1, 1. Perform calculations using angular-momentum techniques, including the Wigner-Eckart theorem. The aim and objective of the course is to introduce the techniques of Relativistic quantum mechanics so that he/she can use these in various branches of physics as per his/her requirement.

Course No: PHS 201.2: Methods of Mathematical Physics - II

Marks: 25 Credit: 2 Classes: 20

1. Partial differential equations: Elliptic, parabolic and hyperbolic type equations, Lagranges formula for 2nd order partial differential equation, Dirchlet Neumann and cauchy Boundary value problem. Greens function with applications.

2. Integral transforms: Fourier series, Fourier transforms, laplace transformation inverse laplace transform. Solution of differential equation using LT and FT. Dirac delta function and its FT.

3. Definition and nomenclature ; Examples ; Rearrangement theorem ; Cyclicgroups , Subgroups and Cosets ; Conjugate elements and class structure ; Factor groups ; Isomorphy and Homomorphy ; Direct product groups ; Symmetric groups , Cayley's theorem ; Representation of finite groups- Definition , Unitary representation , Schur's Lemma , Orthogonality theorem , Reducible and irreducible representations , Characters ; Regular representation ; Product representation , Character table , Examples of S_3 and C_4v ; Introduction to Lie groups and Lie algebra ; Clebsch-Gordon coefficients.
4. Integral equations. Fredholm and volterra equations of the first and second kinds. Fredholm’s theory for non-singular kernel.

COURSE OUTCOME:

The course - Mathematical Physics - provides a tool to realize the laws of physics and focused on a rigorous exposition to some of the principles of mathematical physics. Offers a sound knowledge of integral and Fourier transform. Focuses on techniques of group theory. At the end of the course, students will be able to identify a range of mathematical methods that are essential for solving advanced problems in theoretical physics, interpret and illustrate the interactions between mathematics and the associated field and demonstrate the ability to apply mathematical concepts and techniques in to problems in that field, elaborate the understanding of basic concept of Fourier and Laplace’s transform. Understand the applications of group theory in all the branches of Physics problems. Use Fourier series and transformations as an aid for analyzing experimental data. Use integral transform to solve mathematical problems of interest in Physics. Develop mathematical skills to solve quantitative problems in physics.

Course No: PHS 202.1: Solid State II   Marks: 25   Credit: 2   Classes: 20

1. Superconductivity: Basic phenomenology, Thermodynamics of Superconducting transition, Resistance less circuit, Consequence of zero resistance, Meissner effect, Type I and II superconductors, Magnetic Levitation, London equation, Quantum Mechanical Current, Supercurrent Equation, Two-Fluid Model, Josephson Tunneling: D. C. Josephson Tunneling & A. C. Josephson Tunneling, Application of super conductivity.

2. Dielectrics: Review of Dielectric in DC, Local field in liquids and Solids, Clausius-Mosotti Relation, Complex dielectric constant and dielectric losses, dielectric losses and relaxation time,

Books Recommended:

1. Introduction to Solid State Physics, by C. Kittel Wiley Publishers.
2. Introduction to Superconductivity, by A. C. Rose-Innes and E. H. Rhoderick, Peragom Press.
3. Introduction to Solid State Physics, by C. Kittel, Wiley Publishers.
4. Solid State Physics, by A. J. Dekker, Macmillan India Limited.
5. Elementary Solid State Physics- Principles & Applications, by M. Ali Omar, Pearson.
6. Solid State Physics, by N. W. Ashcroft and N. D. Mermin, Cengage Learning
7. Solid State Physics, by S. O. Pillai, New Age International Publishers.
8. Solid State Physics, by R. L. Singhal, Kedar Nath Ram Nath Publishers.

COURSE OUTCOME:

This course is combined with the basic theory and phenomenology of superconductivity and dielectrics and their many applications in basic science and technology. The course on superconductivity includes the electrical and magnetic properties of superconductors, the thermodynamics of superconductors, the origin of quantized magnetic flux and the Josephson tunneling. The dielectrics course is devoted to the study of dielectric polarization and relaxation phenomena in condensed matter. Basic theory and different experimental techniques of dielectrics are given.

Course No: PHS 202.2: Semiconductor Physics

Marks: 25   Credit: 2   Classes: 20

1. Electron & Hole statistics in a semiconductors: Non degenerate & degenerate semiconductor, Intrinsic semiconductor, Ionization energy calculation, Distribution function over an impurity state, N type & P type semiconductor

2. PN junction in equilibrium, Einstein Relation, Diffusion length, Derivation of diode equation, Junction capacitance, Metal Semiconductor junction

3. Equilibrium & Non-equilibrium carriers, Photoconductivity & related device, Recombination via trap, Solar cell.

Books recommended:

1. Kireev: Semiconductor Physics
2. Streatman & Banerjee: Introduction to Solid State Electronics
3. Smith: Semiconductor
4. Dekker: Solid State Physics

COURSE OUTCOME:

Students are enriched in semiconductor field by taking the course. Most modern Devices are based on semiconductors. Hence it is important to know the basics of Semiconductors. The students will hence understand the operation and mechanism of important semiconducting devices. The course will also provide interest to students for research in semiconducting field.

Course No: PHS 203.1: Analog Electronics-II

Marks: 25 Credit: 2 Classes: 20

1. (i) Network analysis : Network theorems, equivalent circuits, two-port parameters hybrid parameters, Driving point impedance and admittance, Foster's reactance theorems, properties of poles and zeros of reactance function, Topological descriptions of different commonly used networks, Π to T and T to Π conversions, reduction of a complicated network into its equivalent T and Π form.
   (ii) Filter Circuit : L filter, Π filter, iterative impedance, image impedance of a network, symmetrical network, characteristic impedance and propagation constant of a network. Methods of development of different constant-k filters like high pass, low pass, band pass and band stop filter circuits.

2. Transmission Lines: Line parameters, characteristic impedance and propagation constant of a transmission line, voltage and current equations of transmission line : Telegraphers' equations and their complete solutions, attenuation constant, phase constant, line of finite length behaving as a line of infinite length, reflection co-efficient in a line, velocity of signal in a line, voltage standing wave ratio, Input impedance of Lossless line, line at radio frequency, Origin of distortions in a transmission line, distortion less line, cable fault location telephone cable.

3. Thyristors: SCR, Triac, Diac, characteristics parameters, Thyristor rectifirer & control circuits, DC Power control by SCR and AC power control by Triac.

4. Transducer & sensors: Photo-transducer, thermistor, photo-electric transducer, photo-conductors, Photo diodes, photo-transistors.

Books Recommended:

1. J D Ryder, Networks line and fields.
2. Van Valkenburg - Network Analysis 3rd Edition.
3. Frazier, Telecommunications.
4. S.M. Zee, Physics of semiconductor devices.

COURSE OUTCOME:

After completion of this course, students will be able

1. to achieve the detail knowledge of network analysis.

2. to gain knowledge on transmission lines: its theory and application.

3. to understand the operation of different transducers like LED, Laser diode, photo-detectors, solar cells, thermistor etc.

4. to gain knowledge on different combinational circuits like MUX, DeMUX, Encoder, Decoder, etc.

