SYLLABUS

Proposed course outlines
For
M.S/ M.Phil (Physics) Semester/Term System

Effective from the Academic Session 2021 onward

M.S/M.Phil (Physics) Semester System

Effective from the Academic Session 2021 onward

Total credit: 30 Hours

[Theory course 24 credit hours + Laboratory work/Research thesis: 06 credit hours]

NOTE:

- Theory course of 24-credit hours (8-courses each of 3 credit hours) have to be completed in first two semesters (i.e. 1st & 2nd semester) during ONE academic year.
- Scholar will have to complete FIVE compulsory and THREE optional courses.
- Laboratory work/Research thesis of 06-Credit hours has to be completed in second academic years i.e., in 3rd and 4th semesters.
- Scholar will submit thesis along with ONE Research Paper published or accepted in recognize journal of HEC from their research work before the final defense.

COMPULSORY COURSES

SNo.	Course Code	Course Title	Credit Hours	Marks
1	Phy-701	Research Methodology	3	100
2	Phy-702	Mathematical Methods of Physics	3	100
3	Phy-703	Electromagnetic Theory	3	100
4	Phy-704	Self-Organized Nanostructures	3	100
5	Phy-705	Microelectronics Fabrication Technology	3	100
6	Phy-706	Sensing and Actuation	3	100
7	Phy-707	Signals and System Analysis	3	100
8	Phy-708	Telecommunication networks	3	100
9	Phy-709	Experimental Techniques	3	100
10	Phy-710	Nanoscience and Nanotechnology	3	100
11	Phy-711	Solid State Physics	3	100

OPTIONAL COURSES

SNo.	Course Code	Course Title	Credit Hours	Marks
1	Phy-712	Semiconductor Physics	3	100
2	Phy-713	Computational Physics	3	100
3	Phy-714	Advanced Quantum Mechanics	3	100
4	Phy-715	Medical Physics	3	100
5	Phy-716	Methods and Techniques of Experimental Physics	3	100
6	Phy-717	Surface Physics	3	100
7	Phy-718	Optical Fiber Communication	3	100
8	Phy-719	Cellular mobile system	3	100
9	Phy-720	Renewable Energy Resources	3	100
10	Phy-721	Digital and Analog Circuit Design	3	100
11	Phy-722	Digital Integrated Circuit Design	3	100
12	Phy-723	Plasma Physics-I	3	100

COMPULSORY COURSES

RESEARCH METHODOLOGY: (03) **Phy-701**

1. **Research Methodology:** An Introduction, Meaning of Research, Objectives of Research, Types of Research, Research Approaches (quantitative and qualitative approaches), Significance of Research, Research Methods versus Methodology, Importance of Knowing How Research is Done, Literature surveys, Research Process, Defining the Research Problem: What is a Research Problem? (Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem), Research Design,
2. **Writing Academic Papers:** Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Mechanics of Writing a Research Report, Writing and presentation of scientific papers, plagiarism, what is plagiarism and how to avoid it, contents and referencing writing papers, Computers and Researcher
3. **Application of Statistical Concepts:** Graphs, numerical summaries, normal distribution, regression analysis and correlation, Sample Designs and their Types, Methods of Data Collection, Collection of Primary Data, Observation Method, Interview Method, Collection of Data through Questionnaires, Collection of Secondary Data, Processing and Analysis of Data, Sampling Fundamentals, probability, statistical inference for one or two samples, hypothesis tests, Chi square tests, conceptual understanding application of statistics, advanced theory, derivatives of quantitative statistics, descriptive statistics, confidence intervals, variance, standard deviations, curve fitting, Least squares method etc.

