S. V. U. College of Sciences

DEPARTMENT OF PHYSICS

Vision
To impart quality education and appropriate training to produce talented Physicists and to pursue research in thrust areas for the betterment of contemporary society.

Mission
The Department of Physics is one of the founder departments, started in 1954 and has been playing a pivotal role in the University. The mission of the department is to

- develop qualified and competent Physicists/Scientists through effective teaching.
- train students with hands on laboratory training in advanced fields of Physics.
- promote in depth research in thrust areas for societal applications.

Program Educational Objectives
The main educational objectives of the program are to

- Impart students with better knowledge and understanding of the subject.
- Train students to take up local and global competitive challenges in Physics.
- Prepare analytically and technically skilled students to get good employment.
- Provide an opportunity for students to purse quality research in thrust areas.
- Create a sense of academic and social ethics among students.

Program Outcomes
(1) To explain the basic ideas and concepts in theoretical and applied Physics
(2) To make students learn mathematical methods in solving real physical problems.
(3) To train students to compete national level tests like UGC-CSIR NET, JEST, GATE etc.
(4) To motivate students towards higher studies and to purse research in advanced areas.
(5) To disseminate scientific knowledge and temperament to contribute towards human cause.
(6) To develop human values and professional ethics for betterment of the society.

Branch: PHYSICS **Course code: PHY 101**
Course title: Classical Mechanics **Credits: 4**
Semester: I **Marks: 80 + 20 (Internal)**

Course Educational Objectives

1. To define and interpret the concepts of Langrangian and Hamiltonian Mechanics.
2. To explain canonical transformation, poisson brackets and Hamilton-Jacobi theory.
3. To acquaint the theory of small oscillations and Euler's equations of motions of rigid bodies.
4. To inculcate the students the concepts of special theory of relativity andrelated problems.

SYLLABUS

UNIT – I: Lagrangian Mechanics and Hamiltonian Mechanics

Newtonian mechanics of one and many particle systems: Conservation laws, Constraints and their classification, Degrees of freedom: Generalized coordinates: Principle of virtual work, D'Alemberts principle, Lagrange's equations of motion. Applications: Inclined plane, Linear harmonic oscillator and simple pendulum.

Hamiltonian principle, Lagrange's equation from Hamilton's principle, Hamilton's equation of motion. Applications: Simple pendulum, Compound pendulum.

UNIT – II: Canonical Transformations and Hamilton - Jacobi Theory

Canonical Transformations, generating function and their properties, Condition for transformation to be canonical, Illustration of canonical transformation, Poisson – Brackets, Canonical equations in terms of Poisson, Bracket notation. Lagrange - Brackets and their properties.

Hamiltonian - Jacobi equation, one dimensional harmonic oscillator, Small oscillations and normal modes, Action Angle variables, Kepler problem in action angle variables.

UNIT –III: Motion in a Central Force Field

Reduction to the equivalent one body problem; Motion in a central force field: Conditions for closed orbits: Inverse square law of forces: Kepler's laws of planetary motion; Rutherford scattering. Rotations – Space and body fixed axes: Angular momentum and Torque; Eulerian angles – Euler's equations of a rigid body: Motion of symmetrical top; Expression for slow and fast precessions; Larmour precision; Gyroscope.

UNIT –IV: Special Theory of Relativity

Introduction – Postulates of Special Theory of Relativity – The principle of constancy of light – The Lorentz transformations. Relativistic Kinematics: The velocity transformations – The transformations for the acceleration of a particle, The Doppler effect.

Relativistic Mechanics: The mass of a moving particle – The relativistic dynamics of a single particle – Applications of relativistic dynamics of a single particle: Motion in electric field – Motion in a magnetic field – Experimental verification of the variation of mass with velocity – Bucherer's experiment - Transformation of momentum and force. (7-9)

Books for Study

1. Classical Mechanics by N.C. Rana and P.S. Joag (Tata Mc-Graw Hill) 1991
2. Classical Mechanics by H. Goldstein (Addi Wesely) 1980
3. Classical Mechanics by J.C.Upadyaya
4. Classical Mechanics by Gupta, Kumar and Sharma
5. Introduction to Classical Mechanics by R.G. Takwale and P.S. Puranic
6. Theory of Relativity by W.Pauli
7. Introduction to the theory of relativity by P.G.Bergmann

Course Outcomes: After completion of the course, the student shall be able to

1. Formulate the Lagrangian and Hamiltonian mechanics concepts, solve the related problems and learn the concepts of Poisson brackets, Hamilton-Jacobi equations and action angle variables.
2. Understand the Kepler's laws, Rutherford scattering, Euler's equations and solve the related problems and learn the theory of relativity and its applications.

Branch: PHYSICS **Course code: PHY 102**
Course title: Atomic and Molecular Physics **Credits: 4**
Semester: I **Marks: 80 + 20 (Internal)**

Course Educational Objectives
1. To understand effects of magnetic and electric fields on the spectra of different elements and its analysis
2. To introduce to students the various concepts of atomic and molecular states of different elements
3. To know various applications of rotational, vibrational and electronic spectra in structure determination

SYLLABUS
UNIT I: Atomic Spectra
Introduction: Hydrogen atom (one electron atom) - quantum numbers- Spectra of hydrogen atom- Spectra of alkali elements- Fine structure- Elements with more than one valence electron- Forbidden transitions and selection rules- Vector atom model – Spin-orbit interaction energy - Stern-Gerlach experiment- Experimental setup to demonstrate S-G effect using a thermal evaporation system and magnetic field **-** Coupling schemes- Spectral terms and term symbols based on electron configuration - LS coupling - JJ coupling- Interaction energies in LS and jj couplings - Hund’s rule of multiplicity - Pauli’s exclusion principle - Equivalent and non-equivalent electronic systems.
UNIT II: Zeeman and Stark Effects
Introduction: Zeeman effect- Normal and anomalous Zeeman effects - Experimental details - Magnetic moment of atom and Lande’s ‘g’-factor - Zeeman effect in sodium atom - Lande g-formula for LS and JJ couplings - Paschen-Back effect - Splitting of sodium lines and selection rules - Stark effect - Experimental details - Weak and strong field effects – linear and quadratic Stark effects -Width of spectral lines.
UNIT III: Diatomic Molecular Spectroscopy – Rotational Energies
Introduction – Rotational, vibrational, electronic spectra of diatomic molecules –types of molecules – Linear, symmetric top, asymmetric top and spherical top molecules – Rotational spectra of a diatomic molecule as rigid rotator – Energy levels and spectra of non-rigid rotor – Intensity of rotational lines - Rotational spectra of polyatomic molecule – Rotational analysis of electronic spectra- Evaluation of rotational constants - Effect of isotopic substitution on rotational levels – Stark splitting of rotational lines - Stark modulated microwave spectrometer -Applications of rotational spectroscopy - Determination of molecular structure, dipole moment, atomic mass, nuclear quadrupole moment – Microwave oven.
UNIT IV:Diatomic Molecular Spectroscopy – Vibrational Spectra
Introduction – Vibrational spectra of diatomic molecule – Diatomic molecule as simple harmonic oscillator – Anharmonic oscillator – Energy levels and spectrum – Molecule as vibrating rotator – PQR branches – progressions and sequences – Vibrational analysis of electronic spectra - Deslander’s table – Evaluation of vibrational constants – Morse potential energy curve – Frank-Condon principle – Intensity distribution in absorption and emission spectra - Effect of isotopic substitution on vibrational bands – IR spectrometer – FTIR spectroscopy – Principle – Interferometer arrangement – advantages- Applications of vibrational spectroscopy: Identification of molecular constituents – Elucidation of molecular structure – Characterization of the transition phases of ceramics – Biological applications.
Books for Study:
1. Introduction to Atomic Spectra, H.E. White, McGraw-Hill Kogakusha. Ltd., New Delhi (1934).
2. Fundamentals of Molecular Spectroscopy, C.N. Banwell, E.M. McCash,Tata McGraw-Hill Pub.. (1994)
3. Spectroscopy, Vol. I & III, B.P. Straughan and S. Walker, John Wiley & Sons Inc., New York. (1976).
4. Introduction to Molecular Spectroscopy, G.M. Barrow, McGraw - Hill Book company, Inc., (1962).
6. Molecular Structure and Spectroscopy, G. Aruldhas, Prentice- Hall of India, Pvt., New Delhi, (2005).

Course Outcomes: After completion of the courser, the students will be able to
1. Understand the various basic concepts of atomic and molecular physics and know the analysis of different molecular spectra and then get the structural details.
2. Learn the various applications of atomic and molecular spectroscopy in different fields.

Branch: PHYSICS
Course title: Solid State Physics
Semester: I

Course code: PHY 103
Credits: 4
Marks: 80 + 20 (Internal)

Course Educational Objectives:
1. To impart knowledge on different types of interactions, forces and temperature effect on solids
2. To learn l the behavior of electrons in solids based on classical and quantum theories
3. To become familiar with classification of solids using band theory
4. To provide basic ideas in superconductivity and the related theories and parameters.

SYLLABUS

UNIT – I: Lattice Energies and Lattice Vibrations

Origin of chemical binding in ionic and van der Waals crystals – Elastic properties – Stress andstrain – Elastic moduli - Lattice energy calculations for ionic and van der Waals crystals – Lattice vibrations: ono and diatomic one dimensional infinitely long lattices – Vibrational spectra – Infrared absorption in ionic rystals – Vibrational spectra of finite lattice – Quantization of lattice vibrations – Phonons – Properties – Experimental measurement of dispersion relation.

UNIT – II: Transport Phenomena and Band Theory

Concept of electrical and thermal resistivity – Expression for thermal and electrical conductivities for metals – Lorenz number - Different scattering mechanisms – Matheissens rule- Distribution function - Formulation of Boltzmann transport equation – Relaxation time approximation.

Sommerfeld model – its consequences – electron-lattice interaction (Quantitative only) – Bloch function - Motion of electron in periodic potential –Kronig - Penny model – Formation of energy bands in solids – Brillouin zones – Concept of effective mass – Distinction between metals, insulators and semiconductors.

UNIT – III: Semiconductor Physics

Intrinsic and extrinsic semiconductors – Expression for position of Fermi levels and carrier concentrations – Variation of Fermi level with temperature – np product – Carrier mobility, conductivity and their variation with temperature – Direct and indirect band gap semiconductors – Differences and examples – Hall effect - Continuity equation – Drift and Diffusion – Einstein relation – Generation, Recombination and life time of non-equilibrium carriers – Heyness- Schockley experiment – Determination of life time, diffusion length.

UNIT – IV: Superconductivity

Concept of zero resistance – Magnetic behavior – Distinction between a perfect conductor and superconductor – Meissner effect – Isotope effect – Specific heat behavior – Two-fluid model – Expression for entropy difference between normal and superconducting states – London's equations – Penetration depth – BCS theory –Josephson junctions – SQUIDS and its applications - Applications of superconductors – High T C superconductors – Preparation – Properties.

Books for Study
1. Solid State Physics, C. Kittel, John Wiley & Sons.
2. Solid State Physics, A.J. Dekkar, Macmillan India Ltd.
3. Elementary Solid State Physics, M. Ali Omar, Addison-Wesley.
4. Solid State Physics, M.A. Wahab, Narosa Publishing House.
5. Solid State Electronic Devices, B.G. Streetman.
6. High T C Superconductivity, C.N.R. Rao and S.V. Subramanyam.

Course Outcomes: After completion of the course, the students will be able to
1. Understand different bonds in solids, importance of lattice vibrations, their models and elastic properties
2. Explain electronic properties of solids in classical, quantum and the nearly free electron model.
3.Able to classify materials as metals, insulators and semiconductors and sketch the band diagram for each Hall effect and Heyness-Schockley experiment, properties, theories and applications of superconductors.

Branch: PHYSICS **Course code: PHY 104**
Course title: Analog and Digital Electronics **Credits:** 4
Semester: I **Marks: 80 + 20 (Internal)**

Course Educational Objectives
1.To prepare students to perform the analysis of any Analog electronics circuits.
2. To understand design and working of BJT/FET/MOSFETs amplifiers, oscillators, operational amplifiers.
3.To acquire knowledge of digital logic levels and to understand digital electronics circuits.