Course No: PHS 203.2: Digital electronics-II

Marks: 25 Credit: 2 Classes: 20

1. Combinational circuits: MUX, DeMUX, Encoder, Decoder, 4 bit comparator.
A to D and D to A Conversion

2. The ALU: ALU organization, Integer representation, Serial and Parallel Adders, 1's and 2's complement arithmetic, Multiplication of signed binary numbers, Floating point representation, Overflow detection, Status flags.

3. Memory Unit: Construction of memory, Expansion of memory, Memory classification, Bipolar and MOS storage cells. Organization of RAM, address decoding, Registers and stack, ROM, PROM, EPROM, EEPROM, SRAM, DRAM, and FPLA. Organization and erasing schemes, Magnetic memories, Optical Memories, Semiconductor Memories.

4. Review of 8085 Microprocessor, Internal structure, Different register system, organization and assembly language. Instructions of 8085 Microprocessor, Microprocessor Programming.

5. Basic ideas of Digital Communication: Sampling theorem, Pulse amplitude modulation, Quantization, Pulse Coded Communication System.

Books Recommended:

1. R S Gaonkar – *Microprocessor Architecture, Programming and Applications with 8085/ 8085A* (2^{nd} Ed.).
2. R P Jain, Modern digital electronics, Tata McGraw Hill.
3. Anand Kumar, Fundamentals of Digital Circuits, PHI
4. Taub & Schilling, Principals of Communication Systems, Tata McGraw Hill.
5. G.K. Kharate, Digital Electronics, Oxford
6. Digital Circuits and Design, D. P. Kothari and J. S. Dhillon (Pearson)
7. Digital Logic and Computer Design, Moris Mano
8. Digital Systems ; Principles and Applications, R. J. Tocci, N. S. Widmer, G. L. Moss (10^{th} Edition)

COURSE OUTCOME:

After completion of this course, students will be able

1. to understand the basic structure of 8085 microprocessor.

2. to learn the structure and use of different memory units.

3. to gain basic idea of digital communication.

Course No: C-PHS 204: Concepts of Physics: Inventions and applications (CBCS)

Marks: 50 Credit: 4 Classes: 40

1. Important Developments of Physical Science before 20thcentury: Archimedes' principle, Inertia: Galileo Galilee, Laws of motion and law of gravity: Newton, Planetary motion: Kepler’s Law, Concept of Classical Mechanics, Wave theory of light: Young, Atomic theory of matter: Dalton, Discovery of electron.

2. Progress of Physics in 20thcentury: Introduction, Photoelectric effect: Einstein, Discovery of the atomic nucleus: Rutherford, Concept of Quantum Mechanics, Radioactivity, Introduction to electronics and devices, Electromagnetic induction, induction oven.

3. Physics of Nature: Bluesky, Scattering of light, Colour of Sun, Rainbow, Halo, Refraction and reflection of light, Mirage.

4. Electrical conductivity, perfect conductivity, super conductivity, meissner effect, magnetic levitation.

5. Electromagnetic wave, Basic idea about the generation of electromagnetic spectrum from radio frequency to γ-ray, Microwave oven.

6. Crystal and amorphous, Nano materials, Glass.

7. Development of different light sources: Incandescent bulb, Vapour lamp, Arc Lamp, Fluorescence Lamp (Tube light, CFL), Light Emitting Diode (LED), LASER, basic idea on different level laser system, Field emission.

8. Basic idea about: Optical fiber, photo-detector, Holography, Non-linear Optics**.**

9. Medical Instrumentation: X-ray, Ultrasonography(USG), Magneto Resonance Imaging (MRI), Photodynamical Therapy (PDT).

10. Working principle of Optical camera, Transistor radio, AM and FM radio, Digital Camera, Mobile, Fan, electric generator, Refrigerator.

Books recommended:

1. Bowler, Peter J. and Iwan Rhys Morus (2005), Making Modern Science: a Historical Survey. Chicago: University of Chicago Press.
2. History of Science, Samarendra Nath Sen, Saibya Prakasan Bibhag, (in Bengali)

3. Itihase Bijnan, J.D. Barnal, Ananda Publishers. (in Bengali)
4. Medical Instrumentation Application and Design, John G. Webster (Editor). Wiley 4th Edition.
5. Handbook of Biomedical Instrumentation, Dr R.S. Khandpur, McGraw Hill Education (India) Private Limited, Third Edition.
6. Introduction to Light: The Physics of Light, Vision, and Color, Gary Waldman, Dover Publications.
7. Introduction to Superconductivity, by A. C. Rose - Innes and E. H. Rhoderick, Peragom Press.
8. Optical Electronics, by A. Ghatak and K. Thyagarajan, Cembridge University Press India Pvt. Ltd, New Delhi.
9. Laser Physics and Applications by L. Tarasov, Mir Publishers, Moscow.
10. Fundamentals of Molecular Spectroscopy, by C. N. Banwell and E. M. McCah, Tata McGraw - Hill Publishing Company Limited, New Delhi.

COURSE OUTCOME:

The course is offered to introduce the basic concepts of modern physics to the students coming from outside the Physics Department as a choice based subject. The course is aimed to offer the students to understand the important developments of physical Science, physics of Nature, electrical conductivity, electromagnetic wave, development of different light sources, applied optics, medical instrumentation and working principles of different instruments.

Course No: PHS 295: Electronics Practical-II **Credit: 4** **Marks: 50**

1. To design a 4 bit ripple up/down counter and to develop different modulo counters from it.
2. To design 4 bit Ring counter and Twisted Ring counter.
3. Study of differential amplifier circuit using OP-amp and find out its transfer characteristics and differential mode gain.
4. Design of a window comparator using Op-amps and study its characteristics
5. Astable and Monostable multivibrator with timer IC 555.
6. Determination of the slew rate of an Op-amp.
7. To design an LC oscillator using transistor.
8. To design and develop cascaded FET amplifier and to find out its linearity and frequency response characteristics.
9. Band gap measurement of a Semiconductor using P-N junction.

COURSE OUTCOME:

This course will help the students to design and fabricate various digital and analog electronic circuits, e.g. counters, multivibrators, oscillator circuits.

Course No: PHS 296: Advance Practical-I **Credit: 4** **Marks: 50**

Group-A

1. Linearisation LED Characteristics and finding out the quantum efficiency.
2. Determination of Plank's constant (using photo electric effect).
3. Measurement of the Hall coefficient of a given sample and calculation of its concentration.
4. Determination of refractive index using Michelson Interferometer.
5. Measurement of e/m by magnetron valve
6. Study of the characteristics of a GM tube.
7. Crystal structure determination by X-ray diffraction method.
8. To verify inverse square law using G-M counter.
9. Determination of electron temperature by single probe method.

Group-B

1. Determination of LDR conductivity with input LED power.
2. Determination of Plank's constant (using solar cell).
3. To Study experimentally the variation of resistivity of semiconductor with temperature and hence to find out the band gap energy.
4. To estimate the separation between the two plates of a Febry-Perot interferometer.
5. Frank Hertz experiment.
6. Determination of Electron / Ion temperature by Double probe method.
7. Determination of the gamma and beta ray absorption coefficients by using a G.M. counter.
8. Determination of Curie temperature.
9. Study of nuclear counting statistics using GM counter.
10. Characteristics of a Photo Diode.