BOOKS:

1. C. R. Rathori, **Research Methodology and Techniques**, Cambridge University Press, 2001
2. Ranjit Kumar, **Resarch Methodology: A step by step Guide for Beginners**, Addison Wisely, 1996
3. Alan Agrest, **An application to Categorical Analysis,** John Wiley and Sons, 1996
4. R. B. Burns, **Introduction to Research Methods**, McGraw Hill, 2000
5. C. H. Hart, Doing **A Literature Review**, Cambridge University Press, 1996

MATHEMATICAL METHODS OF PHYSICS: (03) **Phy-702**

1. **Fourier series:** introduction and general properties, convergence of trigonometric series, Gibbs phenomenon, Parseval's theorem, applications to various phenomena. Integral transform, development of the Fourier integral, Fourier transform, inversion theorems, Fourier transform of derivatives, convolution theorem, momentum representation, transfer functions. Complex arguments in Fourier transforms.
2. **Laplace transform**: Laplace transform of derivatives, convolution products and Faltung's theorem, inverse Laplace transform.
3. **Partial differential equations:** Separation of variables in three dimensions, method of characteristics. Boundary value problems. Integral transforms, generating functions, Neumann series, separable (degenerate) kernels, Hilbert–Schmidt theory, integral equations.
4. **Calculus of variations:** dependent and independent variables, Euler-Lagrange equation and applications, several independent and dependent variables, Lagrange multipliers, variational principle with constraints, Rayleigh–Ritz variational technique, application to discrete mesh. Nonlinear methods and chaos, the logistic map, sensitivity to initial conditions and parameters, nonlinear differential equations.
5. **Probability:** definitions and simple properties, random variables, binomial distribution, Poisson distribution, Gauss's normal distributions, statistics.

BOOKS:

1. Tai L. Chow, **Mathematical Methods for Physicists**, Cambridge University Press, 2002.
2. M. I. Boas, **Mathematical Methods in the Physical Science**, publisher Kay Pace, 2006
3. E. Krevzig, **Advanced Engineering Mathematics**, John Wiley and Sons, 2006
4. G. B Arfken & H. I. Weber, **Mathematical Methods for Physics,** Elsevier Academic Press, 2005
5. P. K. Chattopdhya, **Mathematical Physics**, N C Age Intl., 1990

ELECTROMAGNETIC THEORY: (03) **Phy-703**

1. Review: Coulomb's law, electric field, Gauss's law, scalar potential surface charge distributions of charges and dipoles, Poison's and Laplace equations, Biot and Sarvat law, Ampere's law, vector potential, magnetic induction in a circular loop of current, Faraday's law of induction, energy in magnetic field, Maxwell's equation, gauge transformations, Green's function, independent wave equations, initial value problems; Kirchoff's integral representation, Pointing theorem, conservation laws, microscopic equation

2. Wave guides and Resonant cavities: Fields at the surface of and within a conductor, cylindrical cavities and wave guides, modes in a rectangular guide, energy flow and attention in wave guides, general angular and frequency distribution of radiation from accelerated charges, frequency spectrum from relativistic charge particles in an simultaneously circular orbit, synchliro radiation, Thomson scattering by quasi free charges

3. Simple Radiation Systems and Diffraction: Field and radiation of a localized source, oscillating dielectric dipole, magnetic dipole and quadruple field, centre fed antenna, Kirchhoff's integral for integration, vector equivalent of Kirchhoff's integral, Babinef's principle, diffraction by circular aperture and by small apertures, scattering by a conduction sphere an short wavelength

BOOKS

1. D Jackson, **Classical Electrodynamics**, John Wiley and Sons, 2007
2. D J Griffiths, **Introduction to Electrodynamics**, Prentice Hall, 2009
3. H C Ohanion, **Classical Electrodynamics,** Aliyan and Bacon Inc., Massachusetts, 1988
4. P L Lorian and D R Corson, **Electromangnetic Fields and Waves**, W H Freeman & Co.,1978
5. E O George, Introduction to Electrodynamics Theory, Courier Douer publication, 2003

SELF-ORGANIZED NANOSTRUCTURES (03) Phy-704

1. Introduction: : Photo lithography, Electron Beam lithography, interference lithography, Nanosphere lithography, Nanoimprint lithography, Micro-contact printing, Inkjet printing, Pattern transfer, Self organized nanostructures.