SYLLABUS
UNIT – I: Introduction to Electronic Devices:
Field Effect Transistor: Structure working of JFET, Characteristics, and parameters of JFET. Advantages of FET over BJT. FET as switch and amplifier, Application of FET as voltage variable resistor. Structure of MOSFET, depletion and enhancement types, MOSFET Characteristics, MOSFET as variable resistor, Concept of CMOS. Structure, working and characteristics of UJT, Its application as a Relaxation oscillator.
UNIT – II:
(a) Operational Amplifiers:
Block diagram of a typical Op-Amp, differential Amplifier, Comparator open loop configuration, inverting and non-inverting amplifiers. Op-amp with negative feedback, CMRR, frequency response, slew rate. Instrumentation Amplifier, integrator and differentiator. Waveform generators (Square and triangle). Converters: R-2R Ladder D/A Converter, Successive Approximation A/D Converter.
(b) Transducers (temperature, pressure/vacuum, magnetic fields, vibration, optical, and particle detectors). Measurement and control, Sig conditioning and recovery, Impedance matching, amplification, filtering and noise reduction.
UNIT – III : Digital Electronics
Combinational Logic: Multiplexers, Decoder, Demultiplexer, Data selector, Multiplexer, Encoder. Sequential Logic: Flip–Flops, 1-bit memory, The RS Flip-Flop, JK Flip – Flop, JK Master Slave Flip–Flops, T Flip-Flop, D Flip-Flop, Shift Registers, Serial in Serial out, Serial in Parallel out, parallel in Serial out, Parallel in Parallel out Registers. Counters: Asynchronous and Synchronous Counters, MOD-3 Counter, MOD-5 Counter.
UNIT – IV: 8051 Microcontrollers
Introduction of Microprocessors and Microcontrollers, Microcontroller: 8051 Internal Architecture, Register Structure, I/O pins, Memory Organization, 8051 Addressing modes. 8051 Assembly Language Programming Tools. 8051 Instruction set: Data Transfer Instructions, Arithmetic instructions, Logical instructions, Boolean Variable Manipulation Instructions-Bit Addressability, Single-Bit instructions, Program Branching instructions-Jump, Loop, and Call instructions, Rotate Instructions, Stack Pointer.
Books for Study:
1. Micro Electronics, Milliman and Halkias. TMH Publications
2. OP-Amps & Linear Integrated Circuits, Ramakanth A.Gayakwad, PHI, 2nd Edition, 1991.
3. Digital Systems, Ronald J. Tocci, 6th Edition, PHI, 1999.
4. Digital Principles and Applications, A.P. Malvino and D.P. Leach, Tata McGraw-Hill, New Delhi, 1993.
5. The 8051 Microcontroller and Embedded systems, M. Ali Mazidi and J.G. Mazidi, PEA Pvt. Ltd., 2000.

Course Outcomes: After completion of the course, the student shall able to
1. Understand the design and working of BJT/FET/ MOSFETs based electronic circuits, observe the effect of negative feedback on amplifier parameters, types of negative feedback topologies. Perceive the effect of positive feedback on working of Op-Amps based Oscillators.
2.Learn and understand the basics of digital electronics, Boolean algebra, and be able to design the simple logic circuits and test/verify the functionality of the logic circuits.
3. Develop the skill to build, and troubleshoot analog and digital electronic circuits.

Branch: PHYSICS **Course code: PHY 105**
Course title: General Lab – I **Credits:** 4
Semester: I **Marks: 100**

Course Educational Objectives
1. Students able to learn experiments in basic as well as certain advanced areas ofphysics such as semiconductor physics and optics.
2. To provide hands on experience in measurements to motivate towards research

List of Experiments

01. Plank's constant determination
02. Thermo EMF of bulk samples
03. Resistivity measurement – Four probe Method
04. Lasers – Determination of wavelength with (a) Grating (b) Metal Scale
05. Hartmann's Dispersion formula.
06. Thermistor – Characteristics
07. X-Ray diffraction – Determination of lattice constant, grain sixe.

Course Outcomes: After completion of the course, the students will have hands on experience in
1.Determining the value of Planck's constant and Seebeck coefficient of a thermocouple, and also measurement and behavior analysis of semiconductor, laser, thermistor and white light dispersion.
2. Structural determination using X-ray diffraction method.
3. Demonstration of skills related to the said experiments in Physics.

Branch: PHYSICS **Course code: PHY 106**
Course title: Electronics Lab – I **Credits:** 4
Semester: I **Marks: 100**

Course Educational Objectives
1. To explain the students about different electronic circuits and their application in practice.
2.To impart knowledge on assessing the performance of electronic circuits through monitoring ofsensitive parameters.
3.To evaluate the use of computer-based analysis tools to review the performance of semiconductor device circuits.

List of Experiments

01. UJT Characteristics
02. 555 – Timer Astable Multivibrator
03. Wien Bridge Oscillator using Op-Amp
04. Op Amp Parameters (a) Input offset voltage, (b) Input bias current, (c) CMMR and(d) Slew rate
05. Op-Amp offset null adjustment Inverting Amplifiers
06. Op-Amp Integration, Differentiation & Summation

Course Outcomes: After completion of the course, the students are able to
1. Identify relevant information to supplement the Analog Electronic Circuits.
2. Set up testing strategies and select proper instruments to evaluate the performance characteristics of the electronic circuit.
3. Choose testing and experimental procedures on different types of electronic circuits and analyze their operation at different operating conditions.

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Branch: PHYSICS | **Course code: PHY 201**
Course title: Statistical Mechanics | **Credits:** 4
Semester: II | **Marks: 80 + 20 (Internal)**

Course Educational Objectives
1. To learn the dependence of equilibrium properties of various systems on their microscopic constituents and calculation of thermodynamic parameters by using classical statistics.
2. To learn partition functions, Maxwell-Boltzmann distribution and Maxwell's distribution of velocities
3. To understand the use of methods of quantum statistics to obtain properties of systems made of microscopic particles which either obey Fermi-Dirac statistics or Bose-Einstein statistics.
4. To gain knowledge of first order and second order phase transitions and critical phenomena.
5. To learn the implication of probability in statistical physics.

SYLLABUS:
UNIT- I : Ensembles
Phase space – Concept of ensembles – Types of ensembles – Ensemble average - Liouville's Theorem – Microcanonical ensemble : ideal gas – Gibb's paradox and its resolution – Entropy and probability – Canonical ensemble – Ideal gas in canonical ensemble – Grand canonical ensemble – Ideal gas in grand canonical ensemble – Comparison of various ensembles.
UNIT – II : Partition Functions
Canonical partition function – Molecular partition function – Transnational partition function – Rotational partition function – Vibrational partition function – Electronic and Nuclear partition functions – Applications of Rotational partition function – Applications of vibrational partition function to solids.
UNIT – III: Maxwell – Boltzmann and Bose – Einstein Statistics
Maxwell – Boltzmann distribution – Distribution of velocities – Experimental verification – Calculation of mean values – Equipartition energy- Bose – Einstein distribution, Bose – Einstein condensation, Black body radiation and the Planck's radiation law – Dulong and Petit's law – Einstein and Debye's theories of heat capacities – Liquid helium – Two fluid model of liquid helium II – Super fluid phase of ^{3}He.
UNIT – IV: Fermi – Dirac Statistics & Fluctuations
Fermi – Dirac distribution – Electrons in metals – Thermionic emission – Magnetic susceptibility of free electrons – White dwarfs – Fluctuations in ensembles, Onsagar's one dimensional and reciprocal rotations and their applications to thermoelectric phenomena, Kelvin's first and second equations: One dimensional random walk – Random walk and Brownian motion.
Books for study:
1. Statistical Mechanics by B.K. Agarwal, Melvin Eisner
2. Statistical Mechanics and properties of Matter by ESR Gopal
3. Statistical and Thermal Physics by F. Reif
4. Elementary Statistical Mechanics by C.Kittel
5. Statistical Physics by Bhattacharjee
6. Thermal Physics by Kittel and Kremer

Course Outcomes: After completion of the course, the students should be able to
1. Learn different ensembles and partition functions and their applications to thermal properties of solids
2. Understand the concepts of Maxwell-Boltzmann, Bose-Einstein and Femi-Dirac distributions.
3. Disseminate the applications of Maxwell's distribution of velocities and various applications of systems behaving as ideal ideal Bose gas or Fermi gas.

Branch: PHYSICS | **Course code: PHY 202**
Course title: Electromagnetic Theory, Lasers and Modern Optics | **Credits:** 4
Semester: II | **Marks: 80 + 20 (Internal)**

Course Educational Objectives

1. To understand principles of Electromagnetic theory, lasers,modern optics and their applications
2. To study the importance of holography in different fields and the applications of Fourier optics
3. To know about optical fibres and light propagation through them and applications of optical fibres.

SYLLABUS

UNIT – I: Electromagnetic Theory

Electromagnetic radiation ; Introduction to electrostatics and magnetostatics – Electrodynamics : emf – electromagnetic induction – Maxwell's equations in differential and integral forms - Retarded potentials – Radiation from moving point charge and oscillating dipoles– Linear antenna – Radiation resistance – electric quadrupole radiation – Lienard – Wiechert potentials.

General wave equation – Propagation of light in isotropic dielectric medium – Dispersion – Propagation of light in conducting medium-skin depth – Reflection and refraction at the boundary of a dielectric interface – Fresnel's equations – Propagation of light in crystals-Double refraction.

UNIT – II: Lasers and Non-Linear Optics

Introduction to lasers – Spontaneous and stimulated emission – Laser beam properties – Einstein coefficients – Population inversion – Pumping schemes – Losses in laser radiation – Threshold condition for laser oscillation –Role of feedback (Laser cavity) – Q factor– different experimental methods – Ruby laser – GaAs laser – He-Ne laser – Argon ion laser – CO_2 laser – Laser applications.

Basic Principles – Origin of optical nonlinearity – Harmonic generation – Second harmonic generation – Phase matching condition – Third harmonic generation – Optical mixing – Parametric generation of light – Parametric light oscillator – Frequency up conversion – Self focusing of light – Guided wave optics – Pulse compression – Optical solutions.

UNIT – III: Holography and Fourier Optics

Introduction to Holography – Basic theory of Holography – Recording and reconstruction of Hologram – Diffuse object illumination –Speckle pattern – Fourier transform Holography – Applications of Holography.

Introduction to Fourier optics– Two dimensional Fourier transforms – Transforms of Dirac-delta function – The convolution integral – convolution theorem- Spectra and correlation – Parseval's formula – Auto correlation and cross-correlation – Apodization – Array theorem – Fourier methods in diffraction – Fraunhofer diffraction of single slit, double slit and transmission grating using Fourier method.

UNIT – IV: Fiber Optics

Total internal reflection – Optical fiber modes and configuration – Single mode fibers – Graded index fiber– Fiber materials and fabrication – Mechanical properties of fibers – Fiber optic cables – Attenuation – Signal distortion on optical wave guides- Erbium doped fiber amplifiers – Solitons in optical fibers – Block diagram of fiber optic communication system – Applications in communication and medicine.

Books for Study

1. Introduction to Electrodynamics, D.J. Griffiths, Prentice-Hall, India
2. Modern Optics, Fowels
3. Laser and their Applications, M.J. Beesly, Taylor and Francis, 1976
4. Optical Fiber Communications, Gerel Keiser, McGraw Hill Book, 2000

Course Outcomes: After completion of the course, the **s**tudents should be able to

1. Understand the laws related to electrostatics and magnetostatics
2. Learn about light propagation in various materials and understood properties of lasers and applications
3. Know holographic concept, use of Fourier transforms in optics and optical fibre applications

Branch: PHYSICS **Course code: PHY 203**
Course title: Mathematical Physics **Credits:** 4
Semester: II **Marks: 80 + 20 (Internal)**

Course Educational Objectives
1. To learn the use of different special functions in solving physical problems.
2. To understand Laplace and fourier Transform and their applications to electrical circuits
3. To give the basic knowledge and understanding of numerical techniques.
4. To solve problems related to complex variables that contain real and imaginary parts.

SYLLABUS
UNIT – I: Special Functions
Beta and Gamma Functions – Definitions and properties – Evaluation of integrals, Legendre, Bessel and Hermite differential equations – Solutions – Generating functions – Orthogonal properties of Legendre, Bessel and Hermite Functions (Proof not necessary) – Recurrence relations – (Proof for Legendre polynomials only).
UNIT – II: Integral Transforms
Fouriers Transforms: Properties of Fourier transforms – Fourier sine and cosine transforms- Power in Fourier series – Modulation theorem, Fourier transform of impulse function, Constants, Unit step function and Periodic functions.
Laplace Transforms: Definition and notation – Properties of Laplace transforms – Laplace transforms of Dirac delta function and periodic functions (Square wave, sawtooth wave and triangular wave) – Inverse Laplace transforms – properties – Solution of linear differential equations with constant coefficients – Applications to LCR circuits and resonance of simple pendulum.
UNIT – III: Numerical techniques
Solution of an equation – Bisection method, Regular False method, Newton – Rhapson method – Solutions of simultaneous – Gauss elimination method and Gauss-Seidel method – Interpolations – Newton's interpolation and Lagrange's interpolation, Curve fitting – Method of Least squares. Numerical differentiation and integration – Trapezoidal rule and Simpson's 1/3 rule – Solutions of differential equations- Euler's method and Runga-Kutta Methods.
UNIT – IV: Complex Variables
Functions – Complex differentiation – Analytic function – Cauchy – Reimann equations –Derivatives of elementary functions – Singular points and classification. Complex integration – Cauchy's theorem – Integrals of special functions – Cauchy's integral formula – Taylor's and Lorentz theorem (statements only) – Residues, calculations of residues - Residue theorem – evaluation of definite integrals.
Reference Books:

1. Functions for Scientists and Engineers, W.W. Bell, D.Van Nostrand Company, London (1968)
2. Fourier Analysis, Hsu P Jewi, Unitech Division
3. Laplace Transforms by Murray Spiegle, Schaum's outline series, McGraw Hill Com., New York.
4. Applied Mathematics for Engineers, Pipes and Harval, Third Edition, McGraw Hill Books Co.
5. Mathematical Physics, H.K. Das and Ramaverma, S. Chand & Co Ltd., New Delhi, 2011.
6. Mathematical Physics, B. Bhattacharyya, New Central Book Agency Pvt. Ltd., 2010
7. Theory and Properties of Complex Variables, Murray Speigal, Schaum's series, Mc Graw Hill Co., .
8. Complex Variables and Applications, Churchle

Course Outcomes: After completion of the course, the students shall be able to
1. Understand and apply the mathematical skills to solve quantitative problems in physics.
2. Apply Laplace and Fourier transforms in solving different problems of mechanics, electronics etc.
3. Solve different physical problems using numerical techniques and those that contain complex variables.

