Syllabus for Two Years M. Sc. (Applied Physics)(Second Year)(2017-18)

Programme Objectives:

1. To develop strong student competencies in Physics and its applications in a technology rich and interactive environment.
2. To train postgraduates with advanced knowledge and understanding of physics with higher order critical, analytical, problem solving and research skills; ability to think rigorously and independently to meet higher level expectations of academia and research with sufficient transferrable skills.
3. To prepare the students to successfully compete for employment in Manufacturing and Teaching industry.

M.Sc. 2nd year(course structure)

Third semester (Theory)				Fourth semester (Theory)			
Code	**Subject**	**Contact Hours**	**Credit(L-T-P)**	**Code**	**Subject**	**Contact Hours**	**Credit(L-T-P)**
PH61112	Advanced Quantum Mechanics and Field theory	50	4 (3-1-0)	PH61123	Instrumental Techniques for Materials Characterization	50	4 (3-1-0)
PH61113	Basic and Digital Electronics	50	4 (3-1-0)	PH61124	Nuclear and Particle Physics	50	4 (3-1-0)
PH61114	Atomic & Molecular Physics	50	4 (3-1-0)	PH62125 PH62126 PH62127	**Elective Theory Subjects** 1. Fiber Optics and Optoelectronics -II 2. Materials Science and Technology -II 3. Plasma Physics-II	50	4 (3-1-0)
PH62115 PH62116 PH62117	**Elective Theory Subjects** 1. Fiber Optics and Optoelectronics -I 2. Materials Science and Technology -I 3. Plasma Physics-I	50	4 (3-1-0)	PH63428	Project	60	6 (0-0-6)
PH63318	Seminar	24	2 (0-0-2)				
		Total	18			Total	18
Practical /Sessional				**Practical /Sessional**			
PH61219	Basic and Digital Electronics Lab		6 (0-0-6)	PH61229	Modern Physics Lab	50	6 (0-0-6)
PH62220 PH62221 PH62222	**Elective Lab Subjects** 1. Fiber Optics and Optoelectronics –I 2. Materials Science and Technology -I 3. Plasma Physics-I		6 (0-0-6)	PH62230 PH62231 PH62232	**Elective Lab Subjects** 1. Fiber Optics and Optoelectronics -II 2. Materials Science and Technology -II 3. Plasma Physics-II	50	6 (0-0-6)
	Grand Total		**30**		**Grand Total**		**30**

SYLLABUS DETAILS
THIRD SEMESTER

PH61112 (ADVANCED QUANTUM MECHANICS AND FIELD THEORY)

Marks – 100

UNIT – I **(8 Hours)**

Klein-Gordon Equation: Klein-Gordon equation and its drawbacks need for a relativistic equation, Real and Complex Klein-Gordon fields.

UNIT – II **(10 Hours)**

Dirac Equation: Dirac equation, Properties of Dirac gamma-matrices, Non-relativistic reduction of Dirac equation, Magnetic moment of electron, Spin-Orbit coupling,

UNIT – III **(10 Hours)**

Covariance of Dirac equation and Hole Theory: Covariance of Dirac equation and bilinear covariant, Solution of Dirac Equation: Free particle solution of Dirac equation and its physical interpretation, Dirac hole theory, Projection operator for spin and energy, Zitterbewegung, Dirac Hole theory.

UNIT – IV **(12 Hours)**

Symmetry in Dirac equation: charge conjugation, space reflection, time reversal symmetries of Dirac equation, Continuous systems and fields, Transition from discrete to continuous systems, Lagrange and Hamiltonian formulation, Noether's theorem.

UNIT – V **(10 Hours)**

Quantization of Free field: Second quantization, Equal Time Commutators, Normal Ordering, covariant quantization of electromagnetic field, quantization of neutral scalar field , electromagnetic field and Dirac field, Propagators for scalar, spinor and vector fields

BOOKS:

1. Lectures on Quantum Field Theory - Ashok Das
2. Quantum Field Theory- Mandl, F.; Shaw, G. (1993)
3. An Introduction to Quantum Field Theory - Peskin, M.; Schroeder, D. (1995)
4. Gauge Theory of Weak Interactions- Greiner, W; Müller, B. (2000)
5. Quantum Field Theory - Ryder, L.H. (1985)
6. The Quantum Theory of Fields - Weinberg, S. (1995).
7. Modern Quantum Mechanics - J. J. Sakurai,
8. Quantum Mechanics (Non- Relativistic theory) - L. D. Landau
9. Relativistic Quantum Mechanics- Bjorken and S. D. Drell (Mc-Graw Hill)

PH61113 (BASIC & DIGITAL ELECTRONICS) **Marks – 100**

UNIT – I **(10 Hours)**

Amplifiers: Transistor parameters and equivalent circuit, Amplifier characteristics of transistor in CE, CB and CC configurations, Small signal low and high frequency transistor circuits and analysis, The Miller effect, Gain band width product.