2. Anodic Aluminum oxide nanostructures: Types of anodic oxide film, general structure of anodic porous alumina, pore diameter, inter pore distance, wall thickness, Barrier layer thickness, porosity, pore density, incorporation of anions, cell wall structure, crystal structure of oxide, density and charge of oxide film, Miscellaneous Properties of Anodic Porous Alumina, Aluminum Pre-Treatment, Anodization of Al, Removal of the Aluminum Substrate, Removal of the Barrier Layer, Structure and Thinning of the Barrier Layer, Theories for self-organization of AAO nanostructures.

3. AAO Template-Assisted Fabrication of Nanostructures: Metal (Nanodots, Nanowires, Nanorods, and Nanotubes), Metal Oxide (Nanodots, Nanowires, and Nanotubes), Semiconductor (Nanodots, Nanowires, Nanopillars, and Nanopore Arrays), Polymer, Organic and Inorganic (Nanowires and Nanotubes), Carbon Nanotubes.

4. Zinc oxide nanostructures: Basic properties (Crystal Structure, Lattice Parameters, Electronic Band Structure, Mechanical Properties, and Piezoelectric effect of ZnO), Synthesis of ZnO Nanostructures (Vapor Transport Process, Metalorganic Vapor-Phase Epitaxy and Molecular Beam Epitaxy, Hydrothermal Synthesis, Growth of ZnO in general alkaline solutions, Growth mediated by hexamethylenetetramine, Seeded growth on general substrates, Electrodeposition, Template assisted growth), Doping of ZnO (n-Type Doping, p-Type Doping).

5. Carbon Nanotubes: Introduction, Carbon Nanotube Production, Arc Discharge, Laser Ablation, Chemical Vapor Deposition, Miscellaneous Synthesis Methods, Catalysts, Metallic Catalysts, Ceramic Catalysts, Catalyst Free, Growth Enhancement, Growth Mechanisms, Floating Catalyst Methods, Supported Catalyst Routes, Catalyst-Free Routes, Functionalization, Purification.

BOOKS

1. Richard C. Alkire, Yury Gogotsi, Patrice Simon, Ali Eftekhari, "**Nanostructured Materials in Electrochemistry**" WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim 2008

2. Hadis Morkoç and Ümit Özgür "**Zinc Oxide: Fundamentals, Materials and Device Technology**", WILEY-VCH Verlag GmbH & Co. KGaA, 2009.

3. Dirk M. Guldi and Nazario Martín "**Carbon Nanotubes and Related Structures Synthesis, Characterization, Functionalization, and Applications**", WILEY-VCH Verlag GmbH & Co. KGaA, 2010

MICROELECTRONICS FABRICATION TECHNOLOGY (03) **Phy-705**

1. Semiconductor Processing Technology: An Introduction to Microelectronic Fabrication, Roadmap of semiconductor manufacturing, Semiconductor Materials and Process, Crystal Growth and Wafer Preparation, Contamination Control

2. Overview of Wafer Fabrication: Phase Diagrams and Solid Solubility, Basic Wafer Fabrication Operations, Hot Processing and Ion Implantation, Construction of a Semiconductor Circuit, Chip Terminology, Process Yields

3. Principles of Microelectronics Fabrication: Diffusion, Fick's diffusion equation, Oxidation, Rapid Thermal Processing,

4. Pattern Transfer: Lithography Overview, Optical Lithography, Diffraction, Contact / proximity printers, projection printers, alignments, Photoresists, Non optical Lithographic Techniques

5. Processing of thin films: Vacuum science and Plasmas, Etching, Physical deposition, Evaporation and Sputtering, Chemical Vapor Deposition, Epitaxial Growth, Device Isolation, Contacts, and Metallization, Fundamentals of MEMS

6. Overview of Wafer Fabrication: The Business of Wafer Fabrication, Semiconductor devices and IC formation, Integrated Circuit types, Chip packaging

BOOKS:

1. S. A. Campbell:**The Science and Engineering of Microelectronics Fabrication**, Oxford University Press, Second Edition, 2000 (ISBN: 0195136055)
2. P. V. Zant: **Microchip Fabrication: A Practical Guide to Semiconductor Processing**, 3rd Edition, Semiconductor Services, 2000 (ISBN: 0071356363)
3. S. M. Sze, **Physics of Semiconductor Devices,** 3rd Edition, John Wiley & Sons, (2007)

SENSING AND ACTUATION (03) **Phy-706**

1. Sensing Principle: Introduction to sensing, static and dynamics characteristics of sensors, motion and dimensional sensors, force, torque, and power sensors, pressure and sound sensors, fluid flow sensors, temperature sensors

2. Signal conditioners: Introduction to operational amplifier, inverting amplifier, non-inverting amplifier, integrator, summing amplifier; difference amplifier, comparator circuits, logarithmic scales and simple RC filters; lC band pass filter; low pass filter; high pass filter, twin T notch filter; active filters, composite filters, design of input signal conditioners, design of output signal conditioner.

3. Electrical Actuators: Introduction to Electro-Magnetic Principle, Classification of Electrical Actuators, DC Motors and Modeling, DC Motor Drivers, AC Motors and Modeling, AC Motor Drivers, Stepper Motors and Modeling, Stepper Motor Drivers, Servo motors. H-bridge circuit, different types of motor drivers for unipolar and bipolar stepper motors.

4. Hydraulic and Pneumatic Actuators: Description of Fluid Behavior, Hydraulic Actuator and System, Pneumatic Actuator and System

5. Digital Control: Introduction to Microcontrollers, Arduino Uno, Arduino Mega, Arduino Nano, ESP 32, Bluetooth module, wifi module, programing of microcontrollers for sensors and actuators, mBlock and arduino IDE softwares.

BOOKS

1. Brindley, **Sensors and Transducers**, Heinemann Newnes, 1989.
2. J. W. Dally, W. F. Riley, and K.G. Mcconnell: **Instrumentation for Engineering Measurements**, 2nd edition, John Wiley & Sons Inc., 1993.
3. E. O. Doebelin: **Measurement Systems Application and Design**, 4th edition, McGraw-Hill, 1998.
4. P. Hauptmann: **Sensors, Principles & Application**, Prentice Hall, 1993.
5. J.L. Jones and A.M. Flynn: **Mobile Robots, Inspiration to Implementation**, AK Peters, 1999.

SIGNALS AND SYSTEM ANALYSIS:(03) **Phy-707**

1. Review of Mathematical Concepts: Functions, limits, differentiation and integration (graphical), complex variables, continuous time signals, categories of system and signals, signal representation,

symmetry and signal space concepts, Fourier transformation and their properties, singularity functions and their properties, unit step functions, delta functions and finite train of delta functions

2. Time Frequency Occupancy of Signals: Bandwidth, continuous time system (linear time invariant system), frequency domain approach, filters, frequency domain system analysis on a nutshell, time domain approach, relationship of impulse response to step response, pulse approximation method for determining as impulse response, combination of systems

3. Distortion System: Ideal low pass filter, nonlinear systems, time varying systems, modulation systems, amplitude modulation, phase modulation, frequency modulation, multiplexing schemes, time division multiplexing, sampling their z-transform (solution of different equations) impulse response sequences and discrete convolution, finding the impulse response sequence (direct iteration and Z-transform) discrete Fourier transform, relationship to convolution, digital filters, types of digital filters and design methods, Hilbert transform, envelope and phase of band pass signals, filtering, single sideband modulation, complex envelope, envelope correlation and spectrum matters

BOOKS:

1. B. P. Lathi, **Signal Processing and Linear Systems**, 1st Edition, Berkeley-Cambridge Press Publisher, 1998
2. E Kretsig, **Advanced Engineering Mathematics**, Willy N Y, 1992
3. Olmsted J M, **Advanced Calculus**, Appleton Century Clifts, 1961
4. Asteline JA, **Transform Methods in Linear System Analysis**, McGraw Hill, NY, 1989
5. Fredrick D K and Carlson, **Linear Systems on Communication and Control**, Wiley, 1971