Branch: PHYSICS **Course code: PHY 204**
Course title: Nuclear Physics and Analytical Techniques **Credits:** 4
Semester: II **Marks: 80 + 20 (Internal)**

Course Educational Objectives
1. To know the basics and applications of nuclear reactions and their importance in nuclear reactors
2. To know the various elementary particles and their properties in nature
3. To understand about various analytical techniques and their use in 11nalyzing the material properties.

SYLLABUS
UNIT – I: Nuclear Reactions
Classification of nuclear reactions – Reaction mechanisms –Compound nuclei – Direct reactions, Nuclear fission reactions – Types of fission - Distribution of fission products – Neutron emission on fission – Spontaneous fission – Nuclear fission and thermonuclear reactions – Hydrogen bomb.
Nuclear fusion reactions – Nuclear chain reactions – Four factor formula – The critical size of a reactor – General aspects of reactor design – Classification of reactors – Research reactors and Power reactors.
UNIT – II:Elementary particles
Discovery and classification of elementary particles – Types of interactions – Conservation laws – Iso-spin, parity, charge conjugation – Time reversal – CPT theorem – Properties of leptons, mesons and baryons – Elementary particle symmetries (SU_2 and SU_3 symmetries) – Quark model – Search for Higg's particle – Elementary ideas.
UNIT III : ESR, NMR and NQR Techniques
Introduction to ESR: Magnetic moment of an electron, ESR theory- spin-spin interaction – Hyperfine interaction-g factor, Relaxation effects, Experimental methods and applications.
Introduction to NMR: Nuclear spin and magnetic moment, Quantum description of NMR,
theory of NMR, chemical shift, Spin-lattice (T_1), spin-spin (T_2) couplings, Bloch equations, Carbon-13 NMR and NMR applications.
Basic concepts of NQR spectra: Half integral and integral spins, Instrumentation, Super regenerative oscillator, applications of NQR.
Mossbauer spectroscopy: Introduction-Mossbauer effect, Recoilless emission and absorption, Mossbauer spectrum, Experimental methods and applications.
UNIT – IV: Advanced Spectroscopic and Microscopic Techniques
Spectroscopic Techniques: Energy dispersive spectroscopy, X-ray photo electron spectroscopy, X ray fluorescence spectroscopy, Photoemission spectroscopy and Auger Electron Spectroscopy. Imaging Techniques: Scanning electron microscopy, Transmission electron microscopy, Atomic force microscopy, Diffraction Techniques : X-Ray diffraction – Laue method – Power method.
Reference Books

1. Elements of X-ray Diffraction, B.D. Cullity.
2. Methods of Surface Analysis, Techniques & Applications, J.M.Walls Cambridge University Press, 1990.
3. X-ray Structure Determination, H. Stout and LH. Jenson, Macmillan, London, 1968.
4. Instrumental Methods of Analysis, Willard Merritt, Dean Settle, CBS publishers, New Delhi, 1986
5. Spectroscopy, B.P. Straughan and S. Walker, John Wiley & Sons Inc., New York,1976.
6. Spectroscopy, B.K. Sharma, Goel Publishers House, Meerut, 1975.
7. NMR Spectroscopy, R.K. Harris, Longman Sci. Tech, 1983.
8. Atomic and Nuclear Physics, R.C. Sharma, K. Nath & Co., Meerut.

Course Outcomes: After completing the course, the students will be able to
1. know the concepts of nuclear reactions and their usefulness in nuclear reactors.
2. apply the various analytical techniques in getting structural details of unknown compounds
3. understand the various advanced spectroscopic techniques and microscopic techniques

Branch: PHYSICS **Course code: PHY 205**
Course title: General Lab – II **Credits:** 4
Semester: I **Marks: 100**

Course Educational Objectives

1. To provide experimental knowledge in theoretical concepts and important areas ofresearch .
2. To provide knowledge in measurements and its importance information of new devices

List of Experiments:

1. Laser –Determination of (a) Slit width and (b) Diameter of Wire
2. Young's Modulus-Interference Method
3. Stefan's Constant
4. Verification of Malus Law
5. Refractive index of liquids
6. Phototransistor characteristics
7. G M Counter

Course Outcomes: Students will have hands on experience of
1. Lasers and its slit width calculation and refractive index measurement, Young's modulus finding through interference and Stefan's constant calculation
2. Intensity variation of light, photo transistor working, absorption and decay of nuclear radiation
3.Analyse the results and able to design the instruments

Branch: PHYSICS **Course code: PHY 206**
Course title: Electronics Lab – II **Credits:** 4
Semester: I **Marks: 100**

Course Educational Objectives
1. To explain the students about different electronic circuits and their application in practice.
2.To impart knowledge on assessing the performance of electronic circuits through monitoring ofsensitive parameters.
3.To evaluate the use of computer-based analysis tools to review the performance of semiconductor device circuits.

List of Experiments

1. First order filters using –Op-Amp : Low Pass, High Pass and Band Reject – Frequency Response
2. Digital Trainer Kit a) Flip-Flop (R-S, R-S-T, J-K)
3. Microprocessor 8085 Programming
4.. Amplitude Modulation (AM) and Demodulation
5. Frequency Modulation (FM) and Demodulation
6. DAC-using Op-Amp & R-2R Ladder Network.

Course Outcomes: After completion of the course, the students are able to
2. Identify relevant information to supplement the Analog Electronic Circuits.
2. Set up testing strategies and select proper instruments to evaluate the performance characteristics of the electronic circuit.
3. Choose testing and experimental procedures on different types of electronic circuits and analyze their operation at different operating conditions.
4. Evaluate possible causes of discrepancy in practical experimental observations in comparison to theory.
5. Practice different types of wiring and instruments connections keeping in mind technical, Economical, safety issues.
6. Prepare professional quality textual and graphical presentations of laboratory data and Computational results.

Branch: PHYSICS **Course code: PHY 301**
Course title: Quantum Mechanics - I **Credits:** 4
Semester: III **Marks: 80 + 20 (Internal)**

Course Educational Objectives:
1. To provide an understanding of the formalism and language of quantum mechanics.
2. To gain knowledge of Quantum Dynamics
3. To understand the concepts of perturbation theory and their applications to physical situations.
4. To solve the harmonic oscillator and hydrogen-like atom problems using perturbation methods.
5. To illustrate scattering theory and to determine the scattering parameters.

SYLLABUS:
UNIT - I: Formulation and Simple Problems
Wave particle duality – Wave functions in coordinate and momentum representation- Postulates of quantum mechanics -Linear vector space: Hilbert space - Dirac's Bra and Ket notations-Hermitian operators and their properties- Matrix representation of an operator- Unitary operators- Unitary transformation - The Kronicker Delta and Dirac delta functions Eigen values and Eigen functions for finite potential well and step barrier – Quantum mechanical tunneling
UNIT - II: Quantum Dynamics and Simple Problems
Equations of motion - Schrodinger Picture- Heisenberg Picture- Interaction Picture- Equivalence of various Pictures- . Poisson and Commutation brackets- Their Properties Eigen values and Eigen functions for Simple harmonic oscillator- Polynomial method and abstract operator method in one dimension- Eigen values and Eigen functions for a free particle and particle in a box in three dimensions.
UNIT - III: Approximate Methods
Time independent perturbation theory for non-degenerate levels: Perturbed harmonic oscillator, Normal Helium atom, Stark effect of the plane rotator. First order perturbation theory for degenerate levels: First order Stark effecting in hydrogen atom; Time dependent perturbation theory: Transition to continuum (Fermi Golden rule). WKB approximation – Turning points and connecting formulae: Application to potential barrier.Variational methods.
UNIT - IV: Scattering Theory
Introduction: classical theory of scattering - Quantum theory of scattering - Method of partial wave analysis - Scattering by a perfectly rigid sphere - Greens function in scattering theory - Born approximation - Validity of Born approximation - optical theorem.
Reference Books
1. Quantum Mechanics: S. L.Kakani and H.M.Chandalia.SultanChandandSonsFirst Edition
2. Advanced Quantum Mechanics : B.S. Rajput, Pragatiprakasan.
3. Quantum Mechanics: V.K. Thankappan, Wiley Eastern Limited
4. A Textbook of Quantum Mechanics : P.M. Mathews& K. Venkatesan, Tata McGrawHill Pub. Comp
5. Quantum Mechanics: S.L. Gupta, V. Kumar, H.V. Sharma and R.C. Sharma JP Nath and Company.
6. An introduction to QuantumMechanics, P.T. Mathews c Graw Hill Publishing Company.

Course Outcomes: After completing the course, the students will be able to
1. Solve problems in quantum mechanics using Schrodinger's equation and Dirac representation.
2. Grasp the concepts of different pictures and familiar with the applications
3. Know with approximation methods applied to atomic, nuclear and solid-state physics.
4. Explain scattering theory, formulate and solve scattering equation- solve problems using this theory

Branch: PHYSICS | **Course code: PHY 302**
Course title: Physics of Semiconductor Devices | **Credits:** 4
Semester: III | **Marks: 80 + 20 (Internal)**

Course Educational Objectives

1.To introduce the concept of junctions, calculation of junction parameters, different diodes and applications.
2.To learn the difference between BJT and FET, their applications and working of MOSFET.
3.To learn different types of power devices and their technological applications.

SYLLABUS

UNIT - I: Junctions and Interfaces

p-n Junctions: Description of p-n Junction action – Junction in equilibrium- application of bias – energy band diagrams. Abrupt junction – calculation of the built-in voltage - electric field and potential distributions – Expression for Depletion layer capacitance, Static I-V characteristics of p-n junction diodes: Ideal diode model- Derivation of ideal diode equation. Real diodes – Carrier generation – recombination in the junction depletion region, I-V characteristics of Real Diodes.

Electrical breakdown in p-n junctions: Zener and Avalanche breakdown in p-n junctions, Distinction between the Zener and Avalanche breakdown, Applications of breakdown diodes. Metal-Semiconductor interfaces, Ohmic and Schottky contacts.

UNIT- II: Junction Diodes

Tunnel diode- I-V characteristics, Schottky barrier diode - operation and applications. Varactor diode, Gunn diode, IMPATT diode, TRAPATT diode, BARITT diode - basic principle, operation and its applications. Solar cell – Structure - Principle of operation – Solar cell parameters – Light Emitting Diodes (LEDs), Semiconductor lasers – principle of operation and applications.

UNIT - III: Junction Transistors

Bipolar junction transistors: Principle of operation- Analysis of the ideal diffusion transistor – Calculation of terminal currents, DC parameters. Ebbers-Moll Equations – Four regions of operation of a bipolar transistor. Real transistors - carrier recombination in the Emitter-Base junction depletion region – Effect of collector bias variation, avalanche multiplication in the collector – base junction and base resistance.

MOS transistors and charge-coupled devices: MOS capacitor – Surface field effect – Energy band diagrams of an MOS capacitor for different bias conditions. C-V characteristics of the MOS capacitors. Charge Coupled Devices (CCD)- principle of operation.

UNIT – IV: Power Devices and Semiconductor Technology

Technology of Semiconductor Devices: Crystal growth and Wafer preparation, Methods of p-n junction formation, Growth and deposition of dielectric layers, Planar technology, Masking and lithography, Pattern definition, Metal deposition techniques.

Power rectifiers and Thyristors: Power rectifiers, Thyristors, Some special thyristor structures, Bidirectional thyristors, Field-controlled thyristor.

Books for Study

1. Introduction to Semiconductor Materials and Devices, M.S. Tyagi, John Wiley & Sons Pvt. Ltd., 2000.
2. Microwave Devices and Circuits, Samuel and Y. Lao, Prentice-Hall of India, 1999.
3. Microwave and Radar Engineering, M. Kulkarni, UMESH Publications, New Delhi, 1999.
4. Physics of Semiconductor Devices , S.M. Sze, 3rd Edition , Oct.2006, John Wiley.
5. Solid State Electronic Devices, B.G. Streetman, PHI, New Delhi.