Effect of cascading, Frequency response of linear amplifier, Amplifier pass band, R-C, L-C and transformer coupled amplifier, Feed back amplifier, Effect of negative feedback on gain, Distortion, Input and output resistances, Different feedback circuits, Boot-strapping the FET, Stability of amplifier, Noise in amplifier

UNIT – II **(10 Hours)**

Oscillators: Feedback and circuit requirement for oscillators, Analysis of Hartley, Colpitt, RC (phase shift) and Wein-bridge oscillator, Klystron oscillator (principle, description, and operation) Multivibrator: Astable, Monostable, Bistable (Principle, Description and Operation)

UNIT – III **(10 Hours)**

Operational amplifiers: Basic OP-AMP-differential amplifier, Inverting and non-inverting type, Common mode rejection ratio, Use of OP-AMP in scale changing, Phase shifting, summing, Voltage to current (and vice-versa) conversion, Multiplying, Differentiating and integrating circuits, Solution of linear and differential equation using OP-AMPS.

UNIT – IV **(12 Hours)**

Digital Electronics: Logic fundamentals, Boolean theorem, Logic gates-RTL, DTL, TTL, Boolean algebra, De Morgan theorem, AND, NAND, NOT, NOR gates, Exclusive OR gate, Exclusive NOR gate (Logic symbol, truth table and circuit with operation), Sequential logic design: Different type of Flip-Flops and their characteristics, RS flip-flop, JK flip-flops, advantage of master-slave configuration.

UNIT – V **(8 Hours)**

Radio Communication: Ionospheric Propation, Antennas of different types, super heterodyne, receiver (Block Diagram), Various types of optical fibers and optical communications

BOOKS:

1. The art of electronics - Paul Horowitz, Winfield Hill, Cambridge University Press
2. Electronic Devices and Circuit Th - Robert L. Boylestad, Louis Nashelsky, Prentice Hall
3. Electronic Principles - Malvino and Bates
4. Integrated Electronics - Millman and Halkias, Tata McGraw-Hill
5. Electronic Devices and Circuits - Millman, Halkias and Jit, Tata McGraw Hill
6. Circuit Analysis - Edminister, (Schaum Series)
7. Electronics - Allan R. Hambley, Prentice Hall

8. Introduction to Electronics - Earl Gates, Cengage Learning
9. Op-amps and linear integrated circuits - R.A.Gayakwad, Prentice Hall of India
10. Microelectronics - Millman, Grabel, McGraw-Hill
11. Linear circuit analysis - DeCarlo, and Lin - Oxford University Press
12. Engineering Circuit Analysis - Hayt, Kammerly and Durbin, Tata McGraw-Hill

PH61114 (ATOMIC AND MOLECULAR PHYSICS) **Marks – 100**

UNIT – I **(10 Hours)**

One Electron Atom: Introduction: Quantum States; Atomic orbital; Parity of the wave function; Angular and radial distribution functions.
Hyperfine structure: Review of Fine structure and relativistic correction, Lamb shift. Hyperfine interaction and isotope shift; Hyperfine splitting of spectral lines; selection rules.
Many electron atom: Independent particle model; He atom as an example of central field approximation; Central field approximation for many electron atom; Slater determinant; L-S and j-j coupling; Equivalent and non-equivalent electrons; Energy levels and spectra; Spectroscopic terms; Hunds rule; Lande interval rule.

UNIT – II **(10 Hours)**

Molecular Electronic States: Concept of molecular potential, Separation of electronic and nuclear wave functions, Born-Oppenheimer approximation, Electronic states of diatomic molecules, Electronic angular momenta, Approximation methods for the calculation of electronic Wave function, The LCAO approach, States for hydrogen molecular ion, Coulomb, Exchange and Overlap integral, Symmetries of electronic wave functions, Shapes of molecular orbital and bond, Term symbol for simple molecules.

UNIT – III **(10 Hours)**

Rotation and Vibration of Molecules: Solution of nuclear equation; Molecular rotation: Non-rigid rotator, Centrifugal distortion, Symmetric top molecules, Molecular vibrations: Harmonic oscillator and the anharmonic oscillator approximation, Morse potential.

UNIT – IV **(10 Hours)**

Spectra of Diatomic Molecules: Transition matrix elements, Vibration-rotation spectra: Pure vibrational transitions, Pure rotational transitions, Vibration-rotation transitions, Electronic transitions: Structure, Franck-Condon principle, Rotational structure of electronic transitions, Fortrat diagram, Dissociation energy of molecules, Continuous spectra, Raman transitions and Raman spectra.