TELECOMMUNICATION NETWORKS: (03) **Phy-708**

1. **Telecommunications Systems:** History of Telecommunications, Telecommunications Fundamentals, Changes in Telecommunications Systems, The New Public Network, Basic elements of Telecommunications, Introduction to communication networks and services, network hardware Voice and data network structures and protocols, Introduction to access network technologies including xDSL, PONS, Fiber Coax, Evolution and potential of ATM, ADSL and PONs, outline and development, Introduction to mobile networks and mobility, GSM, UMTS, GPRS overview, Introduction to satellite networks, public Switched Telephone Network.

2. **Signals Carried Over the Network:** Types of Information and Their Requirements, Simplex, Half-Duplex, and Full-Duplex Communication, Analog and Digital Signals and System, Frequency Division Multiplexing (FDM), Time Division Multiplexing (TDM), Pulse Code Modulation, Power Levels of Signals; Decibel; Gain and Loss

3. **Transmission Media and Systems:** Transmission Media: Copper Pairs; Optical Fibers; Radio Waves, Microwave Radio Relay Lines, Satellite Communications Networks, Optical Fiber Communication Networks, Mobile Communication Systems, Wireless Local Loop Systems, DSL Technology, Integrated services digital network (ISDN), Principle of ISDN

4. **Data Communications:** Principles of Data Communication, Data Communications Protocols, Internet Protocol (IP); TCP/IP, Voice over IP, Classifications of the Internet Telephony Networks, Network Architecture ,Quality of Service, Multi-services networks.

BOOKS:

1. R. L. Freeman: **Networks and Telecommunications**, John Wiley & Sons, 1991
2. M.P. Clark: **Fundamentals of Telecommunication Networks**, John Wiley & Sons, Inc., 1994
3. James F. Kurose and Keith W. Ross, **Computer Networking: A Top-Down Approach,** Fifth Edition, 2009.

EXPERIMENTAL TECHNIQUES :(03) **Phy-709**

Fundamentals of vacuum system, vacuum pumps, vacuum gauges, substrate deposition technology, substrate materials, substrate cleaning, uniform and non-uniform deposition, mask and connections, multiple file, deposition, physical (resistive heating, flash evaporation, sputtering, laser beam evaporation, electro bean evaporation etc), deposition techniques (electro deposition, chemical vapor deposition, spray pyrolysis, screen printing etc), low temperature techniques, crystal growth techniques.

Fundamental principles of X-rays of diffraction, photo graphic powder techniques, scanning electron and transmission electron microscopy, spectroscopy (atomic spectroscopy, Raman spectroscopy) techniques for measurements of electrical conductivity, Hall coefficient, optical, mechanical and dielectric properties of materials

BOOKS:

1. R. W. Cahn, P. Hassen & E. K. Krampers, Material Science & Technology: **A Comprehensive Treatment**, 2001
2. B.D. Culliy, **Elements of X-Rays Diffraction**, Addison Wisely Academic Press, 1998
3. R.L.Hovitz & V A Johnson, **Methods of Experimental Physics**, Academic Press, 1999
4. D. William, **Methods of Experimental Physics**, McGraw Hill, 2002

NANOSCIENCE AND NANOTECHNOLOGY (03) Phy-710

1. Nanoscience Introduction: About size scales, History, Feynman scorecard, Fluctuations and "Darwinian Nanoscience", Overview of quantum effects and fluctuations in nanostructures, why physics is different for small systems-the story of the Hitachi experiment

2. Making nanostructures- top down: Overview of nanofabrication, Photolithography, Electron beam lithography, Micromechanical structures, Thin film technologies, Molecular beam epitaxy, Self-assembled masks, Focused ion beam milling, Stamp technology, Nanoscale junctions

3. Making nanostructures- bottom up: Common aspects of all bottom-up assembly Methods, Organic synthesis, Weak interactions between molecules, Vesicles and micelles, Thermodynamic aspects of self-assembling, nanostructures, A self-assembled nanochemistry machine-the mitochondrion, Self-assembled molecular monolayers, Kinetic control of growth: nanowires and quantum dots, DNA nanotechnology