Course Outcomes After completion of course students able to

1.classify different diodes and its importance in different applications
2.gain theoretical knowledge on devices formation and able to fabricate devices
3. learn applications of MOSFET power devices

Branch: PHYSICS **Course code: PHY 303**
Course title: Specialization – A: Applied Spectroscopy– I **Credits:** 4
Semester: III **Marks: 80 + 20 (Internal)**

Course objectives:

1. To understand about rotational and vibrational effects on diatomic and polyatomic molecular spectra.
2. To know details and analysis of rotational, vibrational and Raman spectra using various techniques.
3. To know the instrumentation involved in different spectrophotometers like UV-Vis –IR, NIR and FTIR.
4. To become familiar with the concepts of different types of luminescence and their applications.

SYLLABUS

UNIT I: Molecular Spectroscopy

Introduction – Rotational structure of electronic bands of diatomic molecules – Fortrat diagram – General relations – Combination relations for $^1\Sigma$ - $^1\Sigma$ and $^1\Sigma$ – $^1\pi$ bands– Evaluation of rotational constants with reference to above transition.Isotope effect in electronic spectra of diatomic molecules – Vibrational effect and rotational effect. Potential energy curves and dissociation energy, and pre-dissociation energy. Vibrations of polyatomic molecules: CO_2 and H_2O).

UNIT- II: Raman Spectroscopy

Introduction – Theory of Raman Scattering – Rotational Raman Spectra – Vibrational Raman Spectra – Mutual Exclusion Principle – Laser Raman Spectroscopy – Sample Handling Techniques – Polarization of Raman Scattered Light – Single Crystal Raman Spectra – Raman Investigation of Phase Transitions – Resonance Raman Scattering – Structure Determination using FTIR and Raman Spectroscopy. Fourier Transform (FT) Raman Spectroscopy and its additional advantages over the conventional Raman Spectroscopy, Significance of confocal Raman spectrometer, Surface enhanced Raman Scattering-Coherent Anti-Stokes Raman Spectroscopy.

UNIT – III: Spectrophotometry

Introduction – Beer's law – Absorptivity – UV and visible absorption – Instrumentation – Essential parts of spectrophotometer – Gratings and prisms – Radiant energy sources – Filters – Photosensitive detectors – Barrier layer cells – Photo emissive cells – Photomultiplier tubes – Relationship between absorption in the visible and UV region and molecular structure – IR Spectrophotometry – Fourier Transform Infrared (FTIR) Spectrometer – Molecular structure – Qualitative and Quantitative analysis –Importance of photography in the spectrochemical analysis.

UNIT - IV:Fluorescence and Phosphorescence Spectroscopy

Introduction – Normal and Resonance Fluorescence – Intensities of Transitions – Non-radiative decay of fluorescent molecules – Phosphorescence and the nature of the triplet state – Population of the triplet state – Delayed Fluorescence – Excitation spectra – Experimental methods – Emission lifetime measurements – Time resolved emission spectroscopy – Applications of Fluorescence and Phosphorescence.

Books for Study

1. Molecular spectra and Molecular structure Vol. I, G. Herzberg, 2nd Ed, Van. Nostrand.
2. Fundamentals of Molecular Spectroscopy, C.N. Banwell, Tata Mc Graw-Hill, 1983.
3. Spectroscopy Straughan and Walker (vol. 2 & 3, John Wiley & Sons, 1976.
4. Molecular Structure and Spectroscopy BY G. Aruldhas, Printice-Hall Pvt. Ltd. 2001.
5. Instrumental Methods of Analysis Willard, Merritt, Dean & Settle, CBS Pub, 2001.
6. Spectrochemical Analysis, L.H. Ahrens and S.R. Taylor,Addison – Wesley, London.

Course outcomes: At the end of the course, the students shall able to

1. Understand the molecular structure and importance of various molecular transitions, know the rotational, vibrational and Raman spectroscopy of molecules and their various applications.
2. Understand the instrumentation techniques that are used in different regions of spectra.
3. Learn about fluorescence and phosphorescence spectroscopy in detail and their applications.

Branch: PHYSICS

Course code: PHY 303

Course title: Specialization – B: Condensed Matter Physics - I

Credits: 4

Semester: III

Marks: 80 + 20 (Internal)

Course Educational Objectives:

1.To familiar with the different crystal growth techniques and various crystal imperfections
2. Tounderstand the dielectric properties and ordering of dipoles in dielectrics and ferroelectrics
3. To learn the different types of magnetism and magnetism-based phenomenon
4. To know photoconductivity, luminescence, type of excitations in solid and their importance

SYLLABUS:

UNIT - I: Crystal Growth and Imperfections in Crystals

Crystal growth: Nucleation and growth – Homogeneous and heterogeneous nucleation – Classification of crystal growth techniques – Melt growth: Bridgman, Czochralski techniques.Imperfections: Classification– Point defects – Schottky and Frenkel defects **-** Expressions for equilibrium defect density – Colourcentres – its production – Line defects – Edge and Screw dislocations – Burger vector – Estimation of dislocation densities – Mechanism of creep – Determination of creep activation energy.

UNIT- II: Dielectrics and Ferroelectrics

Dielectrics: Introduction – Dipole moment – various types of polarization – Electronic, ionic and orientational polarization – Langevin's theory – Lorentz field – Clausius-Mosotti equation – Measurement of dielectric constant – Applications of dielectrics.Ferroelectrics: Piezo-, Pyro- and ferroelectric crystals– Spontaneous polarization – Classification and properties of ferroelectrics **-** Ferroelectric domains – Oxygen ion displacement theory – Applications of ferroelectrics.

UNIT- III: Ferromagnetism and Anti-ferromagnetism

Ferromagnetism: Introduction – Weiss molecular field theory – Temperature dependence of spontaneous magnetization – Heisenberg model – Exchange interaction – Ferromagnetic domains – Magnetic bubbles – Bloch wall – Thickness and energy – Ferromagnetic spin waves – Magnons – Dispersion relations.
Anti-ferromagnetism: Introduction – Two sub lattice model of anti-ferromagnetism – Ferri magnetism - Ferrites – Structure – Applications – Multiferroics.

UNIT-IV: Photoconductivity and Luminescence

Excitons: Weakly bound and tightly bound – Photoconductivity – Simple model – Influence of traps – Space charge effects – Determination of photoconductivity. Luminescence – Various types– Thermoluminescence, Electroluminescence, Photoluminescence, Cathodoluminescence and Chemiluminescence - Excitation and emission – Decay mechanisms – Applications.

Reference Books

1. Introduction to Solid State Physics, Charles Kittel VII edition, John Wiley & Sons.
2. Solid State Physics, A.J. Dekker, McMillan Publications.
3. Material Science and Engineering, V. Raghavan, PHI, New Delhi.
4. Crystal Growth, B.R. Pamplin, Pergamon Press.
5. Crystal Growth from High Temperature Solutions, D. Elwell and H.J. Scheel,Academic Press.
6. Solid State Physics, M.A. Wahab, Narosa Publishing House.

Course Outcomes: The students are able to

1. Learn the classification of growth techniques and its importance, able to analyze the defects and its importance in properties of solids, gain knowledge on defects importance in growth of crystals
2. Explain various magnetic phenomena and describe the different types of magnetic ordering based on the exchange interaction, and magnons and their importance
3. Describe different dielectric properties and know methods to study dielectrics behavior
4. Differentiate between ferroelectric, anti-ferroelectric, piezoelectric and pyroelectric materials.
5. Understand excitons, photoconductivity, types of luminescence, decay mechanisms

Branch: PHYSICS
Course title: Specialization – C: Electronics- Embedded Systems
Semester: III

Course code: PHY 303
Credits: 4
Marks: 80 + 20 (Internal)

Course Educational Objectives

1. To know the basic working of a PIC microcontroller system and its programming in assembly language.
2. To program PIC microcontroller for data acquisition and processing application.
3. To know Interface sensors, transducers, motors, relays, and various input/output devices with PIC microcontroller.
4. To provide experience to integrate hardware and software for PIC microcontroller application systems

SYLLABUS

Unit - I: Introduction to Embedded Systems

Embedded systems in today's world – examples of Embedded systems – Microprocessors and Microcontrollers – Microchip and PIC microcontroller – Introduction to PIC microcontrollers using the 12 series. Architecture of 16F84A – Memory organization – in 16F84A – Timing generation – Power-up and Reset functions in 16F84A.

Unit - II: Hardware Details of 16F84A

Parallel ports : Basic idea – Technical challenge – connecting to the parallel port – Parallel ports of PIC16F84A -Clock oscillator -Power supply- Interrupts -Timers and counters -watch dog timer -Sleep mode.

Unit - III: Assembler and Assembler Programs

Basic idea – PIC 16 series instruction set and ALU – Assemblers and Assembler format – creating simple programs – Adopting a development environment – Building structured programs – Flow control: Branching and Subroutines – Generating time delays and intervals – Logical instruction – Arithmetic instructions.

Unit - IV: PIC Microcontroller PIC 16F873A

Block diagram and CPU – Memory and memory maps – Interrupts – Oscillator, Reset and Power supply – Parallel ports.

PIC 16F87XA Timer 0 and Timer 1 – 16F87XA Timer 2, Comparator and PR2 register – capture/Compare/PWM (CCP) Module – Pulse width modulation – ADC module.

Interface: LED displays – Liquid crystal displays –Sensors –Actuators.

Books for Study

1. Designing Embedded Systems with PIC Microcontrollers: Principles and applications, Tim Wilmshurst, First Edition, 2007, Newnes – Elsevier – Publishers.
2. Microcontrollers: Theory and Applications, Ajay V. Deshmukh, , Tata McGraw Hill, New Delhi, 2005
3. Designing with PIC Microcontrollers, John B. Peatman, Pearson Education, Inc.,1998.
4. The 8051 Microcontroller and Embedded systems, M.A. Mazidi and J.G. Mazidi, PEA, Pvt. Ltd., 2000.

Course Outcomes: After completion of the course, the students are able to

1. Acquire knowledge about PIC microcontrollers embedded processors and their applications.
2. Ability to understand the internal architecture/functional block diagram of PIC microcontrollers.
3. Develop programs for data transfer, arithmetic, logical and I/O port operations.
4. Develop program for PIC microcontroller timers, serial port and Interrupts using "C".
5. Interface LCD, keyboard, ADC, DAC, sensors, relays, DC and stepper motor with PIC microcontroller.
6. Develop the design concept of embedded systems and the role of embedded systems in the industry

Branch: PHYSICS **Course code: PHY 304**
Course title: Elective – A: Photonics – I **Credits:** 4
Semester: III **Marks: 80 + 20 (Internal)**

Course Educational Objectives

1. To objective of the course is to inspire the student to learn from basics to applications of Photonic devices where the interaction of light with matter. Here the role and influence of properties of light and structural details of matter is highlighted.
2. To develop the creativity to understand and formulate problems related to photonic structure and potential applications.

SYLLABUS

UNIT - I: Laser systems

General description, Laser structure, Single mode laser theory, Excitation mechanism and working of: CO_2, Nitrogen, Argon ion, Excimer, X-ray, Free-electron, Dye, Nd:YAG, Alexanderite and Ti:sapphire lasers, Diode pumped solid state laser, Optical parametric oscilater (OPO) lasers. Optical amplifiers- Semiconductor optical amplifiers, Erbium doped waveguide optical amplifiers, Raman amplifiers, Fiber Lasers. Laser applications-Lasers in Isotope separation, Laser interferometry and speckle metrology, Velocity measurements.

UNIT - II: Properties of laser Radiation

Introduction, Laser linewidth, Laser frequency stabilization, Beam divergence, Beam coherence, Brightness, Focusing properties of laser radiation, Q-switching, Methods of Q-switching: Rotating-mirror method, Electro-optic Q-switching, Acoustic-optic Q-switching and Passive Q-switching, Modelocking, Methods of mode locking: Active and passive mode locking techniques, Frequency doubling and Phase conjugation

UNIT - III: Opto-electronic Devices

Introduction, P-N junction diode, Carrier recombination and diffusion in P-N junction, Injection efficiency, Internal quantum efficiency, Hetero-junction, Double hetero-junction, Quantum well, Quantum dot and Super lattices; LED materials, Device configuration and efficiency, Light extraction from LEDs, LED structures-single heterostructures, double heterostructures, Device performances and applications, Quantum well lasers; Photodiode and Avalanche photodiodes (APDs), Laser diodes-Amplification, Feed back and oscillation, Power and efficiency, Spectral and spatial characteristics.

UNIT – IV: **Modulation of Light**

Introduction, Birefringence, Electro-optic effect, Pockels and Kerr effects, Electro-optic phasemodulation, Electro-optic amplitude modulation, Electro-optic modulators:scanning and switching, Acousto-optic effect, Acousto-optic modulation, Raman-Nath and Bragg modulators : deflectors and spectrum analyzer, Magneto-optic effect, Faraday rotator as an optical isolator. Advantages of optical modulation.

Books for study

1. Lasers: Principles and applications, J.Wilson And J.F. Hawkes, Prentice Hall of India, New Delhi, 1996.
2. Laser fundamentals, W.T.Silfvast, Foundation books, New Delhi, 1999.
3. Semi conductor opto electronics devices, P. Bhattacharya, Prentice – Hall of India, New Delhi, 1995.
4. Optical fiber communications, John M. Senior, Prentice-Hall of India, New Delhi, 2001
5. Optoelectronics: An Introduction, J.Wilson And J.F.B.Hawkes, Prentice Hall of India, New Delhi, 1996.
6. Electro-Optical devices, M.A. Karim, Boston, Pws-Kent Publishers, 1990

Course Outcomes: After completion of the course, the students shall able to

1. Understand the fundamental properties of lasers and laser systems
2. Know about the different optoelectronic devices and their behavior
3. Aware of wide variety of applications of opto-electronic components.