UNIT – V **(10 Hours)**

Vibration of Polyatomic Molecules: Application of Group Theory Molecular symmetry; Matrix representation of the symmetry elements of a point group; Reducible and irreducible representations; Character tables for C_{2v} and C_{3v} point groups; Normal coordinates and normal modes; Application of group theory to molecular vibration.

BOOKS:

1. Physics of Atoms and Molecules - Bransden and Joachain.
2. Introduction to Atomic Spectra - H.E. White.
3. Introduction to Atomic Spectra - HG Kuhn.
4. Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles - Robert Eisberg and Robert Resnick Wiley.
5. Fundamentals of Molecular Spectroscopy - C. N. Banwell, Tata McGraw Hill.
6. Introduction to Atomic and Molecular Spectroscopy - V.K.Jain
7. Fundamentals of molecular spectroscopy - C.B. Banwell
8. Spectroscopy Vol. I and II - Walker and Straughen
9. Introduction to Molecular spectroscopy - G. M. Barrow
10. Spectra of diatomic molecules - Herzberg
11. Molecular spectroscopy - Jeanne . L. McHale
12. Molecular spectroscopy - J.M. Brown
13. Spectra of atoms and molecules by P. F. Bemath
14. Modern spectroscopy by J.M. Holias

PH62115 (Elective Theory-I)

FIBER OPTICS AND OPTOELECTRONICS-I **Marks – 100**

Unit – I **(8 Hours)**

Semiconductor laser sources: Energy bands and carrier distribution in semiconductors, absorption and emission in semiconductors, optical gain in a semiconductor, gain in a forward biased p-n junction, laser oscillations and threshold currents, double hetero-structure lasers.

Unit – II **(8 Hours)**

Optical detectors: Principle of detectors, PIN photo detector, Responsivity and quantum efficiency, and Elementary idea of avalanche photo diode.

Unit – III **(12 Hours)**

Planar Optical Waveguides: Maxwell's equations in a medium – TE and TM modes, TE modes of a symmetric step index planar optical waveguide, Physical understanding of modes, TM modes of a symmetric step index planar optical waveguide, Power associated with a mode and Relative magnitude of the longitudinal components of E and H, elementary idea about rectangular waveguides (rib and channel waveguides)

Unit – IV **(10 Hours)**

Optical fibers: Numerical aperture of an optical fiber, Attenuation in optical fibers-absorptive and radiative loss and Pulse dispersion in a step index fiber (using ray treatment).

Ray paths and pulse dispersion in optical waveguides: One dimensional ray equation, Ray paths in a homogeneous and in a square law medium. Transit time calculation-Pulse dispersion in parabolic index medium.

Unit – V **(12 Hours)**

Modes: Weakly guiding approximation and scalar (LP_{lm}) modes, Modal analysis of a step index fiber, Fractional modal power inside core, Concept of cut-off of a mode, Single mode fiber, Gaussian approximation for a single mode fiber, Gaussian spot size, mode field diameter, Expressions (without derivation) for splice loss due to longitudinal, transverse and angular misalignments.

BOOKS:

1 Introduction to Fiber Optics, A. K. Ghatak and K. Thyagarajan, Cambridge University Press, Cambridge, UK, 2002

2. Optical Waveguide Theory, A.W. Snyder and J. D. Love, Chapman and Hall, London, 1983

3. An Introduction to Optical Waveguides, M. J. Adams, John Wiley and Sons, Chichester

4. Fiber Optics through Experiments, M.R. Shenoy et al, Viva publications

5. Fundamentals of Optical Waveguides, Okomoto

6. Optical Fiber Communication, Gred Keiser, Mc-GrawHill International edition

7. Photonics, A.Yariv, P. Yeah, Oxford University Press, 6th edition.

8. Fundamentals of Photonics, B.E.A.Saleh & M.C. Tiesch, John Wiley& Sons, 2nd edition,2007

PH62116 (Elective Theory-I)
MATERIALS SCIENCE AND TECHNOLOGY I: **Marks – 100**
Unit-I **(10 Hours)**

Structure of Materials: Introduction to Materials Science, Classification of Materials, Crystal Structures (SC, BCC, FCC, HCP), Ceramics (Rock Salt, Diamond Structure, Spinel, Perovskite, Silicate), Polymers, Classification, Glass transition, Composites (classification, combination effect)

Unit-II **(8 Hours)**

Imperfection in Solids: Point Defects (vacancies, interstitial, self-interstitials, Schottky and Frankel defects), Impurities in metals and ceramics, dislocations—linear defects (Burger vector, Edge dislocation, screw dislocation), Interfacial defects (grain boundary, stacking faults)