4. Nanostructured materials: Nanostructures for electronics, Zero-dimensional electronic structures: quantum dots, Nanowires, 2D nanoelectronics: superlattices and heterostructures, Photonic applications of nanoparticles, 2D photonics for lasers, 3D photonic bandgap materials, Physics of magnetic materials, Superparamagnetic nanoparticles, A 2D nanomagnetic device: giant magnetoresistance, Nanostructured thermal devices, Nanofluidic devices, Nanofluidic channels and pores for molecular, separations, Enhanced fluid transport in nanotubes, Superhydrophobic nanostructured surfaces, Biomimetic materials

BOOKS:

1. S.M. Lindsay, "**Introduction to Nanoscience**" by Oxford University Press Inc. New York (2010)
2. Luisa Filipponi and Duncan Sutherland, '**Nanotechnologies: Principles, Applications, Implications and Hands-on Activities'** Edited by the European Commission (2012)
3. Directorate-General for Research and Innovation
4. G. Louis Hornyak, Joydeep Dutta, Harry F. Tibbals and Anil K. Rao, **'Introduction to NanoScience'**, CRC Press of Taylor and Francis Group LLC, (2008)
5. Janos H.Fendler, ' **Nanoparticles and nanostructured films: preparation, characterization and applications'**,Wiley VCH, (1998)
6. Kenneth J. Klabunde, '**Nanoscale materials in chemistry**', Wiley, John & Sons, (2001)
7. Zhon Ling Wang, '**Characterization of nanophase materials'**, Wiley-VCH Verlag GmbH (2000)

SOLID STATE PHYSICS: (03) Phy-711

1. Introduction: Bloch's theorem and Brillion zones, electronic states, electron-electron interaction, screening, Kohn effect, dielectric constant, Plasma oscillations, dynamics of electronics, electron and holes, excitons, zenner breakdown, scattering of electrons by impurities, multi-phonon process, inter-band transitions, interaction with conduction electrons, anomalous skin effect, ultrasonic attention, magnetism including Paramagnetism, ferro-magnetism, anti-ferromagnetism and magnons, superconductivity including the electron-electron interaction, BCS theory and Ginsburg Landau theory

2. Physics Of Material And Alloys: Drude theory of metals, the Summerfield theory of metals, failure of free electron model, electron level in periodic potential, electrons in a weak periodic potential, the Tight binding method, other methods for calculation of band structure of metals, classical and semi classical theory of calculation in metals, Fermi surface and its measurements, band

structure of some selected metals, electronic structure of alloys, solid solutions, Home Rotherry rules, order and disorder phenomena and its physical basis

BOOKS:

1. Neil W Asheroft and David M, **Solid State Physics**, Saunders College Publishing
2. James Zyman, **Principles of the Theory of Solids**, Cambridge University Press
3. R E. Peierls, **The Quantum Theory of Solids**, Oxford Press
4. J M Ziman, **Principles of the Theory of Solids**, Cambridge University Press
5. P T Landsburg, **Solid State Theory,** John Wiley and Sons,
6. C Kittle, **Quantum Theory of Solids**, John Wiley and Sons,
7. M Jones and N H March, **Theoretical Solid States Physics**, Wiley Inter Science

OPTIONAL COURSES

SEMICONDUCTOR PHYSICS: (03) **Phy-712**

Wave function and energy of an electron in solids, infinite square well, periodic square well, quantum states and Pouli principle, impact of impurities on semiconductor conductivities, thermal generation and recombination, intrinsic material, density of state functions, calculation of n from f (E)Si(E), calculation of P_o from f (E)Si(E), charge neutrality equations, Fermi level calculations, the insulator and the intrinsic semiconductors, impurity of extrinsic semiconductors, impurity energy levels in extrinsic conductors, and extrinsic conductor with a large donor concentration, a donor semiconductor, impurity of extrinsic semiconductor, a donor semiconductor with a very low temperature, drift phenomena in a semiconductor, dependence of mobility on temperature and the nature of collisions, filed dependence of mobility, drift current density, temperature dependence conductivity, a relation between the electron and hole current densities