Branch: PHYSICS | **Course code: PHY 304**
Course title: Elective – B: Solar Energy- Thermal Aspects | **Credits:** 4
Semester: III | **Marks: 80 + 20 (Internal)**

Course Educational Objectives
1. To provide information on thermal component of solar energy, measurement of radiation
2. To learn about theoretical aspects of solar collectors, performance evaluation and procedures.
3. To understand various types of solar thermal applications in the day-to-day life.

SYLLABUS
UNIT - I: Solar and Thermal Radiation- Basics
Spectral distribution of Extra-terrestrial radiation – Solar Constant-Concept of Zenith Angle and Air-Mass. Standard Time, Local Apparent Time, Equation of Time. Definitions of Declination, Hour Angle, Solar and Surface Azimuth Angles. Direct, Diffuse and Total Solar Radiations - Intensity Measurements - Thermoelectric Pyranometer, Thermoelectric Pyrheliometer and Angstrom Pyrheliometer.
Reflection, Absorption and Transmission of solar radiation through single and multiple covers-Transmittance-Absorptance product. Kirchoff's law-Relationship among absorptance, emittance and reflectance. Spectrally Selective Surfaces-Methods of obtaining selectivity -Direct measurement of solar absorptance and thermal emittance of a selective surface.
UNIT - II: Flat-Plate Collectors:
General description of a flat-plate collector - Liquid heating type flat-plate collector-Energy balance equation and efficiency. Temperature distribution in the flat-plate collectors-Collector over-all heat-loss coefficient-Definitions of fin efficiency - Collector efficiency factor, Collector heat-removal factor and Collector flow-factor. Standard method of testing the thermal performance of Liquid heating type flat-plate collector. Evacuated tubular collectors.
UNIT - III: Concentrating Collectors
Types of Concentrating Collectors - non-imaging and imaging concentrators-single axis and two-axis tracking – Definitions of Aperture, Rim-angle, Concentration ratio and Acceptance angle. Thermal performance of Linear Parabolic Trough Concentrator with an uncovered receiver.
UNIT - IV: Solar Thermal Energy Applications
Thermal Energy Storage - Sensible heat storage- liquid and pebble-bed storage, Latent Heat storage and Thermochemical storage.
Principles of Solar Water Heating System- Natural and Forced Circulation types-sizing of domestic water system. Solar space heating systems-active heating system-liquid heating type- Passive space heating and cooling concepts. Solar vapour absorption type and vapour compression type cooling systems. Solar Cookers, Solar Desalinators. Solar Air Heaters - Different configurations-Solar Driers - Principle of working – Solar thermal power generation.
Boos for study:
1. Solar Thermal Energy Engineering, J.A.Duffie&W.A.Beckman, John Wiley & Sons (1990)
2. Solar Energy Utilization, G.D.Rai , Khanna Publishers.
3. Principles of Solar Energy Engineering, Kreith and Kreider
4. Handbook of Solar Energy Technology - Part A and Part B, Chemisnoff and Dickinson.
5. Treatise on Solar Energy - Vol. 1, H.P.Garg, John Wiley.
6. Applied Solar Energy, Meinel and Meinel

Course Outcomes: After successful completion of the course, the student will be able to:
1. Understand the fundamentals of solar energy, particularly the thermal energy component.
2. Acquire knowledge on solar radiation measurement techniques and procedures.
3. Demonstrate skills related collector performance analysis through hands on experience

Branch: PHYSICS | **Course code: PHY 304**
Course title: Elective – C: Vacuum and Thin film Physics | **Credits:** 4
Semester: III | **Marks: 80 + 20 (Internal)**

Course Educational Objectives
1. To know about vacuum, creation and measurement of vacuum using vacuum pumps and gauges.
2. To design and construct the system for required vacuum level.
3. To learn various techniques used for thin film formation.
4. To understand the various mechanisms of thin film formation and thickness measurement techniques.

SYLLABUS
UNIT - I: Production and Measurement of Vacuum
Vacuum pumps: Fundamentals of kinetic theory applicable to vacuum technology- Mechanical Pumps: Rotary pump, Roots pump: Dry Pumps- Turbo molecular pump – Diffusion pump – Sorption pump – Cryogenic pump.
Vacuum Gauges: Thermal conductivity (Pirani) gauge- Ionization gauges: Penning gauge, Hot cathode ionization gauge – Bayard –Alpert gauge – Quadruple mass spectrometer
UNIT - II: Construction and Operation of Vacuum Systems
Valves for medium and high vacuum – Devices for transmitting motion – Working vessel – Pump combinations – Design of vacuum systems - Leaks and leak detection.
Vacuum application: Vacuum metallurgy, Space simulators, Freeze drying – Vacuum in electrical applications (Drying, Impregnation, circuit breakers).
UNIT - III: Preparation of Thin Films
Physical Methods: Vacuum evaporation: – Thickness distribution of evaporated films (Point and Ring sources) **-** Resistive heating, Electron beam evaporation, Co-evaporation Pulsed laser ablation – Epitaxial thin deposition: Close-space vapour transport (CSVT) and molecular beam epitaxy. Sputtering: Glow discharge, DC and RF sputtering, Reactive sputtering and magnetron sputtering.
Chemical methods: Electroplating – Spray pyrolysis – Chemical vapour deposition (CVD), Sol-gel – spin coating.
UNIT - IV: Growth and Thickness Measurements of Thin Films
Growth of thin films: Condensation, Nucleation and growth of thin films – Langmuir Frenkel theory of condensation – Theories of thin film nucleation – Capillarity theory – Statistical or Atomistic theory – Comparison of nucleation theories – The four stages film growth – Incorporation of defects during growth.
Thickness measurement: Multiple beam interferometer (MBI) methods – Quartz crystal thickness monitor, Stylus profiler.
Books for Study

1. Vacuum Technology, A. Roth, North-Holland, 1986.
2. Vacuum Science and Technology, V. Vasudeva Rao, T.B. Ghosh and K.L. Chopra, Allied Pub., 1998.
3. Handbook of Thin Film Technology, L.I. Maissel and R.L. Glang, Mc Graw Hill Book Co., 1970.
4. Thin Film Phenomena, K.L. Chopra, Mc Graw Hill Book Co., New York, 1969.
5. Vacuum Deposition onto Webs, Films and Foils, Charles A. Bishop, Elsevier, London, 2011.
6. The Materials Science of Thin Films, M. Ohring, Academic Press, New York, 1992.
7. The User's Guide to Vacuum Technology, J.F .O'Henlon, John Wiley & Sons, 2003.

Course Outcomes: After the completion of this course, students shall be able to
1. Demonstrate various pumps and gauges, design a vacuum system and inspect leak in system.
2. Prepare thin films, outlining the conditions for deposition of amorphous, crystalline and epitaxial films.
3. Understand the thin film growth mechanism and measure the thickness of a given film.

Branch: PHYSICS **Course code: PHY 305**
Course title: Specialization Lab – A. Applied Spectroscopy - I **Credits:** 4
Semester: III **Marks: 100**

Course Objectives:
1. To introduce of various experiments techniques for analysis.
2. To translate certain theoretical concepts learnt earlier into experimental knowledge by providing hands on experience of basic laboratory techniques required.

List of Experiments
1. Measurement of Refractive indices of various liquids, using Abbe's Refractometer with sodium lamp.
2. To determine the Cauchy's constant of given prism by using dispersion phenomenon.
3. To study the nature of polarization with the aid of quarter wave plate and photo cell.
4. To determine the specific charge of an electron using gauss metre with neon discharge lamp as source by the Zeeman Effect.
5. Dispersive nature of Iron atomic spectra - a) To verify the dispersion relation in the wavelength region between 2660Ǻ to 4880Ǻ based on a prism spectrograph/ Littrow spectrograph; b) To verify the dispersion relation in the wavelength region between 2660Ǻ to 4800Ǻ based on a prism spectrograph/ Jarell ash spectrograph.
6. Qualitative analysis-To identify the elements that are present in the given powder by the method of qualitative analysis. Corresponding spectral lines recorded on the given film for the powder mixer.

Course Outcome: After completion of the course, the students shall be able to
1. Gain experience with some statistics to analyse data in laboratory.
2. Handle the spectrophotometers and could analyse the data.
3. Identify the compounds based on qualitative analysis.

Branch: PHYSICS **Course code: PHY 305**
Course title: Specialization Lab – B. Condensed Matter Physics - I **Credits:** 4
Semester: III **Marks: 100**

Course Educational Objectives
1. To provide experimental knowledge in properties of solids and its behavior .
2. To provide knowledge in analysis of experimental results to drive students towards

List of Experiments

1. Energy gap-Reverse saturation current
2. B-H Loop
3. Creep - activation energy determination
4. BaTiO 3 -Dielectric behavior
5. Mono and Diatomic lattice- Saturation frequency

Course Outcomes: Students will have hands on experience of
1. Minority charge carrier current in calculation of band gap, analysis of magnetic materialin terms of coercivity and saturation magnetization, creep importance
2. Transition temperature determination by finding dielectric constant, calculation of dispersion frequency of mono and diatomic lattices through electrical analog

Branch: PHYSICS **Course code: PHY 305**
Course title: Specialization Lab – C. Electronics – Embedded Systems **Credits:** 4
Semester: III **Marks: 100**

Course Educational Objectives
1. Demonstrate the different physical parameters of PIC 16F877A.
2. Explain the calibration of parameters measured and displayed.
3. Demonstrate PIC 16F877A on simulation module.
4. Evaluate the data transfer

List of Experiments

Software Experiments

1. To add two 8- bit Numbers using PIC Microcontroller 16F877.
2. To subtract two 8- bit Numbers using PIC Microcontroller 16F877.
3. To convert Uppercase letter to lowercase letter using PIC Microcontroller 16F877 A.
4. To find maximum of two 8- bit numbers using PIC Microcontroller 16F877.

Hardware Experiments

5. Interface LED to PIC Microcontroller 16F877 A.
6. Interface Switch to PIC Microcontroller 16F877 A.
7. Interface Buzzer to PIC Microcontroller 16F877 A.
8. Interface Relay to PIC Microcontroller 16F877 A.

Course Outcomes: After completion of the course, the students are able to
1. Define the arithmetical and logical assembly language for microcontroller PIC 16F877A
2. Know the downloading procedure on hardware into flash ROM of PIC 16F877A and show the testing data on a defined port wish board.
3. Competent to evaluate the data transfer response of PIC 16F877A.

Branch: PHYSICS
Course title: Elective Lab – A. Photonics
Semester: III

Course code: PHY 306
Credits: 4
Marks: 100

Course Educational Objectives

1. To demonstrate the various experiments based on Photonics
2. To train the students to study various characteristics of Photonic materials through modulation of light.

List of Experiments

1) Optical rotation by Sugar solution
2) Determination of bending losses in optical fibre
3) Determination of the pitch of the wire mesh using laser diode
4) Determination of refractive index of the transparent solids
5) Study of Electro optic effect in $LiNbO_3$
6) Determination of numerical aperture of a fibre
7) Determination of numerical aperture of a fibre optic material
8) Construction of diffraction grating using holographic technique
9) Study of Laser beam divergence and measurement of spot size
10) Construction of Refraction Hologram of an object by using Holographic technique

Course Outcomes: At the end of the courser, the students shall able to

1. Demonstrate both the theory and experiments related to propagation and modulation of light with mater besides quantification of material properties.
2. Propose and design new experiments based on the verification of theory with available optical components

Branch: PHYSICS **Course code: PHY 306**
Course title: Elective Lab – B. Solar Energy Physics **Credits:** 4
Semester: III **Marks: 100**

Course Educational Objectives
1. To train the students to in studying the characteristics of solar thermal and photovoltaic experiments.
2. To demonstrate the skills related to effect of various parameters on the behavior of solar cells

List of Experiments
1. To measure direct radiation using thermoelectric pyrheliometer
2. To measure global and diffuse radiation using thermoelectric pyranometer
3. To prepare CuO coating by chemical conversion method and study quality of the coatings
4. To prepare black chrome selective surface using electroplating method
5. To study of I-V characteristics of solar cell at a constant light intensity
6. To study of I-V characteristics of a solar module at a constant light intensity.
7. To study of I-V characteristics of cells when connected in series.
8. To study of I-V characteristics of cells when connected in parallel.
9. To study of spectral response of a solar cell

Course Outcomes: At the end of the courser, the students shall able to
1. Demonstrate the skills related to measurement of direct, diffuse and global solar radiation.
2.Understand the working of a solar cell and its efficiency measurement
3. Verify the influence of different parameters on the solar cell efficiency
4. Design a solar module for a specific output current and voltage ratings.