COURSE OUTCOME:

This practical course structure is designed to impart the students to provide strong hands-on laboratory training in modern, currently active, areas of Physics particularly in optics, semiconductor physics and nuclear physics.

SEMESTER- III

Course No: PHS 301.1: Quantum Mechanics-III

Marks: 25 Credit: 2 Classes: 20

1. System of identical particles, permutation symmetry, symmetric and anti-symmetric wave function, Pauli Exclusion Principle. Spin functions for two and three electron atoms. Helium atom (ground state and first excited state)

2. Atoms, Molecules: Central field approximation, Hartree and Hartree-Fock approximation, Koopman's theorem, Thomas-Fermi statistical model, LS coupling, JJ coupling, Hund's rule, spectral terms; Zeeman effect (weak field, strong field, quadratic). Molecules, Classification of energy levels, rotation and vibration of diatomic molecules, Hydrogen molecule.

3. Time dependent perturbation; ionization of a Hydrogen atom, sudden approximation. , Fermi's golden rule, transition probabilities, constant and harmonic perturbations, semi-classical treatment of radiation. Intensity ratio of transitions in alkali atoms.

4. Quantum theory of scattering -cross sections, partial wave analysis, phase shifts, optical theorem. Schrodinger's equation as an integral equation, Green's function, Lippman-Schwinger equation, Born's approximation, Coulomb scattering.

COURSE OUTCOME:

At the end of the course, students will be able to provide an understanding of the formalism and language of non-relativistic quantum mechanics and various approximation methods. To understand the concepts of time-independent perturbation theory and their applications to physical situations and quantum scattering theory which are applicable in nuclear and particle physics. The students will be able to formulate and solve problems in quantum mechanics using Dirac representation. The students will be able to grasp the concepts of spin and angular momentum, as well as their quantization and addition rules. The students will be familiar with various approximation methods applied to atomic, nuclear and solid-state physics.

Course No: PHS 301.2: Statistical Mechanics - I

Marks: 25 Credit: 2 Classes: 20

1. Recapitulation: Connection between statistical mechanics and thermodynamics, Macroscopic and microscopic states, classical ideal gas, Gibbs paradox. Elements of ensamble theory: Phase space and density function, Liouville's theorem, microcasnonical ensamble, Canonical ensamble, mean-square fluctuation of an observable, energy fluctuation in the canonical ensamble: correspondence with the micro canonical ensamble, a system of harmonic oscillator, thermodynamics of magnetic systems: negative temperature problems.

2. Grand canonical ensamble: density and energy fluctuation in the grand canonical ensamble: correspondence with the other ensambles.

3. Quantum mechanical ensamble theory: Postulates of Quantum Statiatical mechanics, Density matrix, statistics of various ensambles Ideal gas in Quantum mechanical miro canonical ensamble , determination of entropy in Boltzman Gas, Bose gas, Fermi gas, Ideal gas in other quantum mechanical ensambles

Books Recommended:

1. R. K. Pathria : Statistical Mechanics
2. K. Huang : Introduction to Statistical Mechanics
3. Silvio R. A. Salinas : Introduction to Statistical Mechanics.
4. F. Reif : Fundamentals of Statistical and Thermal Physics.
5. Kadanoff : Statistical Mechanics. World Scientific.
6. R. Kubo : Statistical Mechanics. (Collection of problems)

COURSE OUTCOME:

The aim and objective of the course on Statistical Mechanics is to equip the M.Sc. student with the techniques of Ensemble theory so that he/she can use these to understand the macroscopic properties of the matter in bulk in terms of its microscopic constituents. The students will be able to work out equations of state and thermodynamic potentials for elementary systems of particles. To have an appreciation for the modern aspects of equilibrium and non-equilibrium statistical physics. To describe the features and examples of Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics. At the end of the course, the student will be able to understand Equations of state and thermodynamic potentials for elementary systems of particles. Learning the Modern aspects of equilibrium and non-equilibrium statistical Physics. Describe the features and examples of Maxwell-Boltzmann, Bose-Einstein, and Fermi-Dirac statistics. Work with various models of phase transitions and thermodynamical fluctuations. Describe physical quantities in quantum systems.

Course No: PHS 302.1: Molecular Spectroscopy & Laser Physics

Marks: 25 Credit: 2 Classes: 20

1. Microwave spectroscopy: Conversation of different spectroscopic units.Basic idea about the generation of electromagnetic spectrum from radio frequency to ν-ray. Rotations of molecules, Diatomic molecular rotationalspectroscopy of rigid and non-rigid diatomicmolecules, Intensity of spectral lines, microwave spectroscopy of symmetric type of molecules, Stark effect.

2. Infra-red spectroscopy: Diatomic molecular vibrational spectroscopy with harmonic and anharmonic vibration, vibrational and rotational spectroscopy, anharmonic oscillation constant, rotational constant, Dissociation energy.

3. Visible and ultraviolet spectroscopy: Molecular electronic spectroscopy, Frank Condon principle, Molecular electronic vibrational-rotational spectroscopy, Born-Oppenheimer approximation, Fortrat diagram, Band head.

4. Laser: Spontaneous and stimulated emission, Laser resonator, population inversion, active and passive laser resonator, Threshold condition, saturation condition, Quality factor, Burger's law, classification of laser Three level laser and four level laser system, equation of population inversion and threshold power calculation for the laser systems. Q switching, Application of laser.

Books Recommended:

1. Fundamentals of Molecular Spectroscopy, by C. N. Banwell and E. M. McCah, Tata McGraw - Hill Publishing Company Limited, New Delhi.
2. Molecular Structure and Spectroscopy, by G. Aruldhas, PHI Learning Private Limited, New Delhi.
3. Molecular Structure and Molecular Spectra: vol. 1, Spectra of Diatomic Molecules, 2^{nd}ed, by G. Herzberg, Van Nostrand.
4. Molecular Structure and Molecular Spectra: vol. 2, Infrared and Raman Spectra of polyatomic Molecules, by G. Herzberg, Van Nostrand.
5. Molecular Spectroscopy, by G. M. Barrow, Mc – Graw Hill.
6. Optical Electronics, by A. Ghatak and K. Thyagarajan, Cembridge University Press India Pvt. Ltd, New Delhi.
7. Fundamentals of Light Sources and Lasers, by Mark Csele, John Wiley & Sons, Inc.

COURSE OUTCOME:

This course is combined with the basic theory and phenomenology of Laser Physics and provides an introduction to molecular spectroscopy. The course on laser physics provides an insight into the physical principles of operation of lasers, construction of laser, and their applications in different areas of science and industry. This course also covers different methods of Q-switching for the generation of ultra-short laser pulse.

The course on molecular spectroscopy introduces the three key spectroscopic methods used by physicist, chemist and biochemist to analyze the molecular and electronic

structure of atoms and molecules. These are Rotational, Vibrational and Electronic spectroscopy. Numerous exercises are provided to facilitate mastery of each topic

Course No: PHS 302.2: Nuclear Physics-I

Marks: 25 Credit: 2 Classes: 20

1. Properties of Nuclei: Double focusing mass Spectrometer (Nier and others), Nuclear Spin, magnetic moment Rabi method; nuclear shape-electric quadruple moment; parity; statistics.