BOOKS:

1. H E Telly and D G Daugherty, **Physical Principles of Semiconductor Devices**, Lowa State University Press,
2. K G Niclos and E V Vernon, **Transistor of Physics**, Chapman and Hall Limited,
3. S M Sze, **Physics of Semiconductor Devices**, John Wiley and Sons

COMPUTATIONAL PHYSICS: (03) **Phy-713**

1. Boundary Value and Eigen value Problems: The Neurove algorithm, direct integration of boundary value problems, Green's function, solution of boundary value problems, eigen value of the wave equation, stationary solution of one dimension Schroedinger equation

2. Special Functions and Gaussian Quadrature: Special function, Gaussian quadrature, Born and Eikonal approximation to quantum scattering

3. Matrix Algebra and Simultaneous Equations: Elementary operations of matrices, matrix inversion, Gauss Jordan elimination method, Gauss Seidel iterative method, eigen values of a tridiagonal matrix, reduction to tridiagonal form, determining nuclear charge densities

4. Elliptical Partial Differential: Equation, discritization and the variational principles, iterative methods for boundary value problems, elliptical equation in two dimensions

5. Parabolic Partial Differential Equation: Naive discritization and instabilities, implicit schemes and inversion of tridiagonal matrices, diffusion and boundary value problems in two dimensions, and iterative methods for eigen value problems, time dependent Schroedinger equation

6. Monte Carlo Method: The basic Monte Carlo strategy, generating random variable with a specific distribution, the algorithm of metropolis et al, the using model in two dimensions

BOOKS:

1. I.C.F. Gerald & P.O. Wheatley '**Applied Numerical Analysis'** 7/e Pearson Education 2004
2. S.C. Chapra and R.P. Canale '**Numerical Methods for Engineers with Software and Programming Applications**' McGraw-Hill (2002)

3. J.H. Mathews '**Numerical Methods for Mathematics, Science and Engineering'** 2/e Prentice Hall (1992)
4. B.S. Grewal '**Numerical Methods in Engineering and Science'** 7/e Khanna Publishers, Delhi (2005)
5. J. Mehdi, **Statistical Methods**, New Age International Publications, 2006
6. G Shankar Rao, **Numerical Analysis,** New Age International Publications, 2010

ADVANCED QUANTUM MECHANICS: (03) Phy-714

Scattering Theory: Scattering amplitude and cross section, Lipman Schwinger equation, Born approximation, optical theorem partial wave decomposition, phase shifts, analytical properties of the scattering matrix, inelastic scattering and reactions

WKB Approximation: Connection formula, Bohr Summerfield quantization, application to scattering, motion in External Electromagnetic Field: Gauge invariance, uniform magnetic field, Landau levels, Aharonov Bolm effect, electric field

Time Dependent Problems: Time dependent perturbation theory, sudden and adiabatic approximation, golden rules, Berry phase, level crossing, Born Openheimer approximation

Many Body Systems: Identical Particles, second quantization of bosons and fermions, field operators, Fermi gas, Hertee Fock and Thomas Fermi methods, and particle whole formalization

Quantization of the Electromagnetic Field and its Interaction with Matter: Field in quantum mechanics, the elastic string, Hamiltonian quantization of the electromagnetic field, emission and absorption of radiation, multi pole expansion, select rule

Quantum Information: Quantum bits, Bell states, quantum gates, entanglement and teleportation, quantum computation and cryptography

BOOKS:

1. S Gastorowics, **Quantum Physics**, John Wiley and Sons, 2003
2. B H Bransden and C J Joachain, **Quantum Mechanics**, 2000
3. P W Aitkans and R S Freidman, **Molecular Quantum Mechanics**, 1997
4. G L Squires, **Problems in Quantum Mechanics**, 1995