Branch: PHYSICS
Course title: Elective Lab – C. Thin Films Physics
Semester: III

Course code: PHY 306
Credits: 4
Marks: 100

Course Educational Objectives

1. To train the students understanding the working of pumps, studying different properties of thin films.
2. To learn the skills related to thin film characterization for optical and electrical properties.

List of Experiments

1. Study of rotary pump characteristics and determination of its speed.
2. Study of diffusion pump characteristics and determination of its speed.
3. Determination of optical energy band gap of a semiconductor using transmission measurements.
4. Determination of optical constants of thin films using transmittance data (Swanepoel method).
5. Hall effect – determination of carrier mobility and concentration in a semiconductor film.
6. Study the temperature dependence of thermo emf of a semiconductor thin film.
7. Study the current-voltage characteristics of a solar cell.

Course Outcomes: At the end of the courser, the students shall able to

1. Understand the working of rotary and diffusion pumps
2. Demonstrate the skill acquired in connection with thin film and device characterization

Branch: PHYSICS **Course code: PHY 401**
Course title: Quantum Mechanics – II **Credits:** 4
Semester: IV **Marks: 80 + 20 (Internal)**

Course Educational Objectives:
1. To gain the knowledge of identical particles and spin
2. To understand the orbital angular momentum and spin angular momentum
3. To learn the basics of relativistic quantum Mechanics
4.To gain knowledge of fields and second quantization

SYLLABUS:
UNIT- I: Identical Particles and Molecules
Identical particles- Indistinguishability of Identical particles- Construction of Symmetric andAnti-symmetric wave functions for two and three particle systems - Pauli's Exclusion Principle-Hydrogen molecule- Spin-orbit interaction- Ortho and Para hydrogen- Spin statistics connection.
UNIT - II: Angular Momentum
Introduction: Motion in Central Potential, Orbital Angular momentum Lx, Ly,Lz,L2, L+ and L- Operators - Commutation rules for angular momentum - Eigen values and Eigen functions of Lzand L2 - Angular momentum in general - Allowed values of angular momentum J - Eigen values
of J+ and J- angular momentum matrices - Addition of angular momenta and Clebsh - Gorden co-efficients: Clebsh-Gorden co-efficient for $J_1=J_2=$ ½ and $J_1=1$, $J_2=$ ½ - spin angular momentum and Pauli's spin matrices.
UNIT - III: Relativistic Quantum Theory
Klein – Gorden Equation – KG equation in Co-variant form- Probability Density and Probability
Current Density – Inadequacies of K.G. Equation – Dirac's Relativistic Equation for a FreeParticle - Dirac`s Matrices – Dirac`s Equation in Co-variant form – Plane wave solution –Negative Energy States – Spin Angular Momentum - Existence.
UNIT - IV: Quantization of Wave Fields
Concept of Field - Method of Canonical Quantization: Lagrangian Formulation of Field,Hamilton Formulation of Field - Second Quantization – Field equation - Quantization of Non-relativistic Schroedinger equation – Commutation and Anti-commutation Relations, The N-representation - System of Fermions and Bosons – Creation and Annihilation.
Books for Study
1. QuantumMechanics:S.L.Kakaniand, H.M. Chandalia Sultan, Chand&SonsCompany.
2. Advanced Quantum Mechanics : B.S. Rajput, Pragatiprakasan
3. Quantum Mechanics : V.K. Thankappan, Wiley Eastern Limited
4. A Textbook of Quantum Mechanics : P.M. Mathews and K. Venkatesan,
5. Quantum Mechanics: S.L.Gupta, V.Kumar, H.V.Sharma and R.C. Sharma,
6. An Introduction to Quantum Mechanics, P.T. Mathews, Mc Graw Hill PublishingCompany

Course Outcomes: After completing the course, the students shall be able to
1. Learn distinguishability and indistinguishability of identical particles, construct symmetric and anti symmetric wave functions , students able to solve real problems
2. Grasp the concepts of spin and angular momentum as well as their quantization and addition rules. Demonstrate angular momentum operators associated with spherical and symmetrical systems, able to obtain Clebsch –Gordon coefficients and learn its importance in atomic physics
3. Understand the principles of relativistic quantum mechanics and importance of Klein Gordon equation in solving real problems and know the concept of spin arising naturally from the Dirac equation
4. Learn different fields and its importance and gain knowledge about second quantization

Branch: PHYSICS **Course code: PHY 402**
Course title: Advances in Physics **Credits:** 4
Semester: IV **Marks: 80 + 20 (Internal)**

Course Educational Objectives

1. To opening knowledge of Nanomaterials and related fields.
2. To make the students acquire an understanding in broadoutline of Nanomaterials and Nanotechnology.
3. To know the recent developmentsinscience and technology of micro- and nano-systems.
4. To introduce the concepts of Remote sensing andGeographic Information System (GIS) to students.
5. To train students in processing and interpretation of imagepatterns for various applications.

SYLLABUS

UNIT – I: Nano Technology

Introduction to Nanomaterials – Zero, One and Two Dimensional Nanostructures - Quantum confinement - Density of states and Dependence of dimensionality – Properties of Nanomaterials – Carbon Nanotubes, Fullerenes, Graphene. Synthesis of Nanomaterials – Physical Techniques: Ball Milling – Plasma Arc Deposition – Inert Gas Condensation – Pulsed Laser Deposition – Molecular Beam Epitaxy. Chemical Techniques: Hydrothermal synthesis– Sol-Gel Process – Chemical Vapour Deposition. Applications: Single Electron Transistor – Solar Cells – Light Emitting Diodes.

UNIT – II: Micro and Nano devices

Microelectromechanical systems (MEMS): Introduction to MEMS, Basic MEM structure. Applications of MEMS: Pressure sensors, Accelerometers, Mass flow sensors.

Nanodevices: Quantum well and quantum dot devices: Infrared Detectors-Quantum Dot Lasers. Carbon nanotube emitters - Photoelectrical cells - Plasmons propagation in wave guides.

UNIT - III: Remote Sensing

Definition of remote sensing; introduction to concepts and systems; Electromagnetic radiation; electromagnetic spectrum; image characteristics; remote sensing systems; remote sensing platform; Sources of remote sensing information; Advantages of remote sensing. Application of Remote sensing in Environmental Management, Natural resource management – forest resources, water resources, land resources and mineral resources.

UNIT IV : Geographic Information System

Introduction – Maps – Definitions – Map projections – types of map projections – map analysis – GIS definition – basic components of GIS – standard GIS softwares – Data type – Spatial and non-spatial (attribute) data – measurement scales – Data Base Management Systems (DBMS).

Books for Study

1. Nanostructures and Nanomaterials: Synthesis, properties & application, G. Cao, Imperial College Press
2. Introduction to Nanotechnology, Charles P. Poole, Jr & Frank J. Owens, Wiley India, 2006.
3. An Introduction to Microelectromechanical Systems Engineering, Nadim Maluf.
4. The 8051 Microcontroller and Embedded systems, M.A. Mazidi and J.G. Mazidi, PEA, Pvt. Ltd., 2000.
5. Remote Sensing Principles and interpretation, F.F. Sabins Jr., W.H. Freeman and Company, New York.
6. Remote Sensing and Image Interpretation, T.Lillesand& R Kiefer, John Wiley & Sons, New York,1994
7. An Introduction to GIS by Ian Heywood et al., Addison Wesley, Longmont Limited, England.
8.Rachael A. McDonnell, ” Principles of GIS”, Oxford University Press, 2000

Course Outcomes: After completion of the course, the students shall be able to

1. Understand the synthesis of nanomaterials, their application and impact on the environment.
2.Know the details of preparation and characterization of nanomaterials, micro and nanoscale devices.
3.Learn the basics of remote sensing, different payloads, sensors, satellite platforms.
4. Get the concept of image processing& interpretation and digital data transmission and storage.

Branch: PHYSICS | **Course code: PHY 403**
Course title: Specialization – A: Applied Spectroscopy - II | **Credits:** 4
Semester: IV | **Marks: 80 + 20 (Internal)**

Course Educational Objectives:

1. To acquire thorough knowledge on ligand field theory and crystal field theory in spectroscopy.
2. To know about rare earth ions doped hosts, the concept of Judd-Ofelt theory and its application in lasers.
3. To develop and to understand different types of detectors and its uses.
4. To get knowledge on two photon spectroscopy and its advantages over single photon spectroscopy.

SYLLABUS

UNIT - I: Solid State Spectroscopy I – Transition Metal Ions

Introduction – Crystal fields and ligand fields-Concept of ligand field – Scope of ligand field theory – 'd' and other orbitals (s,p,f) – Quantitative basis of crystal fields – Crystal field theory – Octahedral crystal field potential on the d-wave functions – The evaluation of 10 Dq - Effect of weak field on S, P, D and F terms. Term energy level diagrams – Correlation diagram for d^2 configuration in octahedral coordination – Tanabe-Sugano diagrams for d^2 configuration in octahedral field.

UNIT - II: Solid State Spectroscopy II – Rare Earth Ions

Introduction – Intensity of absorption and emission bands – Oscillator strengths – Intra-configurational f-f transitions –Selection rules – Electric and Magnetic dipole transitions – Judd-Ofelt theory and evaluation of Judd-Ofelt parameters – Radiative transition probabilities of excited states of rare earth ions – branching ratios, stimulated emission cross-sections – Non-radiative process – Energy transfer – Possible mechanisms of energy transfer – Resonance energy transfer – Process of IR to visible up-conversion – Applications of rare earth doped luminescent materials.

UNIT – III: High Resolution Spectroscopy

Introduction – Light detectors – Single photon counting technique – Phase sensitive detectors – Laser optogalvanic spectroscopy – Matrix isolation spectroscopy – Laser cooling and its applications.

UNIT- IV: Two Photon Spectroscopy

Introduction – Two photon absorption spectroscopy – Selection rules – Expression for the two photon absorption cross section – Photo acoustic spectroscopy – Experimental methodology and applications to Physics, Chemistry, Biology and Medicine.

Books for Study

1. Introduction to ligand fields, B. N. Figgis (Intersci. Pub. New York, 1966.
2. Laser Crystals, A.A. Kaminskii, Springer-Verlag, New York, 1981.
3. Laser and Excited states of Rare Earths, R. Reisfeld and C.K. Jorgnesen, Springer, New York, 1977.
4. Optical Properties of Transparent Rare Earth compounds, S. Hufner, Acad. Press, 1978.
5. High Resolution Spectroscopy, J.M. Hollas.
6. Fundamentals of Molecular Spectroscopy, C.N. Banwell, Tata Mc Graw-Hill Pub. 1983.
7. Instrumental Methods of Analysis, Willard, Merritt, Dean and Settle, CBS Pub. 2001.
8. Opto Acoustic Spectroscopy and Detection, Yoh-Han Pao, Academic Press, 1977.

Course Outcomes: After completion of the course, the student shall able to

1. Have the knowledge on crystal field theory and the effect of weak crystal field on S, P, D and F terms.
2. Understand the importance of rare earth doped materials and able to evaluate various laser parameters.
3. Know the instrumentation techniques used in various spectrophotometers and uses of various detectors.
4. Acquire the knowledge on two photon spectroscopy.

Branch: PHYSICS
Course code: PHY 403
Course title: Specialization – B: Condensed Matter Physics - II
Credits: 4
Semester: IV
Marks: 80 + 20 (Internal)

Course Educational Objectives:
1. To introduce the theories and concepts of elastic and thermal properties of solids
2. To introduce the concept of energy bands and Fermi surface
3. To introduce the concept of advanced functional materials

SYLLABUS

UNIT - I: Elastic Properties of Solids

Lattice as a homogeneous and continuous medium - Analysis of stress and strain tensors –Hooke's law - Elastic compliances and stiffness constants – Elastic energy density – Reductionin the number independent elastic constants in cubic crystals – Cauchy's relations – Bulkmodulus and compressibility – Elastic waves in cubic crystals – Formulation and solution ofwave equations along [100], [110] and [111] directions – Experimental determination of elasticconstants – Pulse-echo technique.

UNIT - II: Thermal Properties of Solids

Quantum theory of lattice vibrations – Properties of phonons – Lattice specific heat at lowtemperatures – Einstein and Debye models – Born cut-off procedure – Inelastic scattering ofneutrons by phonons – Experimental study of dispersion curves – Inadequacy of harmonic model– Anharmonicity – Thermal expansion – Gruneisen parameter- Lattice thermal conductivity –Elementary kinetic theory – Role of U and N processes.

UNIT - III: Energy bands and Fermi Surfaces

Energy band calculations: Plane Wave method and Augmented Plane Wave (APW) method.Importance of Fermi surface – Characteristics of Fermi surface – Construction of Fermi surface -Quantization of electron orbits - Experimental study of Fermi surface: Anomalousskin effect –Cyclotron resonance – de Haas van Alphen effect.

UNIT - IV: Functional materials

Amorphous semiconductors: Band structure – Electronic conduction – Optical absorption –Applications.

Liquid crystals: Classification – Orientational order and intermolecular forces – Magnetic effect– Optical properties – Applications.

Polymers: Classification –Structural property correlation – Molecular weight – Crystallinity inpolymers – Applications.