2. Stable nuclides: Regularities, the odd-even classification, stable isotopes, isotones and isobars, isomers, mass and energy of nuclides, the mass parabolas for isobars.
3. Recapitulation of α–decay spectra, systematics of α- decay energies, Gamow theory of α-decay.

4. β-decay: Continuous nature of Spectrum; neutrino detection; Fermi's theory of beta decay; Kurie plot, Simple ideas of parity violation in beta - decay.

5. γ-decay: The modes of gamma transition, theory of multiple radiation's, selection rules, internal conversions; nuclear isomerism; recoil free gamma-ray spectroscopy.

Books Recommended :

1. Introductory Nuclear Physics- Kenneths Kiane
2. Atomic and Nuclear Physics- S.N. Ghosal
3. Introduction to High Energy Physics-P.H. Berkins
4. Nuclear Physics- Kaplan
5. Concepts of Nuclear Physics- B.L. Cohen
6. Nuclear Theory- R.R. Roy and B.P. Nigam
7. The Atomic Nucleus- R.D. Evans
8. Basic Nuclear Physics- B.N. Srivastava
9. Introductory Nuclear Physics- L.R. B. Elton
10. Nuclei and Particles- E. Segre
11. Theoretical Nuclear reactions: Blatt and Weisskopf

COURSE OUTCOME:

The aim and objective of the course on Nuclear Physics is to familiarize the students of M.Sc. class to the basic aspects of Nuclear Physics like static properties of nuclei and three radioactive decays. The main objectives of this course are to understand the basic properties of nucleus; to develop the understanding of nuclear properties and different nuclear spectroscopy. At the end of the course, students will be able to acquire basic knowledge about nuclear properties such as mass, spin, radius, binding energy and radioactive decay.

Course No: PHS 303A: Solid State Physics –I

Marks: 50 Credit: 4 Classes: 40

1. Band theory of solid: Empty Lattice Approximation, Nearly free electron model, Tight binding approximation, Effective mass approximation method.

2. Optical Properties: Transverse plasma frequency & propagation of electromagnetic wave in a material, Longitudnial plasma frequency & plasmon, Electrostatic screening, Thomas Fermi dielectric function, Motts metal to insulator transition, Polariton & LST relation, Polaron. Exciton, Raman effect in crystal, Kramers Kronig releation,

3. Defect studies: Luminescence, Colour center, Point defects in solid, Diffusion in an ionic crystal, Ionic conductivity, Line defect, Plane defect, types of bonding.

4. Quantization of orbit in a magnetic field {Landau levels}, De Haas Van Alphen Effect, Magnetic breakdown, Boltzman transport equation & applied to metals to find electrical conductivity, Crystal Field Effect.

5. Dielectrics in AC, Ferroelectric characteristics & their classification, Polarization catastrophe, Origin of ferroelectricity, Landaus theory of ferroelectric transition.

Books recommended:

1. Solid State Physics: C. Kittle
2. Kireev: Semiconductor Physics
3. Solid State Physics: Askrof and Mermin
4. O. Madelung – Introduction of Solid State Theory (Springer).
5. J.M. Ziman:Principles of the theory of solids
6. Solid State Physics: Mattis
7. Dekker : Solid State Physics

COURSE OUTCOME:

The course topic is Solid State Physics special paper which covers large part in this field. The course enriches the student in many fields like defects in solid and introduces important new particles like Plasmon, Polariton, Polaron, Exciton. The course also includes Luminescence in solid and transport properties of metal. The course also describes the origin of Landau Levels. The course will motivate the students to do research in these fields both in Theoretical as well as Experimental Solid State physics.

Course No: PHS 303B: Applied Electronics-I

PHS 303B.1: Applied Analog Electronics-I **Marks: 25 Credit: 2 Classes: 20**

1. Special OP- AMP Circuits & applications: Bridge amplifier circuit : advantages over single stage amplifier, instrumentation amplifiers, logarithmic amplifiers, anti-log amplifier, analog multiplier, summing integrator, chopper modulator, chopper stabilized

amplifier, pulse width modulator, Regenerative comparators and their uses, pulse generator, ramp generator, square and triangular wave generator, crystal oscillator, voltage controlled oscillator (VCO). Active filters, Butterworth characteristics, first, second and higher order low pass and high pass active filters, band pass and band stop active filters.

2. Voltage regulators : Series Op-amp regulator, Current limiting, Foldback current limiter, IC regulator, precision current and voltage sources, Switching Regulators.

3. Phase Lock Loop (PLL) & applications: PLL operational characteristics and parameters, Frequency multiplication, tracking, FM demodulation, Order of PLL.

4. Detectors: Peak detectors, zero-crossing detectors, phase-sensitive detectors, precision rectifier.

COURSE OUTCOME:

To develop the concepts of electronics in order to strengthen the understanding of electronic devices those are the part of our surrounding technologies.

After completion of this course, students will be able to

1. **achieve detail knowledge of application oriented Op-Amp circuits.**
2. **understand details inside the linear and switched mode regulated power supplies.**
3. **know the components, operation and use of phase locked loop.**

PHS 303B.2: Applied Digital Electronics-I **Marks: 25 Credit: 2 Classes: 20**

1. Digital Logic families: DTL, TTL, ECL, MOS, CMOS logic circuits, their advantages and disadvantages, Speed of operation, Power dissipation, Figure of merit, Fan-out.

2. Different memory systems : Memory organization and addressing, Sequential Memory : Unit cell of SRAM and DRAM, Static and Dynamic (Ratioed and Ratio-less) shift registers, Development of Read only Memory memories, RAM, MRAM, RRAM, PAL, FPLA. Charge coupled devices (CCD).

3. Revision of different types of Multiplexing, Encoders and Decoders, Code conversions : BCD to Binary converter, Binary to BCD converter.

4. Specialized Communication Systems: Mobile Communication – Concepts of cell and frequency reuse, Hands-off technique, Description of cellular communication standards; Computer communication – Types of networks; OSI model , TCP/IP Protocol, Circuit message and packet switched networks; Features of network, design and examples of ARPANET, LAN, ISDN, Medium access techniques – TDMA, FDMA, ALOHA, Slotted ALOHA, CSMA/CD; Basics of protocol.

Books Recommended:

1. Gaykwad, Operational Amplifier, PHI

2. Millman and Halkias, Microelectronics. Tata mcGraw Hill.
3. Geiger, Allen and Strader – VLSI – Design Techniques for Analog and Digital Circuits.
4. Gray and Meyer – Analysis and Design of Analog Integrated Circuits.
5. S Soelof – Applications of Analog Integrated Circuits.
6. R P Jain, Modern digital electronics, Tata McGraw Hill.
7. A B Carlson – Communication Systems.
8. D Roddy and J Coolen – Electronic Communications.

COURSE OUTCOME:

To develop the concepts of electronics in order to strengthen the understanding of electronic devices those are the part of our surrounding technologies.

1. to get details of different logic families like DTL, TTL, ECL, MOS, CMOS, etc.