Unit-III **(10 Hours)**

Diffusion: Introduction, Diffusion mechanism (vacancy diffusion, interstitial diffusion), steady-state diffusion, nonsteady-state diffusion, factors that influence diffusion (diffusing species**,** temperature)**,** diffusion in ionic and polymeric materials

Unit-IV **(10 Hours)**

Phase diagram and transformation: Solubility limit, Phase, Phase Equilibria, Phase diagram, Unary phase diagram, Gibb's phase diagram, lever rule, Iron carbon phase diagram, Phase transformation, Nucleation and growth of phases, Introduction to TTT curves.

Unit-V **(12 Hours)**

Functional materials and Applications: Piezoelectric Materials, Ferroelectric materials, Ferromagnetic material, Opto-electronic Materials, Superconducting materials, Shape Memory Materials, Fuel cell materials & Applications.

BOOKs:

1. Fundamentals of Materials Science and Engineering (F I FT H E D I T I O N), William D. Callister, Jr, John Wiley & Sons, Inc. (2001).
2. An introduction to materials engineering and science for chemical and materials engineers, Brian S. Mitchell, John Wiley & Sons, Inc., Publication. (2004)
3. Materials science and Engineering - V. Raghavan, Prentice-Hall Pvt. Ltd.
4. Thin Solid Films - K. L Chopra
5. Chemistry of Advanced Materials - Edited L. V. Interrante, and M. J. Hampden-Smith, Wiley, VCH, U. S. A

PH62117 (Core Elective Theory-I)
PLASMA PHYSICS-I **Marks - 100**

UNIT – I **(8 Hours)**

Definition: Quasi-neutrality, Collective Behaviour, Occurrence; Plasma properties, Debye Shielding, Plasma parameters, Plasma Temperature, Plasma sheath, Plasma frequency, Criteria for plasmas, Plasmas in nature and laboratory,

UNIT – II **(12 Hours)**

Plasma Fluid Theory: Single particle motion in uniform, non-uniform and time varying E and B field, Relation of Plasma Physics to Ordinary" Electromagnetic, Fluid description of a plasma, Fluid Drifts Perpendicular to **B**, Fluid Drifts Parallel to **B**, Diffusion and Mobility in Weakly Ionized Gases, Decay of a Plasma by Diffusion, Steady State Solutions, Recombination, Diffusion across a Magnetic Field, Collisions in Fully Ionized Plasmas, The MHD Equations, Diffusion in Fully Ionized Plasmas, Solutions of the Diffusion Equation , Bohm Diffusion.

UNIT – III **(12 Hours)**

Elements of Plasma Kinetic theory: Phase space, Single particle phase space, Many particle phase space, Volume elements, Distribution function, Number density and Average velocity, The Boltzmann equation, Collision less Boltzmann equation, Jacobian of the transformation in phase space, Effect of particle interactions, Relaxation model for the collision term, BBGKY theory- the Vlasov Equation, Correction to Vlasov Equation, Effect of particle interaction, Relativistic form of Vlasov equation, Moment Equations, Plasma oscillations and Landau damping.

UNIT – IV **(10 Hours)**

Plasma Oscillations and waves: Langmuir oscillations, The wave equation, Solution in Plane waves, Harmonic waves, Polarisation, Energy flow, Wave packets and group velocity, Electron Plasma waves, Ion waves, Electrostatic Electron Oscillations Perpendicular to **B**, Electrostatic Ion Waves perpendicular to **B**, The Lower Hybrid Frequency, Electromagnetic waves perpendicular to $\mathbf{B_0} = 0$, Electromagnetic waves perpendicular to finite $\mathbf{B_0}$, Cut offs and resonances, Electromagnetic waves parallel to finite $\mathbf{B_0}$, Magneto-sonic waves, Magneto hydrodynamic waves (Alfven waves, sound waves, Magnetosonic waves).

UNIT – V **(8 Hours)**

Magnetic Confinement: Condition for fusion, The need for magnetic confinement, The Mirror Machine, Toroidal Confinement, Magnetic Surfaces and Toroidal equilibrium, Confinement in TOKAMAKs, Theory of TOKAMAK Equilibrium.