Reference Books

1. Introduction to Solid State Physics, Charles Kittel 7 th Edition, John Wiley & Sons.
2. Solid State Physics, A.J. Dekker, Mac Millan.
3. Solid State Physics, H.C. Gupta, Vikas Publishing House.
4. Elementary Solid State Physics, M. Ali Omar, Addison Wesley.
5. Solid State Physics, M.A. Wahab, Narosa Publishing House.
6. Science of Engineering Materials, C.M. Srivastsava and C. Srinivasan, New Age Inter.

Course Outcomes: After completion of the course, the students shall able to
1. Learn the relation between stress and strain and gain knowledge on elastic constants and velocity of elastic waves in different directions
2. Gain understanding on classical theory of specific heat and quantum theory of specific heat, able to understand Gruneisen parameter and lattice thermal conductivity
3. Know theories of different bands, Fermi construction and experimental determination of Fermi surface
4. Classify, know properties and applications of amorphous semiconductors, liquid crystals and polymers.

Branch: PHYSICS **Course code: PHY 403**

Course title: Specialization – C: Electronics-Wireless Communication Systems **Credits:** 4

Semester: IV **Marks: 80 + 20 (Internal)**

Course Educational Objectives

1. To instruct students and provide hands on experience in the subject areas of digital and optical communication experiments/techniques.
2. Practical demonstration of the theoretical pedagogy.

SYLLABUS

Unit – I: Base band data transmission

Digital Modulation techniques: BPSK, QPSK, DPSK, QASK, BFSK, MSK, M-ary techniques. Base band binary data transmission system – Inter symbol interference – Nyquist pulse shaping criteria – line coding, pulse shaping, and scrambling techniques, Detection of error probability.

Unit – II: Codes for error detection and correction

Linear block codes, Convolutional codes. Encoding, Decoding of convolutional codes, State, Tree and Trellis diagrams. Maximum likelihood – Viterby algorithm, Burst error correction - Interleaving techniques – Block and convolutional interleaving, Types of ARQ.

Unit – III: Introduction to wireless communication systems

Global system for mobile (GSM): cellular concept, system design. Transmission system, Receiving system; frequency re-use; Spread spectrum modulation; Multiple access techniques as applied to wireless communications; 1G, 2G, 3G wireless networks.

Unit – IV: Satellite and Optical communications

Introduction Satellite systems: Orbiting satellites, satellite frequency bands, communication satellite system-modulation and multiple access format-satellite systems in India, Satellite receiving systems, G/T ratio, satellite uplink and down link analysis. Applications to communications and remote sensing. Introduction to Optical communications systems: Optical fibers, sources and detectors, analog and digital systems.

Books for Study

1. Modern Digital and Analog communication system, B.P. Lathi: Oxford 3 rdEdition.
2. Digital Communications Fundamentals and Applications, Bernard Sklar, Sklar Pearson Education.
3. Principles of Communication, R.E. Ziemer, WH Tranter 5th Edition John Wiley (Fifth module).
4. Morden Electronic Communication Systems, Wayne Tomoasi, Person Education/PHI.
5. Digital Communication, John G Proakis, MGH.
6. Digital Communication Techniques Simon, Hindey Lindsey PHI.

7Principles of Communication Systems, Taub and Schilling, Tata McGraw-Hill.

8. Digital and Analog Communication System, K. Sam Shanmugam. John Wiley.
9. Digital and Analog Communication System, Leon W Couch, Pearson Education/PHI.
10. Introduction to statistical signal processing with applications, M.D. Srinath, et. al., PHI.
11. Analog and Digital Communication, M.S. Roden PHI.
12. Digital Modulation and Coding. Wilson, Pearson Education.
13. Applied Coding and Information Theory for Engineers, Wells, Pearson Education.

Course Outcomes: After the completion of the course, the students are able to

1. Understand and visualize the digital and optical modulation techniques.
2. Demonstrate the theoretical concepts in the laboratory.
3. Gain hands on experience and envisage the concepts more clearly.
4. Fetch details in handling the fabrication, concepts of instrumentation and circuit design.

Branch: PHYSICS	**Course code: PHY 404**
Course title: Elective – A: Photonics – II	**Credits:** 4
Semester: IV	**Marks: 80 + 20 (Internal)**

Course Educational Objectives

1. To understand the concepts of Fibre optics and related components in communication and sensors.
2. To provide knowledge on the enhanced optical properties viaplanar wave guides andphotonic crystals.

SYLLABUS

UNIT - I: Fibre Optic Components and Sensors

Connector principles, Fibre end preparation, Splices, Connectors, Source coupling, Distribution networks, Directional couplers, Star couplers, Switches, Fiber optical isolator, Wavelength division multiplexing, Time division multiplexing, Fiber Bragg gratings. Advantage of fiber optic sensors, Intensity modulated sensors, Mach-Zehnder interferometer sensors, Current sensors, Chemical sensors –Fiber optic rotation sensors. Optical biosensors: Fluorescence and energy transfer sensing, molecular beacons and optical geometries of bio-sensing, Bio-imaging, Biosensing.

UNIT - II: Integrated Optics

Introduction – Planar wave guide – Channel wave guide – Y-junction beam splitters and couplers - FTIR beam splitters – Prism and grating couplers – Lens wave guide – Fabrication of integrated optical devices - Integrated photodiodes – Edge and surface emitting laser – Distributed Bragg reflection and Distributed feed back lasers - Wave guide array laser.

UNIT - III: Optical Signal Processing

Introduction, Effect of lens on a wavefront, Fourier transform properties of a single lens, Optical transfer function, Vanderlugt filter, Image spatial filtering, Phase-contrast microscopy, Pattern recognition, Image de-blurring, Photonic switches, Optical transistor, Optical Gates- Bistable systems, Principle of optical Bistability, Bistable optical devices, Self electro-optic effect device.

UNIT - IV: Photonic Crystals

Basics concepts, Theoretical modeling of photonic crystals, Features of photonic crystals, Methods of fabrication, Photonic crystal optical circuitry, Nonlinear photonic crystals, Photonic crystal fibers, Photonic crystals and optical communications, Photonic crystal sensors.

Books for Study

1. Fibre Optic Communication, Joseph C. Palais, Pearson Education Asia, India, 2001
2. Introduction to fibre optics, A. Ghatak & K. Thyagarajan, Cambridge University Press, New Delhi, 1999
3. Optical Guided Wave Signal Devices, R.Syms And J.Cozens. Mcgraw Hill, 1993.
4. Optical Electronics, A Ghatak and K. Thyagarajan, Cambridge University Press, New Delhi, 1991
5. Fundamentals of Photonics, B.E.A. Saleh and M.C. Teich, John Willy and Sons,1991
6. Introduction to Fourier Optics, Joseph W. Goodman, McGraw-Hill, 1996.
7. Nanophotonics, P.N.Prasad, Wiley Interscience, 2003.
8. Biophotonics, P.N.Prasad, Wiley Publications, 2004.

Course Outcomes: After completion of the course, the students shall able to

1. Learn the basics of fibre optic components and sensors
2. Select appropriate fiber optic components for communication
3. Understand the different components involved in optical signal processing
4. Demonstrate their skills related to lasers, fiber optics, photonic and opto-electronic devices.

Branch: PHYSICS **Course code: PHY 404**
Course title: Elective – B: Solar Energy- Photovoltaic Aspects **Credits:** 4
Semester: IV **Marks: 80 + 20 (Internal)**

Course Educational Objectives
1. To understand the concept of solar cell, their types, fabrication procedures and applications
2. To learn the efficiency measurement procedures and fault analysis of modules
3. To know various societal applications of solar photovoltaic energy.

SYLLABUS
UNIT - I: Fundamentals
Photovoltaic effect, Types of interfaces, homojunction, heterojunction and Schottky barrier - Choice of semiconductor materials for fabricationof homojunction solar cells. Equivalent circuit of a solar cell. Solar cell output parameters -Fill-factor, conversion efficiency, quantum efficiency. Effect of series and shunt resistance on the efficiency of solar cells. Variation of Open-circuit voltage and short circuit current with intensity of incident light. Effect of temperature on I-V characteristics. p-n heterojunction solar cells- criteria for choosing absorber and window layers in heterojunction solar cell.
UNIT – II: Silicon Photovoltaics
Preparation of metallurgical grade and solar grade silicon **-** Single crystal silicon ingot growth – Float Zone and Czochrolski methods – silicon wafer fabrication – wafer to cell formation - I-V characteristics and spectral response of single crystal silicon solar cells. Factors limiting the efficiency of silicon solar cells - Poly-silicon wafer fabrication methods – EFG, Web, Heat Exchange methods
UNIT – III: Thin Film Solar Cells
Amorphous Silicon – differences in properties between crystalline silicon and amorphous (a-Si) silicon. a-Si deposition by glow discharge method – Electrical and optical properties of a-Si. Amorphous silicon solar cell configurations. Outline of a-Si Solar module processing steps. CdTe/CdS, CuInGaSe/CdS (CIGS) and GaAs thin film solar cells - Cell configuration – techniques used for the deposition of each layer- cell characteristics. Outline of $CuInGaSe_2$ (CIGS) solar module processing steps.
UNIT - IV: Solar Photovoltaic (PV) Systems
Photovotaic Module Assembly: Description of steps involved in the fabrication of Silicon Photovoltaic Module - Performance of Photovoltaic Module - Module Protection - Modules in series and in parallel - Use of Bypass and Blocking Diodes, Solar photovoltaic system - components – PV Array, battery, invertor and load. Applications of solar PV systems. Stand alone, Hybrid and Grid connected PV systems.
Books for Study
1. Solar Cells- Charles E.Backus, IEEE Press
2. Fundamentals of Solar Cells, Farenbruch and Bube
3. Solar Electric Systems - G. Warfield(Ed), Hemisphere Pub(1983)
4. Terrestrial Solar Photovoltaics by Bhattacharya.
5. Amorphous Silicon solar cells K.Takahashi& M.Konagai, North Oxford Acad. Press (1986)
6. Solar Cells - Martin A Green
7. Thin Film Solar Cells by K.L.Chopra and Das, Plenum

Course Outcomes: At the end of the course, the student shall be able to:
1. Understand the fundamental concepts of solar cells, manufacturing processes and limitations.
2. Acquire knowledge on cell efficiency study techniques and procedures for fault analysis.
3. Demonstrate skills related cell performance and fault analysis through hands on experience
4. Comprehend the applications of solar photovoltaic energy in day-to-day applications

Branch: PHYSICS **Course code: PHY 404**
Course title: Elective – C: Properties and Applications of Thin Films **Credits:** 4
Semester: IV **Marks: 80 + 20 (Internal)**

Course Educational Objectives
1. To understand the principle, working, advantages and limitations of composition analysis techniques.
2. To know the electrical properties of metal and dielectric films and the associated mechanisms.
3. To learn the importance of optical properties, its measurement and different optical components.
4. To disseminate the different applications of thin films.

SYLLABUS

UNIT - I: Chemical and Physical Characterization of Thin Films

Surface Analytical Techniques: Auger Electron Spectroscope (AES), Secondary Ion Mass Spectroscopy (SIMS), Secondary Neutral Mass Spectroscope (SNMS) and Rutherford Back Scattering Spectroscope (RBS); Spectroscopic techniques: UV-Vis-NIR and IR spectrophotometers, Fourier Transform Infrared Spectroscope (FTIR) and Raman spectroscope.

UNIT - II: Transport Properties of Thin Films

Metallic Films: Sources of resistivity in metallic conductors – sheet resistance and temperature coefficient of resistance of thin films – Influence of thickness on the resistivity of structurally perfect thin films – Fuchs Sondhemier theory – Hall effect – Annealing, agglomeration and oxidation; Dielectric films: Electrical conduction in insulator films – Schottky emission – Tunneling, Poole - Frenkel emission.

UNIT - III: Optical Properties of Thin Films

Reflection and transmission at an interface – Reflection and transmission by single film – Reflection from an absorbing film - Multilayer films – Optical absorption – Determination of optical constants by Ellipsometry; Optical devices: Beam splitters – Reflection and antireflection coatings- Optical filters: Neutral filters, Broad band filters, Narrow band filters – Thin film polarizers.

UNIT - IV: Applications of Thin Films

Photolithography: Photoresists, Mask and pattern generation. Thin film resistors – Thin film capacitors – Thin film diodes and transistors – Thin film solar cells, Thin film microbatteries – Thin film sensors: Gas sensors, Bolometers – Transparent conducting oxide coatings - Metallurgical coatings. Hard coatings and Tribological coatings.

Books for Study

1. Thin Film Fundamentals, A. Goswami, New Age Internatuional. Publications, 1996.
2. Preparation of Thin Films, J. Goege, Marcel Dekker, New York, 1992.
3. Hand Book of Thin Film Technology, L.I. Maissel and R.L. Glang, Mc Graw Hill Book Co., 1970.
4. Thin Film Phenomena, K.L. Chopra by Mc Graw Hill book Co., New York, 1969.
5. Introduction to Semiconductor Materials and Devices, M.S. Tyagi, John Wiley & Sons Pvt. Ltd. 2000.
6. Thin Film Solar Cells, K.L. Chopra and S.R. Das, Plenum Press, New York, 1983.
7. The Materials Science of Thin Films, M. Ohring, Academic Press, New York, 1992.