2. to understand the in-depth knowledge of different memory units.

3. to gain basic knowledge of advanced communication systems like mobile & computer communication

Course No: PHS 303C: Applied Optics and Opto-electronics – I

Marks: 25 Credit: 2 Classes: 20

1. **Optical Sources :** Principle of operation of LED , and Semiconductor junction Laser , Internal and External quantum efficiencies of LED , Different efficiencies of Semiconductor junction Laser , Equations relating the light intensity of LED and Semiconductor Laser with applied current, Quantum well laser , Principle of operation of quantum well Laser .

2. **Optical detector :** PiN detector , Quantum efficiency of PiN detector, Avalanche photo detector, Equations relating the applied light intensity with received photo current of a PiN detector and that of a Avalanche photo detector , Dark current of a photo detector, Shot noise , Signal to noise ratio of a photo detector, Photo conductor and its principle of operation, Photo transistor and its principle of operation .
3. **Optical fiber communication :** Types of optical fiber , Propagation of electromagnetic radiation through 3-dimensional cylindrical step index optical fiber and through graded index optical fiber, Concept of TEM modes in cylindrical fiber. Dispersion in optical fiber; multi path dispersion , material dispersion, and wave guide dispersion, Derivation of the expressions of dispersions, concepts of dispersion free fiber and dispersion compensated fiber , maximum bit rate in optical fiber, Power budget equation and Time budget equation, Wavelength division multiplexing and demultiplexing.

COURSE OUTCOME:

The course is important to train the students in important topic i.e applied optics and optoelectronics. The students will be enriched to do research in important fields like Fiber Optics, Optoelctronics, and Semiconductor laser.

Course No: C-PHS 304: Introductory Astrophysics (CBCS)

Marks: 50 Credit: 4 Classes: 40

1. Our Planet, our Universe : (12L)

Our motion in the Universe. The night sky, basic concepts in astronomy such as distances, constellations and the celestial sphere, Dwarf planets, Asteroids, Comets & Meteorites, Formation of our solar system, Sun-Moon-Earth configurations that result in Moon phases and Solar and Lunar eclipses, Rotation of Earth : Lattice and Longitude.

2. Astronomical Tools : (13L)

Light as a tool to probe the Universe. Properties of light. The wave particle nature of light. Atoms and spectroscopy. The thermal spectrum. Stellar classification: Hertzsprung-Russell diagram. Composition of a star's outer layers and its surface temperature, The Inverse square law. Telescopes to learn about astrophysical phenomena.

3. The Sun : (5L)

Basic parameters of Sun, Origin of solar energy, Nuclear fusion, Solar cycle, Solar activity, Solar wind. Solar missions. Main-Sequence lifetime.

4. Evolution of Stars: (10L)

Post-main-sequence evolution of a Sun-like star. Planetary nebulae. White dwarfs. Neutron Stars, Difference between stars, brown dwarfs and giant planets. Supernova explosions. Neutron stars and black holes. Color-magnitude diagrams, Binary star systems.

5. Galaxy and Cosmos : (10L)

Populations of stars and star clusters. Galaxy types and the formation and interaction of galaxies. The Milky Way, Active galactic nuclei, The rotation of our galaxy. Dark matter. The expansion of the Universe and the Big Bang Theory.

Books Recommended :

1. Schneider and Arny: Pathways to Astronomy, McGraw-Hill, 2007
2. M. Schwarzschild: Stellar Evolution
3. S. Chandrasekhar: Stellar Structure
4. K.D.Abhyankar: Astrophysics: Stars and Galaxies
5. Menzel, Bhatnagar and Sen: Stellar Interiors.
6. R.Bowers and T.Deeming: Astrophysics (John and Barlett. Boston).
7. General Relativity, Astrophysics, and Cosmology, A. K. Raychaudhuri, Sriranjan Banerji, Asit Banerjee, Springer-Verlag, 1992
8. Astrophysics: A modern Perspective, K. S. Krisna Swamy (New Age)

COURSE OUTCOME:

The course is arranged to introduce the basic concepts of astrophysics to the students coming from other than physics department as a choice based subject. The course is framed to enable students to understand the

1. **Fundamental concept of Universe**
2. **Stars, galaxy and other celestial objects**
3. **Different parameters for astrophysical measurements**
4. **details of Sun and solar system and related phenomena**

5. **Evolution of universe and stars**

Course No: PHS 395: Advance Practical-II (Practical) Marks: 50 Credit: 4

Group-A

1. Determination of LDR conductivity with input LED power.
2. Determination of Plank's constant (using solar cell).
3. To Study experimentally the variation of resistivity of semiconductor with temperature and hence to find out the band gap energy.
4. To estimate the separation between the two plates of a Febry-Perot interferometer.
5. Frank Hertz experiment.
6. Determination of Electron / Ion temperature by Double probe method.
7. Determination of the gamma and beta ray absorption coefficients by using a G.M. counter.
8. Determination of Curie temperature.
9. Study of nuclear counting statistics using GM counter.
10. Characteristics of a Photo Diode.

Group-B

1. Linearisation LED Characteristics and finding out the quantum efficiency.
2. Determination of Plank's constant (using photo electric effect).
3. Measurement of the Hall coefficient of a given sample and calculation of its concentration.
4. Determination of refractive index using Michelson Interferometer.
5. Measurement of e/m by magnetron valve
6. Study of the characteristics of a GM tube.
7. Crystal structure determination by X-ray diffraction method.
8. To verify inverse square law using G-M counter.
9. Determination of electron temperature by single probe method.

COURSE OUTCOME:

This practical course structure is designed to impart the students to provide strong hands-on laboratory training in modern, currently active, areas of Physics particularly in optics, semiconductor physics and nuclear physics.

Course No: PHS 396A: Solid State Physics-I (Practical) Marks: 50 Credit: 4

Group-A

1. Study of Hall effect with variation of temperature.
2. Determination of Lande g-factor for the given sample using electron spin resonance spectrometer.
3. Determination of barrier potential and doping profile of transistor junctions
4. Determination of ionic conductivity of the given sample.
5. Study of Hysterisis loop of magnetic materials by using Hysterisis Tracer.
6. Study of characteristics of the given solar cell
7. Study of Diac & Triac characterestics with application.

Group-B

1. Study of magneto resistance of the given material
2. Determination of carrier life time in Photoconductor
3. Measurement of magnetic susceptibility and Bohr magneton number of given sample by Gouy method.
4. Absorption/Transmission spectra of thin films by using UV/VIS spectro photometer.
5. Dielectric measurement of polycrystalline ferroelectric sample.
6. Study of Thermo luminescence in a crystal.
7. Study of UJT &SCR characteristics with application.

COURSE OUTCOME:

This practical course structure is designed to impart the students to provide strong hands-on laboratory training especially in the advance field of Solid State Physics. This will help them immensely for research in condensed matter physics as well as experimental research in Solid State Physics.