BOOKS:

1. Introduction to Plasma Physics and Controlled Fusion, Francis F. Chen , Springer; 2nd ed. 1984. latest edition. 2006.
2. Fundamentals of plasma physics, J. A. Bittencourt, 3rd Edition Springer Verlag New York Inc., 2004
3. The Physics of Plasmas, T. J. M. Boyd and J. J. Sanderson, Cambridge University Press, 2003
4. Elementary Plasma Physics, L .A. Arzimovich Blaisdell, (NewYork,1968.)
5. Cold Plasma in Materials Fabrication from Fundamentals to Applications, A. Grill, (IEEE Press, New Jersey, 1994)
6. Hydrodynamics and Hydromagnetic Stability, S. Chandrasekhar,(Dover, 1981.)
7.Reactions under Plasma conditions Vol. I and II, Venugopalan
8. Introduction to Plasma Physics B M. Smirov, (Mir Publication, Moscow 1977.)
9. Industrial Plasma Engineering (Vol I & II), J Reece Roth, IOP Publishing Ltd 1995, Reprinted 2000.

PH63318 SEMINAR **Marks – 100**

PH61219 (BASIC ELECTRONICS LAB) **Marks – 100**

1. Study of Semiconductors Diodes (Si, Ge) Characteristics.
2. Study of Input and Output characteristics of a Bipolar Junction Transistor (BJT)
3. Study of a solid state power supply.
4. Study of Characteristics of Zener Diode and LED
5. Study of Hartley oscillator.
6. Study of Colpitt Oscillator.
7. Study of Junction Diode Rectifier.
8. Study of single stage Triode Amplifier
9. Study of Filter characteristics
10. Basic Logic gates.

PH62220: FIBER OPTICS AND OPTOELECTRONICS LAB–I (Elective Practical -1)
Marks - 100

1. Study the LED characteristics.
2. Study the LASER diode characteristics.
3. Fiber end-preparation and launching light into a fiber.
4. Mode field diameter of a single-mode fiber
5. Measurement of the numerical aperture.
6. Refractive index profile of a multimode optical fiber by the near-field scanning technique.
7. Study of bend-induced loss in an optical fiber

PH62221: MATERIALS SCIENCE AND TECHNOLOGY LAB-I (Elective Practical-I)
Marks – 100

1. Synthesis of material by solid state reaction method.
2. Synthesis of nano material by Co-precipitation method.
3. Synthesis of nano material by sol-gel method.
4. Preparation of thin film by spin coating method.
5. Preparation of thin film by chemical bath deposition method.
6. Determination of density of a solid specimen by Archimedes principle.

PH62222: PLASMA PHYSICS LAB-I (Elective Practical-1) Marks – 100

1. Determination of critical spark length, verification of Paschen's law and find out ionization law.
2. Measurement of Ion density of Plasma by using a single probe.
3. Study of Hall-effect in plasma.
4. Measurement of electron temperature of plasma using double probe.
5. Measurement of electron density of moving plasma.
6. Measurement of electrons density of plasma using single probe.
7. Measurement of Ion density of Plasma using double probe.

FOURTH SEMESTER

PH61123: (INSTRUMNTATAL TECHNIQUES FOR MATERIALS CHARACTERIZATION) Marks – 100

UNIT – I (10 Hours)

Construction and working principle of X-Ray diffraction and X-Ray photo electron spectroscopy.

UNIT – II (10 Hours)

Infra Red and Far Infra Red spectroscopy – construction and principle, Diffuse Reflectance spectroscopy.

UNIT – III (10 Hours)

Construction and line diagram and working principle of Optical Microscopy, Scanning electron microscopy, Transmission electron microscopy, Energy dispersive X-ray spectroscopy.

UNIT – IV **(10 Hours)**

Construction and line diagram and working principle of UV- Visible and Photoluminescence spectroscopy

UNIT – V **(10 Hours)**

Construction and line diagram and working principle of Electron spin resonance (ESR), Nuclear magnetic resonance spectroscopy (NMR), X-ray photoelectron spectroscopy (XPS).

BOOKS:

1. Physical Methods for Materials Characterisation - P. E. F. Flewitt and R. K. Wild, Institute of Physics (IOP) Publishing Ltd., 2nd Ed, 2003.
2. Encyclopaedia of Materials Characterization - C.R. Brundle, C. A. Evans Jr., and S. Wilson, Butterworth – Heinemann and Manning Publications Co.
3. Surface Analytical Techniques - J. C. Riviere, Clarendon Press, Oxford.
4. Element of X-ray Diffraction - B. D. Cullity, 2nd ed., Addison-Wiley Publisher.
5. Fundamentals of Molecular Spectroscopy - C. N. Banwell, E. M. McCash, 4th ed., London, New York, McGraw-Hill
6. Mass Spectroscopy - H. E. Duckworth, R. C. Barbar and V. S. Venkatasubramanian, 2nd ed., Cambridge Universit y Press.