Course Outcomes: After completion of the course, the students shall be able to
1. Measure and analyze the chemical composition and microstructure of thin films.
2. Understand the electrical transport mechanism and optical behavior of thin films.
3. Learn the various general and technical applications of thin films in day-to-day life.

Branch: PHYSICS **Course code: PHY 405**
Course title: Specialization Lab – A. Applied Spectroscopy - II **Credits:** 4:
Semester: IV **Marks: 100**

Course Objectives:
1. To translate certain theoretical concepts learnt earlier into experimental knowledge by providing hands on experience of basic laboratory techniques required.
2. To develop skill in the recognition of characteristic absorption bands.
3. Learning data analysis, to gain knowledge, handling and interpretation of spectra.

List of Experiments

1. To verify the Beer's law from the measurement of absorption spectra (400 nm-900 nm) of $CuSo_4.5H_2O$) aqueous solution and a) To find the band maximum and b) To find out the unknown concentration of the given solution.

2. Optical Fibre -attenuation and bending losses

3. Groove spacing in audio CD's

4. Measurement of Optical band gap of Cr^{3+} ion from the absorption spectrum.

5. Determination of Oscillator strength for Neodymium (Nd^{3+}) ions.

6. To determine the g-factor by the ESR Spectrometer.

Course Outcome: After completion of the course, the students shall be able to
1. Use standardized material to determine an unknown concentration.
2. Handle the spectrophotometers and could analyse the data.
3. acquire basic knowledge in the field of research.

Branch: PHYSICS **Course code: PHY 405**
Course title: Specialization Lab – B. Condensed Matter Physics - II **Credits:** 4
Semester: IV **Marks: 100**

Course Educational Objectives
1. To provide experimental knowledge in advanced functional materials.
2.To investigate the properties of new materials for future applications

List of Experiments

1. Magnetic anisotropy – Calcite crystal
2. Liquid crystals – phase transition
3. Seebeck coefficient - Semiconductors
4. Heat capacity of solids
5. Energy gap – conductivity

Course Outcomes: Students will have hands on experience of
1. Magnetic susceptibility determination, liquid crystal phases with temperature, working of temperature sensor, heat capacity calculation and resistance variation and measurement in semiconductor
2. Able to analyze the materials and its behavior

Branch: PHYSICS **Course code: PHY 405**
Course title: Specialization Lab – C. Electronics – Wireless Communication Systems **Credits:** 4
Semester: IV **Marks: 100**

Course Educational Objectives
1.To instruct students and provide hands on experience in the subject areas of digital and optical communication experiments/techniques.
2.Practical demonstration of the theoretical pedagogy

List of Experiments

01. TIME DEVISION MULTIPLEXING (TDM)
02. DELTA MODULATION (DM)
03. PULSE CODE MODUCATION (PCM)
04. DIFFERENTIAL PULSE CODE MODUCATION (DPCM)
05. PHASE SHIFT KEYING (PSK)
06. DIFFERENTIAL PHASE SHIFT KEYING (DPSK)
07. AMPLITUDE SHIFT KEYING
08. FREQUENCY SHIFT KEYING (FSK)
09. PHASE LOCKED LOOP (LM565)
10. FIBRE OPTIC ANALOG TRANSMISSION KIT
11. FIBRE OPTIC DIGITAL TRANSMISSION KIT

Course Outcomes: Upon completing the course, students shall able to
1. Understand and visualize the digital and optical modulation techniques.
2. Demonstrate the theoretical concepts in the laboratory.
3. Gain hands on experience and will be able to envisage the concepts more clearly.
4. Know the fabrication process, concepts of instrumentation and circuit design.

Branch: PHYSICS
Course title: Project work
Semester: IV

Course code: PHY 406
Credits: 4
Marks: 100

Course Educational Objectives
1. To train the students for independent thinking, planning and execution of any selected problem.
2. To take-up a simple problem with an aim, plan the experiment, take the measurements, discuss the results and give the conclusion.

List of projects
The student is given choice to select his any problem in Physics, preferably in the following branches.
1. Applied spectroscopy
2. Condensed matter Physics
3. Electronics and digital communications
4. Photonics
5. Solar energy
6. Vacuum and Thin films.
7. Atmospherics
8. Semiconductor devices

Course Outcomes: After completion of the project, the student shall be able to
1. Get the experience of working on a problem independently with planning and execution.
2. Develop skills related to presentation of data, analysis discussion of the results and draw conclusions.

Self-Study Courses

Branch: PHYSICS
Course title: VLSI Design
Semester: IV

Course code: PHY 407
Credits: 4
Marks: 80 + 20 (Internal)

Course Educational Objectives
Course Objectives
1. To know the information about various type of circuitry to achieve logic processing for digital devices.
2. To understand the details of different fabrication steps of CMOS Integrated Circuits
3. To learn the design and electrical characterization of MOSFETs.
4. To design and construct different logic gates.

SYLLABUS
UNIT - I: **An Overview of VLSI and Logic Design with MOSFETs**
Complexity and Design, Basic concepts, Ideal switches and Boolean operations, MOSFETs as switches, Basic logics gates in CMOS, Complex logic gates in CMOS, Transmission Gate circuits, Clocking and data flow control.
UNIT – II: Physical Structure and Fabrication of CMOS ICs
Integrated Circuit layers, MOSFETs, CMOS layers, Designing FET arrays, Overview of silicon processing, Material growth and deposition, Lithography, The CMOS process flow, Design rules.
UNIT - III: **Elements of Physical Design and Electrical Characteristics of MOSFETs**
Basic concepts, Layout of basic structures, Cell concepts, FET sizing and the unit transistor, Physical design of logic gates, Design hierarchies, MOS physics, n-FET current-voltage equations, FET RC model, p-FET characteristics, Modelling of small MOSFETs.
UNIT – IV: **Electronic analysis of CMOS logic gates**
DC characteristics of the CMOS inverter, Inverter switching characteristics, Power dissipation, DC characteristics: NAND and NOR gates, NAND and NOR transient response, Analysis of complex logic gates, Gate design for transient performance, Transmission gates and pass transistors.
Designing High-speed CMOS Logic Networks - Gate delays, Driving Large capacitive loads, Logical effort, BiCMOS drivers.
Book for Study:
1. Introduction to VLSI circuits and Systems, John P. Uyemura, John Wiley & Sons Pvt. Ltd., 2003.
2. VLSI Fabrication principles, S.K. Ghandhi, John Wiley & Sons (Asia) Pte. Ltd., 2003.
3. VLSI Technology, S.M. Sze, McGraw-Hill, 1988.
4. Principles of CMOS VLSI design, N.H.E. Weste and K. Eshraghian, Pearson Education, Inc., 1999.
5. Fundamentals of Modern VLSI devices, Yuan Taur and T.H. Ning, Cambridge University Press, 1998.
6. VLSI design techniques for analog and digital circuits, R.L. Geiger, et. al., McGraw-Hill, 1990.

Course Outcomes: After the completion of this course, students shall be able to:
1. Learn about designing and making process of integrated devices.
2. develop theoretical knowledge of nanofabrication.
3. Gain knowledge of design, construction and characterization of MOSFETS and CMOS logic gates.

Branch: PHYSICS **Course code: PHY 408**
Course title: Nanomaterials and Devices **Credits:**4;
Semester: IV **Marks: 80 + 20 (Internal)**

Course Educational Objectives:
1. To provide knowledge of nanomaterials classification and density of states function
2. To learn different synthesis methods to grow nano structures
3. To provide knowledge of carbon nano tubes and its properties
4. Nanoelectronic devices and concepts are introduced to learn future electronics devices

SYLLABUS:
UNIT – I : Introduction to Nanomaterials
Introduction to Nanomaterials – Zero, One- and Two-dimensional Nanomaterials Quantum confinement, Density of states, Dependence of dimensionality - Physical and chemical properties.
UNIT - II : Synthesis of Nanomaterials
Introduction to Bottom-up and Top-down approaches
Ball milling – Inert Gas condensation - Physical vapour deposition -, Molecular Beam Epitaxy – Sputtering – Pulsed laser Deposition - Chemical vapour deposition – Sol-Gel – Hydrothermal Synthesis
UNIT - III : Nano-Carbon
Carbon molecules: Nature of the carbon bond – New Carbon structure – carbon clusters – Small carbon clusters – Discovery of C_{60} – Structure of C_{60} and its properties –Synthesis of buckyballs and Applications.
Carbon Nanotubes: Fabrication – Structure – Electrical Properties – Mechanical properties – Applications of carbon Nanotubes
Graphene: Fabrication – Structure – Electrical Properties – Mechanical properties – Applications.
UNIT - IV: Nano Devices
Introduction – Nanofabrication – Photo-Lithography – Pattern transfer –Introduction to MEMS - Single Electron Transistor – Solar Cells – Light Emitting diodes – Gas Sensors – Microbatteries- Field emission display devices – Fuel Cells.
Books of Study
1. Nanomaterials:Synthesis, properties and applications, A.S.Edelstein& R.C.Cammarata, IoP Pub. 2002.
2. Introudction to Nanotechnology – Charles P.Poole Jr and Frant J.Owens, Wiley Interscience, 2003.
3. Nanopracticles from Theory to Applications edited by Gunter Schmid, Wiley VCH, 2004.
4. Nanoelectronics and Nanosystems by K.Goser, P.Glosekotter and J.Dienstuhl. (Springer).

Course Outcomes: After completing the course, the students shall be able to
1. Classify material as 0D, 1D, 2D and 3D on the basis of density of states and and sketch the band diagram for each and correlate the physical chemical properties with physical dimensions
2. Categorize different synthesis methods to grow variety of nanostructures
3. Describe allotropic forms of carbon and how they are synthesized, understand mechanical and electrical properties of carbon structures and their device applications
4. Gain knowledge on nanomaterial applications and recent advancement in 2D technologies.

Branch: PHYSICS **Course code: PHY 409**
Course title: Computational Methods and Programming **Credits: 4**
Semester: IV **Marks: 80 + 20 (Internal)**

Course Educational Objectives
1. To provide knowledge on the basics and concepts of C programming language
2. To introduce the basics of various numerical methods used to solve different problems ofScience and Technology.

SYLLABUS
UNIT – I: (a) Fundamentals of C language
C character set – Identifiers and keywords – Constants – Variables – Data types – Declarations of variables – Declaration of storage class – Defining symbolic constants – Assignment statement. Operators: Arithmetic operators – Relational operators – Logic operators – Assignment operators – Increment and decrement operators – Conditional operators.
(b) Expressions and I/O statements: Arithmetic expressions – Precedence of arithmetic operators – Type converters in expressions – Mathematical (library) functions – Data input and output - Getchar and putchar functions – Scan f – Print f – Simple programs.
(c) Control statements: If-Else statement – Switch statement – The ?operator – GO TO – While , Do-while, FOR statements – BREAK and CONTINUE statements.
UNIT – II: (a) Arrays
One dimensional and two-dimensional arrays – Initialization – Type declaration – Inputting and outputting of data for arrays – Programs of matrices addition, subtraction and multiplication.
(b) User Define functions: The form of C functions – Return values and their types – Calling a function – Category of functions. Nesting of functions. Recursion. ANSI C functions – Function declaration. Scope and life time of variables in functions.
(c) Pointers: Accessing address of variable. Declaration and Initialization of pointer variables. Accessing the value of variable via its pointer. Pointer expressions- pointers and arrays,pointers and structures.
UNIT – III: Linear, non-linear equations and curve fitting
(a) Solution of Algebraic and transcendental equations – Bisection, Falsi position and Newton- Rhapson methods – Basic principles – Formulae – Algorithms.
(b) Simultaneous equations:Solutions of simultaneous linear equations – Gauss elimination and Gauss-Seidel iterative methods - Basic principles – Formulae – Algorithms
(c) Curve fitting – Least square fitting – Linear and quadratic equations.
UNIT – IV: (a) Interpolations: Concept of linear interpolation – Finite differences – Newton's and Lagrange's interpolation formulae –Principles and Algorithms
(b) Numerical differentiation and integration:Numerical differentiation – algorithm for evaluation of first order derivatives using formulae based on Taylor's series – Numerical integration – Trapezoidal and Simpson's 1/3 rule – Formulae – Algorithms.
(c) Numerical solution of ordinary differential equations:Euler, method, fourth order Runga-Kutta Method.
Books for Study
1. Programming with 'C', Byron Gottfried, Tata McGraw Hill.
2. Programming in 'C', Balaguruswamy.
3. Numerical Methods, E. Balaguruswamy, Tata McGraw Hill.
4. Computer oriented numerical methods, Rajaraman.
5. Let us Use C, Yeswanth Kanetkar.

Course Outcomes: After completing the course, the students shall be able to
1. Write a C programme for analytical problems, algorithms for numerical problems and execute them.
3. Solve many problems including algebraic/transcendal equations, simultaneous equations, boundary value problems, data analysis, numerical differentiation and integration and also differential equations.