Course No: PHS 396B: Applied Electronics-I (Practical) Marks: 50 Credit: 4

1. Design, Construction and performance testing of a Logarithmic amplifier using μA 741, diode and matched transistors.
2. Design, Construction and performance testing of an antilog amplifier using μA 741 and matched transistors.
3. Design of an IC Power Amplifier and its linearity, frequency response, efficiency, and distortion calculation.
4. Design of a Precision adjustable voltage regulator using μA 741 and series pass transistor and a transistor as current limiter and its performance comparison with LM78XX series fixed regulators.
5. Design and study of Multiplexer: formation, cascading and equation solving.
6. Design and study of De-multiplexer: formation, cascading and equation solving.
7. Design of an Active high pass/Low pass second order Butterworth filter.
8. Design an active band pass filter using single stage μA 741 Op-amp.
9. Design and study of an active phase sifter.
10. Frequency to Voltage converter circuit design.
11. Design and study of a Voltage Controlled Oscillator (VCO)/Voltage to Frequency converter.
12. Design of BCD addition and subtraction using Full Adder IC
13. Shift registers: PISO, SISO, PIPO, SIPO.

COURSE OUTCOME:

This course will help the students to

(i) design and fabricate various advanced digital and analog electronic circuits, e.g. Mux, DeMUX, registers, voltage regulators, active filters etc.

(ii) design and conduct various electronics experiments.

The experiments will help the students to understand the application of the theories in practical field.

Course No: PHS 396C: Applied optics and opto-electronics-I (Practical)

Marks: 50 Credit: 4

Group A:

1) To set up a Mach Zehnder Interferometer by Laser to measure the Phase difference of two light beams.
2) To set up a Mach Zehnder Interferometer (MZI) experiment with single mode fibers and Laser to measure phase modulation.
3) To set up an experiment for measuring displacement by optical fiber sensor.
4) To measure attenuation and splice/ connector loss by using OTDR.
5) To set-up an experiment for measuring temperature by optical fiber sensor.
6) To study interference of light by single mode fiber.
7) To study the spectral response of a photo detector using optical fiber link.

Group B :

1) To measure the V_{Π} voltage of an Electrooptic modulator.
2) To Use magneto-optic modulator for verifying Faraday effect.
3) To generate optical Manchester coded data.
4) Verification of optical cross gain modulation by SOA.
5) Use of Heterodyne detector for measuring phase and intensity of an optical signal.
6) Measurement of threshold current of a Semiconductor Junction Laser from its Light intensity vs. Current density curve.
7) Use of OP AMP for using LED as linear modulator .

COURSE OUTCOME:

This practical course structure is designed to impart the students to provide strong hands-on laboratory training especially in the advance field of Optoelectronics. This will help them immensely for research in Semiconductor Laser and .Fiber Optics.

SEMESTER- IV

Course no: PHS 401.1: Particle Physics   Marks: 25   Credit: 2   Classes: 20

1. Review of the fundamental classification of elementary particles and study of their different properties and decay scheme (Mesons, Muons), Conservation Laws, Gell-mann and K. Nishijima model, +Su(3) model, Quark model, charm and other flavors, color, properties of strange particles, improper symmetry, parity, charge conjugation, time reversal, CPT theorem, spontaneous symmetry breaking, parity non conservation, K-meson, complex and time reversal invariance.

Books Recommended:

1. Griffith, Introduction to Particle Physics
2. Perkins, High Energy Physics
3. Halgen & Martin, Quarks & Leptons
4. M.P. Khanna- Introduction to Particle Physics

COURSE OUTCOME:

The aim and objective of the course on Particle Physics is to introduce the M.Sc. students to the invariance principles and conservation laws, hadron-hadron interactions, relativistic kinematics, static quark model of hadrons and weak interactions so that they grasp the basics of fundamental particles in proper perspective. At the end of the course, the student will be able to understand overview of particle spectrum, their interaction and major historical and latest developments, Various invariance principles and symmetry properties in particle physics, Basic rules of Feynman diagrams and the quark model for hadrons, Properties of neutrons and protons in term.

Course No: PHS 401.2: Statistical Mechanics-II

Marks: 25   Credit: 2   Classes : 20

1. Ideal Bose system: Thermodynamical behaviour, BE condensation, blackbody radiation
2. Ideal Fermi System: Thermodynamical behaviour; Magnetic behaviour of an ideal Fermi gas: Pauli paramagnetism, Landau diamagnetism and DeHaas-van Alphen affect, electron gas in metal, thermo ionic emission, photoelectric emission
3. Theory of phase transition : Theory of Yang and Lee ,Ising model (one and Two dimensional)

Books Recommended:

1. R. K. Pathria, Statistical Mechanics
2. K. Huang, Introduction to Statistical Mechanics
3. Silvio R. A. Salinas, Introduction to Statistical Mechanics.
4. F. Reif, Fundamentals of Statistical and Thermal Physics.
5. Kadanoff, Statistical Mechanics. World Scientific.
6. R. Kubo, Statistical Mechanics. (Collection of problems)

7. S.K. Ma, Statistical Physics(World Scintific, Singapore)
8. Ishihara, Statistical Physics

COURSE OUTCOME:

At the end of the course, the student will be able to understand different quantum statistics for explanation of B.E. condensation, Black body radiations, Pauli paramagnetism, Landau diamagnetism and electron gas systems for thermionic and photoelectric emission; also to use and develop mean field theory for first and second order phase transitions in one and two dimensional Ising model.

Course No: PHS 402.1: Nuclear Physics-II

Marks: 25 Credit: 2 Classes: 20

1. Nuclear interactions and reactions: Nucleon-Nucleon interaction, exchange forces and tensor forces. The deuteron - Square well potential; neutron-proton and proton-proton scattering at low energies. Classifications of nuclear reactions, Conservation laws; reaction channels; the mass & energy balance in nuclear reactions, direct and compound nuclear reaction mechanisms, compound nuclear model; basic ideas on continuum theory; nuclear resonance.

2. Nuclear models: liquid drop model, Bohr Wheeler theory of fission, experimental evidence for shell effect, shell model, spin orbit coupling , magic numbers, angular momenta and parity of nuclear ground state; collective model of Bohr and Mottelson.

3. Neutron Physics: Classification of neutrons, Source of neutrons, Thermal neutrons; Velocity selection and time of flight methods, elements of neutron optics.

4. Reactor physics: Slowing down of neutrons in a moderator, average log decrement of energy per collision, moderating ratio.

5. High energy physics: Types of interaction –typical strength and time scale, Conservation loss, Parity & time reversal, CPT theorem

COURSE OUTCOME:

At the end of the course, students will be able to understand the features of nuclear forces, exchange force and meson theory; to develop the understanding of nucleon-nucleon interactions; to develop the understanding of resonance reactions; to understand the various nuclear models; to understand the different nuclear reactions; to clarify the concepts of elementary particles; and to learn about the concept of subatomic particle and quarks, conservation laws. The most commonly known applications of nuclear physics are nuclear power generation.