PH61124 (NUCLEAR AND PARTICLE PHYSICS) **Marks-100**

Unit-I **(8Hours)**

General nuclear properties:

Radius, Mass binding energy, Nucleon separation energy, Angular momentum, Parity, Electromagnetic moments, Excited states.

Unit-II **(8Hours)**

Two Nucleon Problems:

Central and noncentral forces, Deuteron and its magnetic moment and quadruple moment, Force dependent on isospin, Exchange force, Charge independence and charge symmetry of nuclear force, Mirror nuclei.

Unit-III **(10Hours)**

Nuclear models:

Liquid drop model, Fission, Magic numbers, Shell model, Analysis of shell model predictions, Beta stability line, Collective rotations & vibrations, Nuclear Structure: Form factor and charge distribution of the nucleus, Hofstadter form factor.

Unit-IV **(12Hours)**

Nuclear reaction:

Energetic of nuclear reaction, Conservation laws, Classification of nuclear reaction, Radioactive decay, Radioactive decay law, Production and decay of radioactivity, Radioactive dating, Alpha decay: Gamow theory and branching ratios, Beta decay: energetic angular momentum and parity selection rules, Compound nucleus theory, Resonance

scattering, Breit- Wigner formula, Fermi's theory of beta decay, Selection rules for allowed transition, Parity violation.

Unit-V **(12Hours)**

Particle Physics:

The Standard model of particle physics, Particle classification, Fermions and Bosons, Lepton avors, Quark avors, Electromagnetic, Weak and strong processes, Spin and parity determination, Isospin, Strangeness, Hypercharge and Baryon number, Lepton number, Gell-Mann-Nishijima Scheme, Quarks in hadrons: Meson and Baryon octet, Elementary ideas of SU(3) symmetry, Charmonium, Charmed mesons and B mesons, Quark spin and colour

BOOKS:

1. Nuclear Physics- Satyaprakash.
2. Nuclear and Particle Physics- Mital, Verma, Gupta.
3. Nuclear Physics- Dr. S. N. Ghosal.
4. Atomic and Nuclear physics - Shatendra Sharma.
5. Theoretical Nuclear Physics - J. M. Blatt and V. F. Weisskopt, Wiley, New York
6. Nuclear Physics - R. R. Roy and B. P. Nigam
7. Introductory Nuclear Physics- Samuel S. Wong, Prentice Hall International Inc., 1990
8. Theoretical Nuclear Physics- J. M. Blatt and V. F. Weisskopf, Wiley, New York, 1952

PH62125 (Elective Theory-II)

(FIBER OPTICS AND OPTOELECTRONICS) **Marks – 100**

UNIT – I **(8Hours)**

Pulse dispersion in single mode fibers: Calculation of material dispersion, Group delay and waveguide dispersion, Zero dispersion fiber, dispersion shifted fiber and dispersion compensating fiber.

UNIT – II **(8Hours)**

Optical fiber amplifiers: Optical amplification, Energy levels of erbium ions in a silica matrix and Amplifier modelling-variation of pump and signal powers with length.

UNIT – III **(12Hours)**

Guided Wave Optical Components: Planar waveguide directional couplers, coupled mode theory, power exchange between the waveguides and coupling coefficient, Optical fiber directional couplers, Power exchange and coupling coefficients in identical fiber directional couplers, Fabrication of fiber directional couplers, Fiber Bragg gratings, Principle of operation and fabrication techniques, Long period Fiber Bragg gratings.

UNIT – IV **(12Hours)**

Optical fiber fabrication technique: Elementary idea about double crucible method, Rod-in-tube method, Chemical Vapour Deposition (CVD) method and Modified Chemical Vapour Deposition (MCVD) method, Fabrication of planar and channel waveguides (Ion exchange and Ti indiffusion methods). Prism coupling technique to measure propagation constant of discrete guided modes.

UNIT – V **(10Hours)**

Pulse code modulation and Digital Transmission: Elements of analog and digital modulation, Basic idea of RZ and NRZ pulse trains, Elementary idea about shot noise, thermal noise, signal to noise ratio (SNR) and Bit-Error-Rate (BER), Elementary idea about WDM system of transmission.

BOOKS:

1. Introduction to Fiber Optics, A.K.Ghatak and K. Thyagarajan, Cambridge University Press, Cambridge, UK, 2002
2. Planar Optical Waveguides and Fibers, H.-G. Unger, Clarendon Press, Oxford
3. An Introduction to Optical Waveguides, M. J. Adams, John Wiley and Sons, Chichester
4. Fiber Optics through Experiments, M.R. Shenoy et al, Viva publications
5.Fundamentals of Optical Waveguides, Okomoto
6. Optical Fiber Communication, Gred Keiser, Mc-GrawHill International edition
7.Photonics, A.Yariv, P. Yeah, Oxford University Press, 6th edition.
8.Fundamentals of Photonics, B.E.A.Saleh & M.C. Tiesch, John Wiley& Sons, 2nd edition,2007.