Course No: PHS 402.2: Quantum Field Theory

Marks: 25 Credit: 2 Classes: 20

1. Elements of field theory ; Symmetries and Noether's theorem ; Canonical Quantization ; Creation-Annihilation operators ; Quantization of Klien-Gordan field, Dirac field, quantization of electromagnetic field ; Discrete symmetries of the Dirac theory ; Interacting fields - Perturbation theory , Wick's theorem, Feynman diagrams , cross sections and S-matrix., Non-perturbative methods - Field and Mass renormalization ; LSZ reduction formula ; Renormalized charge and Ward Identities. , brief idea on Gauge theory, weak and strong interactions, brief discussion on Weinberg - Salem model, Grand unified theories

Books Recommended:

1. Ryder, Quantum Field Theory
2. Barger & Phillips, Collider Physics
3. Peskin & Schroeder, Quantum Field Theory
4. Palash Pal and A Lahiri, Quantum Field Theory, Narosa
5. Mandle, Quantum Field Theory

COURSE OUTCOME:

At the end of the course, students will be able to understand Quantum field theory so that he/she can use these in various branches of physics as per his/her requirement. Understand relativistic effects in quantum mechanics and need for quantum field theory. Demonstrate the Lorentz covariant form of Lagrangian and Hamiltonian for scalar, vector fields, electromagnetic fields and their second quantisation. Understand the symmetries and the implications of Noether's Theorem in conserved currents and charges. Understand the interaction picture, S-matrix, and Wick's Theorem. Explain the origin of Feynman diagrams and apply the Feynman rules to derive the amplitudes for elementary processes in QED.

Course No: PHS 403.1: Semiconductor Devices

Marks: 25 Credit: 2 Classes: 20

1. Transistor, FET, MOSFET, Tunnel Diode, Gunn effect oscillator.

2. Boltzman transport equation applied to a non degenerate semiconductor, Electrical conductivity, Hall effect & Thermoelectric effect in semiconductor, Quantum Hall effect.

3. Phototransistors, Four- layer pnpn device, Diac, Triac, Semiconductor laser, Hetero junction, Semiconductor supper lattice.

Books Recommended:

1. Kireev: Semiconductor Physics
2. S.M. Zee : Physics of semiconductor devices
3. Streatman & Banerjee: Introduction to solid state electronics

COURSE OUTCOME:

Most of the devices are based on semiconductors. The course discusses in details the various devices and their operation mechanism. The course describes extensively many important devices like Gunn Diode, FET, MOSFET, Semiconductor Laser. The course also includes important topic like Quantum Hall Effect, Thermoelectric effect in Semiconductors. The course will encourage the students to do researches in Semiconducting devices which is an important topic of Applied Physics.

Course No: PHS 403.2: Applied Optics

Marks: 25 Credit:2 Classes: 20

1. Fiber optics: Different types (single and multi mode) of step index and graded index optical fiber, ray path in graded index optical fiber, Multipath broadening, Modal analysis of Electromagnetic waves in planer waveguide. Application of fiber in digital communication.

2. Holography: Coherent light and application of coherent light in holography. Recording and reconstruction of wave front.

3. Non-linear Optics: Non-linearity of medium, second and higher harmonic generation, phase matching condition, frequency addition and frequency subtraction, self focusing and self defocusing, Pokels & Kerr type of nonlinear materials, Examples of Organic and inorganic nonlinear materials. Photo dynamical therapy.

4. Photonics Information Processing: Optical logic operations, Optical arithmetic operation with binary, optoelectronic logic gates, all optical logic gates, tristate logic system and tristate AND & OR gate.

5. Photosensors, different types of photo-detector, Graphene and graphene based photodetectors, photo sensitivity, photoresponsivity.

Books Recommended:

1. Optical Electronics, by A. Ghatak and K. Thyagarajan, Cembridge University Press India Pvt. Ltd, New Delhi.
2. Semiconductor optoelectronic devices, by P. Bhattacharya, Prentice Hall publication.
3. Optical Electronics, by A. Yariv, Holt McDougal.
4. Laser Physics and Applications by L. Tarasov, Mir Publishers, Moscow.
5. optical computation and parallel processing, S. Mukhopadhyay, Classique Books Publisher.

6. Some digital approaches in optical computation, by P. Ghosh and S. Mukhopadhyay, Premier Books publication, India.

COURSE OUTCOME:

The course is an introduction to the fundamentals of optoelectronics and principles of the optoelectronic devices operation. This course helps students prepare them for advanced study and research in semiconductor optics and optoelectronic devices. Topics include optical waveguides, optical logic operations, nonlinear optics an introduction to different types of detectors, and holography. The course also covers the basic optical and electro-optical properties of semiconductors and low-dimensional semiconductor structures.

Course No: PHS 404A: Solid State Physics - II **Marks: 50 Credit: 4 Classes: 40**

1. Magnetism : Quantum theory of dia, paramagnetism, transition and rare-earth elements, Ferromagnetic, anti-ferromagnetic and Ferri-magnetic order, molecular fields, direct and indirect exchange interaction, Heisenberg and Ising model, domain theory, Bloch wall, spin waves, magnons, magnetic resonance, princple and application of NMR, EPR, ESR.

2. Superconductivity: Review of experimental results, London-Pippard theory, penetration depth, coherence length, electron-phonon interaction, Cooper pair, BCS theory, energy gap, transition temperature, Ginzburg Landau theory, Flux quantization, Critical Current density, SQUID, superconducting devices, recent advances on high Tc superconductors.

Books Recommended:

1. Magnetism in Condensed Matter: Stephen Bludell
2. Theory of Superconductivity, J. Robert Schrieffer,
3. Introduction to Superconductivity, 2nd Edition, by Michael Tinkham

COURSE OUTCOME:

The course topic is Solid State Phyicics special paper which covers large part in this field The course enriches the student in many field like Magnetism, Superconductivity which are two important branches of Physics. The course will motivate the students to do research in these fields both in Theoretical as well as Experimental Solid State physics.

Course No: PHS 404B: Applied Electronics –II   Marks: 50 Classes: 40

PHS 404B.1: Applied Analog Electronics –II   Marks: 25   Credit: 2   Classes: 20

1. Television: Working principle, TV camera- Image Orthicon, Vidicon, Plumbicon ; B/W TV Picture tube, scanning and deflection, synchronization, Details of composite video signal, Transmitting and Receiving systems, Vestigial Side band transmission, Television standards, Advantages of Negative modulation, Different kinds of TV antenna, Block diagram of BW TV receiver and Transmitter.
   Colour TV standards : NTSC, PAL SECAM, colour television principles, Colour subcarrier, transmission format of intensity and colour signal. Colour differencs signals, Reproduction of colour signals at the receiver, Colour TV picture tubes: Delta Gun, PIL and Trinitron,

2. Wave Guides: Wave guides coaxial, rectangular and cylindrical; Different modes of propagation of em signal through wave guides, resonators.

3. Instrumentations: Digital voltmeter: different types, Digital ammeter and ohmmeters, Ultrasonic techniques and instrumentations.

COURSE OUTCOME:

To develop the relevant knowledge of electronics in order to deepen the understanding of modern electronic communication devices those are associated with our social life.

After completion of this course, students will be able to

1. gain in-depth knowledge of monochrome and colour television principle.

2. know the details of signal propagation through wave guide.

3. understand the principle behind instrumentation for different measurements.

PHS 404B.1: Applied Digital Electronics –II   Marks: 25   Credit: 2   Classes: 20

1. Digital communication: Signal sampling, aliasing effect, sample and hold systems, anti-aliasing filter, analog-multiplexer.

2. Pulse modulation and demodulation techniques: PAM, TDM-PAM, PWM, PPM, Pulse code modulation-Coding technique modulation and demodulation, DPCM, Delta Modulation.

3. Digital modulation techniques : ASK, FSK, PSK, DPSK, QPSK, MSK principle, modulation and demodulation techniques.

4. Microprocessor and their applications: Architecture of 8 bit (8085) and 16 bit (8086) microprocessors; addressing modes and assembly language programming of 8085 and 8086. Interfacing concepts memory and I/O interfacing; Interrupts and interrupt controllers; microprocessor based data acquisition (DAS) system, comparison of different microprocessors. Microprocessor programming.

Books Recommended

1. R.R. Gulati – Monochrome and Color TV.
2. A M Dhake – Television and Video Engineering.
3. D Roddy and J Coolen – Electronic Communications.
4. Helfrick & Cooper- Modern Electronic Instrumentation-PHI
5. A B Carlson – Communication Systems
6. Kennedy and Davis – Electronic Communication Systems.
7. Taub and Schilling – Principle of Communication Systems., McGraw Hill
8. A P Mathur – *Microprocessors.*
9. R S Gaonkar – *Microprocessor Architecture, Programming and Applications with 8085/ 8085A* (2nd Ed.).
10. D V Hall – *Microprocessor and Interfacing*.
11. Lin and Gibson – *Microprocessor*.

COURSE OUTCOME:

To develop the relevant knowledge of electronics in order to deepen the understanding of modern electronic communication devices those are associated with our social life.

After completion of this course, students will be able

1. to get details of digital communication including different digital modulation techniques.

2. to develop knowledge on 8085 and 8086 microprocessors with programming

Course No: PHS 404C: Applied Optics and Opto-electronics – II

Marks: 50 Credit: 4 Classes: 40

1. Optical modulators: Electro-optic modulators and Pockels effect, Phase modulation and Amplitude modulations in Electro-optic modulator, Optical Kerr effect, Modulation of light using optical Kerr effect, Self focusing, self defocussing, Optical switches using Kerr effect, Optical Faraday effect.

2. Optical amplifiers : Semiconductor Optical Amplifier (SOA) and its principle of operation, Self phase modulation, cross phase modulation , Cross gain modulation and wavelength conversion of SOA, EDFA and its principle of operation.
3. Photonic measurements: Homodyne and Heterodyne detectors for phase and intensity measurements, OTDR.
4. Optical encoding: Intensity encoding, frequency encoding, polarization encoding, RZ, NRZ, Manchester line encoding, Method of obtaining Manchester coded data, probability error and bit error rate.
5. Optical devices: principle of operation of Liquid Crystal Display; Charge Coupled Devices; Fiber optic displacement, current and temperature sensors.

COURSE OUTCOME:

The course is important to train the students in important topic i.e applied optics and optoelectronics. The students will be enriched to do research in important fields like Fiber Optics, Optoelctronics, Semiconductor laser.

Course No: PHS 495A: Solid State Physics -II (Practical)

Credit: 4 Marks: 50

Group-A

1. Study of magneto resistance of the given material
2. Determination of carrier life time in Photoconductor
3. Measurement of magnetic susceptibility and Bohr magneton number of given sample by Gouy method.
4. Absorption/Transmission spectra of thin films by using UV/VIS spectro photometre.
5. Dielectric measurement of polycrystalline ferroelectric sample.
6. Study of Thermo luminescence in a crystal.
7. Study of UJT &SCR characteristics with application

Group-B

1. Study of Hall effect with variation of temperature.
2. Determination of Lande g-factor for the given sample using electron spin resonance spectrometer.
3. Determination of barrier potential and doping profile of transistor junctions
4. Determination of ionic conductivity of the given sample.
5. Study of Hysterisis loop of magnetic materials by using Hysterisis Tracer.
6. Study of characteristics of the given solar cell
7. Study of Diac & Triac characterestics with application

COURSE OUTCOME:

This practical course structure is designed to impart the students to provide strong hands-on laboratory training specially in the advance field of Solid State Physics. This will help them immensely for research in condensed matter physics as well as experimental research in Solid State Physics.

Course No: PHS 495B: Applied Electronics –II (Practical)

Credit: 4 Marks: 50

1. Design of a Schmitt trigger circuit using μA 741.
2. DSB-TC and DSB-SC generation using analog multiplier IC MC 1495 or MC1496.
3. Design and performance study of a VCO IC (NE 566).
4. Design and performance study of a PLL IC (NE 565).
5. Design a FM demodulator using PLL.
6. Study of Pulse Amplitude Modulation transmission and reception.

7. 8085 Microprocessor programming.
8. Study of Pulse Width Modulation using 555 Timer IC.
9. Pattern waveform generator for analog multiplexing.
10. To study the input stage of an Op-amp using discrete components and find out the differential mode gain.
11. PSIPCE study the input stage of an Op-amp using discrete components and find out the differential mode gain.
12. Study of D.A.C & A.D.C.

COURSE OUTCOME:

This course will help the students to

(i) design and fabricate various advanced digital and analog electronic circuits, e.g. modulator circuits, PLL circuits, Microprocessor programming, etc.

(ii) design and conduct various electronics experiments.

The experiments will help the students to understand the application of the theories in practical field.

Course No: PHS 495C: Applied optics and Opto-electronics-II (Practical)

Credit: 4 Marks: 50

Group A :

1) To measure the V_{Π} voltage of an Electro-optic modulator.
2) To use magneto-optic modulator for verifying Faraday effect.
3) To generate optical Manchester coded data.
4) Verification of optical cross gain modulation by SOA.
5) Use of Heterodyne detector for measuring phase and intensity of an optical signal.
6) Measurement of threshold current of a Semiconductor Junction Laser from its Light intensity vs. Current density curve.
7) Use of OP AMP for using LED as linear modulator .

Group B :

1. To set up a Mach Zehnder Interferometer by Laser to measure the Phase difference of two light beams.
2. To set up a Mach Zehnder Interferometer (MZI) experiment with single mode fibers and Laser to measure phase modulation.
3. To set up an experiment for measuring displacement by optical fiber sensor.
4. To measure attenuation and splice/ connector loss by using OTDR.
5. To set-up an experiment for measuring temperature by optical fiber sensor.
6. To study interference of light by single mode fiber.
7. To study the spectral response of a photo detector using optical fiber link.

COURSE OUTCOME:

This practical course structure is designed to impart the students to provide strong hands-on laboratory training specially in the advance field of Optoelectronics. This will help them immensely for research in Semiconductor Laser and Fiber Optics.

Course No: PHS 496: PROJECT, SEMINAR AND GRAND VIVA

Credit: 4 Marks: 50

COURSE OUTCOME:

A significant aspect of this particular curriculum is the opening that the students will have to perform a dissertation research project during their last two semesters on wide range of modern-day topics under the guidance of any of the faculty members of Physics department and the exam will be held at the end of fourth semester. This gives an ideal atmosphere for converting class room learning to cutting-edge research applications.

Each student has to present a seminar in the final semester. There is a good interacting session in the seminar. Thus seminar gives a good training to student and gives encouragement to be a participant of National and International Seminar.