PH62126 (Elective Theory-II)
(MATERIALS SCIENCE AND TECHNOLOGY II) **Marks – 100**

UNIT – I **(10Hours)**

Materials Preparation Techniques

Single crystal growth: Single crystal growth from melt: Czochralski methods, Float-Zone process for single crystal Si growth, Bridgmen Technique for GaAs growth.

Thin Film growth: Fundamentals of film growth, Vacuum evaporation, Sputtering Comparison of Evaporation and sputtering, Molecular beam epitaxy, Chemical vapour deposition (CVD): Typical chemical reactions, Reaction kinetics, transportant phenomena in CVD, Atomic Layer Deposition, Sol-gel Spin coating.

UNIT – II **(10Hours)**

Nanomaterials:

Importance of Nano-technology, Emergence of Nano-Technology, Bottom-up and Top-down approaches, challenges in Nano Technology.

Nanomaterials synthesis:

Nanopowder synthesis through solid solution technique: mechanical mixing; grinding, Ball Milling, Wet chemical synthesis: hydrothermal solvothermal methods, electrochemical synthesis, Vapour phase methods: Chemical vapour deposition, Metal organic chemical vapour deposition. Applications: Nanogenerator, Field emitter, Drug delivery

UNIT – III **(10Hours)**

Materials Characterizations techniques:

X-ray diffraction (XRD)- X-ray spectrum, methods to remove K_β radiation, Bragg's law, Basic powder diffraction, Crystallinity, particle/crystallite size determination, structural analysis, and Phase identification.

UNIT – IV **(10Hours)**

Scanning Electron Microscopy (SEM)- electron-matter interaction, imaging modes (secondary and backscattered), Specimen preparation, effect of spot size, apertures and accelerating voltage on SEM imaging, Morphology, grain size analysis.
Transmission Electron Microscopy (TEM)- TEM sample Preparation pre thinning, final thinning, Image modes- mass density contrast, diffraction contrast, phase contrast, Applications, Limitations

UNIT – V **(10Hours)**

Energy dispersive X-ray spectroscopy (EDS)- sample preparation, scanning mode, qualitative and quantitative analysis.
X-ray photoelectron spectroscopy (XPS)- peak identification, chemical shift, qualitative and quantitative analysis.

BOOKS:

1. Materials science and Engineering - V. Raghavan, Prentice-Hall Pvt. Ltd.
2. Thin Solid Films - K. L Chopra
3. Materials Science and Thin films - Milton Ohring, Academic Press
4. Nano structures and Nano materials: Synthesis, properties and applications
- Guozhong Cao- Imperial College press.
5. Elements of X-ray diffraction - B. D. Cullity, Addison-Wesley Publishing Co.
6. Elements of crystallography - M. A. Azaroff
7. Engineering Materials - Kenneth G. Budinski, Prentice-Hall of India Pvt. Ltd.
8. Transport in Nanostructures - D. K. Ferry and S. M. Goodnick, Cambridge University Press.
9. Chemistry of Advanced Materials - Edited L. V. Interrante, and M. J. Hampden-Smith, Wiley, VCH, U. S. A
10. Structure of Metals - C. S. Barret and T. B. Massalski, Pergamon Presss, Oxford
11. Materials Characterization-Introduction to Microscopic and Spectroscopic Methods, Yang Leng, John Wiley & Sons (Asia) Pte Ltd., 2008.

PH62127 (Core Elective Theory-II)
PLASMA PHYSICS-II **Marks - 100**
UNIT – I **(10Hours)**
Equilibrium, stability and non-linear effects: Introduction, Hydromagnetic Equilibrium, The Concept of β, Classification of Instabilities, Two-stream instability, The Gravitational Instability, Resistive Drift Waves, The Weibel Instability, Nonlinear effect**s:** Sheaths, Ion Acoustic Shock waves, Ponder motive Force, Parametric instabilities (Coupled Oscillators, frequency matching, Instability threshold, the oscillating two stream instability, the parametric decay instability).

UNIT – II **(10Hours)**
Basic Processes in plasmas and plasma equilibrium models: Classical Townsend Mechanism and Electrical Breakdown in Gases, Streamer mechanism and micro discharges, Degree of Ionisation and Saha Ionisation formula, Paschen's laws and different regimes of E/p in a discharge, Collisions in plasmas, Thermal Equilibrium (TE), Local Thermal Equilibrium (LTE), Corona Equilibrium (CE), Collisional Radiative Equilibrium (CRE). Recombination

UNIT – III **(10Hours)**

Production of Plasma in the laboratory: Arc discharge, Glow discharge, radio frequency (RF) discharges, di-electric barrier and corona discharge, ionization breakdown of gases, electrode less discharge, capacitively and inductively coupled plasmas, Other methods (Ohmic heating, heating by LASER, heating with particle beams) of producing plasmas.

UNIT – IV **(10Hours)**

Plasma Diagnostics: High frequency current measurement (Rogowski Coil), Magnetic Probe. Single and Double Langmuir Probe, Emissive Probe, Plasma Spectroscopy: Radiations from Plasmas and recombination, Optical Emission Spectroscopic (OES) characterisation of Plasmas.

UNIT – V **(10Hours)**

Processing plasmas and applications: Hot and Cold Plasmas, Dusty plasmas, Weiding, Cutting, Hardening, Nitriding, Coating (sputtering), Spraying, Etching, Plasma Wall Reactor for Diamond Films, Applications of Non-equilibrium Plasma in Lighting, Industrial, biomedical, hazardous waste disposal, sterilization, preservation etc.

BOOKS:

1.Introduction to Plasma Physics and Controlled Fusion, Francis F. Chen , Springer; 2nd ed. 1984. latest edition. 2006.
2.Fundamentals of plasma physics, J. A. Bittencourt, 3rd Edition Springer Verlag New York Inc., 2004
3.The Physics of Plasmas, T. J. M. Boyd and J. J. Sanderson, Cambridge University Press, 2003
4. Elementary Plasma Physics, L .A. Arzimovich Blaisdell, (NewYork,1968.)
5.Cold Plasma in Materials Fabrication from Fundamentals to Applications, A. Grill, (IEEE Press, New Jersey, 1994)
6.Hydrodynamics and Hydromagnetic Stability, S. Chandrasekhar,(Dover, 1981.)
7..Reactions under Plasma conditions Vol. I and II, Venugopalan
8. Introduction to Plasma Physics B M. Smirov, (Mir Publication, Moscow 1977.)
9.Industrial Plasma Engineering (Vol I & II), J Reece Roth, IOP Publishing Ltd 1995, Reprinted 2000.

PH63428 PROJECT **Marks - 100**

PH61229 (MODERN PHYSICS LAB) **Marks - 100**

1. Measurements of Lande splitting factor using electron spin resonance spectrometer.
2. Resistivity of semiconductor by Four-probe method.
3. Determine excitation potential by Franck-Hertz Experiment.
4. Effect of temperature on mobility by Hall apparatus.
5. Study of Dielectric constant and Curie temperature of Ferroelectric ceramics
6. Study of energy band gap and diffusion potential of PN junction.
7. Determination of Planck's constant by total radiation method
8. Verification of Richardson's $T^{3/2}$ law.
9. Study of Raman Effect.
10. Study of the following using GM counter:-
    (i) Plateau Characteristics
    (ii) Inverse Square law
    (iii) Absorption co-efficient of beta-ray and gamma-rays in Aluminium foils
    (iv) Dead time characteristics by single source and double source methods.

PH62230: (Elective Practical-II)

(FIBER OPTICS AND OPTOELECTRONICS LAB-II) **Marks - 100**

1. Prism Coupling technique
2. Intensity modulated fiber optic sensor.
3. Characterization of directional coupler.
4. Measurement of power attenuation of the optical fiber
5. Measurement of the splice loss of optical fibers.
6. Characterization fiber Bragg Gratings
7. Power launching and measurement of optical power loss between two plastic optical fibers in ST connectors

PH62231: (Elective Practical-II)

(MATERIALS SCIENCE AND TECHNOLOGY LAB- II) **Marks – 100**

1. Band gap determination of unknown powder sample by UV-Visible spectroscopy.
2. Band gap determination of unknown liquid sample by UV-Visible spectroscopy
3. Band gap determination of unknown thin film by UV-Visible spectroscopy
4. Concentration of sugar or salt in sugar /salt solution UV-Visible spectroscopy
5. Phase identification of unknown sample by FTIR-spectroscopy
6. Phase identification, indexing and lattice parameter determination using XRD.
7. Calculation of particle size using XRD profile.

PH62232: (Elective Practical-II)

(PLASMA PHYSICS LAB-II) **Marks - 100**

1. Study of Arc plasma parameters.
2. Measurement of electron temperature, electron and ion velocities using spectroscopic method.
3. Measurement of collision cross section of electrons in plasma.
4. Use of a Rogoswki coil for plasma characterization
5. Study of dc magnetron thin film deposition unit.
6. Sputtering of target using magnetron.
7. Study of plasma process parameter during sputter coating of thin films.