MEDICAL PHYSICS (03) Phy-715

1. Interactions of Radiation with matter: Introduction, beta rays, range energy relationship, mechanism of energy loss, ionization and excitation, Bremstrahlung, alpha rays, range energy relationship, energy transfer, gamma rays, exponential absorption, interaction mechanism, pair production, Compton scattering, photoelectric absorption, photodisintegration, combined effect, neutron production classification, interaction, scattering, absorption

2. Radiotherapy: Introduction, the developments of radiotherapy, radio therapeutic aims, external beam theory, Brachytherapy, unsealed source therapy, requirements for accuracy and precision, quality assurance, the role medical physics

3. Medical Imaging: Diagnostic X rays, production of X rays, absorption of X rays to other planes, partial volume effect, artifacts, contrast agents in conventional radiography and CT, diagnostic ultrasound, Doppler effect, radio nuclide imaging, positron emission tomography (PET), magnetic resonance imaging (MRI), contrast agents for MRI

BOOKS:

1. Harman C, **Introduction to Health Physics**, McGraw Hill, N Y, 1996
2. D I William, **Radiotherapy physics**, Oxford University Press, N York
3. Peter Armstrong, **Diagnostic Imaging,** Black well Science limited, Oxford
4. J R Greening, **Fundamentals of Radiation Dormitory**, Adam Hilger Ltd, Oxford, 2001
5. G A Edmin and Heinemann, **Physics of Medical Imaging**, McGraw Hill, 2002

METHODS AND TECHNIQUES OF EXPERIMENTAL PHYSCIS: (03) Phy-716

Numerical methods, solution of equations by the method of iteration (Newton Raphson & others methods), solution of differential equation of higher order, Gaussian quadrature, random numbers, Monte Carlo method, resume of theory of errors and experimental statistics, least square fit to a

polynomials, non linear functions, data manipulations, smoothing, interpolation and extrapolation, linear and parabolic interpolation, high vacuum techniques, physical principles of diffusion and rotary pumps, ultrahigh vacuum by ionization, measurements of pressure, leak detection, X- rays electron and neuron diffraction techniques, methods of recording diffraction patterns, examples of structure determination, analysis of results

BOOKS:

1. R L Horovitz and V A Johnson, **Methods of Experimental Physics**, Academic Press
2. D William. **Methods of Experimental Physics**, Academic Press
3. J Yarwood, **High Vacuum Techniques**, Chapman Hall

SURFACE PHYSICS: (03) **Phy-717**

1. An Introduction to Surfaces: what is a surface? The energetic and thermodynamics of creating a surface, introduction to surface physics, surface energies and Wulff Theorem

2. Studying Surfaces: what is UHV? Do we need UHV to study surfaces? Kinetic theory of gases, concept of vacuum and standard vacuum hardware components, comparison of different types of pumps with measurement of vacuum pressure, preparing a clean surface

3. Surface Structures and Reconstructions: Lattice concept, 3D crystal structures, 2D surface structures, specific types of sface fcc, hcp, bcc and stepped surface and a discussion of their relative energies, More complex deconstruction, stability, growth mechanisms, adsorption, de-absorption and experimental probes of surface structures such a LEED and RHEED, the structure of semiconductor surfaces, the surface structures of very small metal particles

4. Adsorption, Desorption Bonding, Catalysis and Growth Processes: Adsorption mechanism and kinetics chemisorptions vs physiorption, the kinetics of adsorption, potential energy curves and adsorption energetic, Adsorption mechanisms and kinetics for low coverage Longmuir Isotherms, derivation, adsorbents phase diagrams and phase transitions

5. The Structure of Adsorbate Layers: Experimental probes of surface structure such as LEED and RHEED Growth processes, vibrational spectroscopy, catalysis, Desorption

The Electronics and magnetic Structure of Surfaces: Band theory, free electron theories and the work function, the electronic structure of semiconductor surfaces, electron emission processes, magnetic processes at surfaces

6. Electron-Surface Interactions: Electron diffraction and quasi-elastic scattering, comparison of particle scattering techniques, electron spectroscopes, discussion of the merits of different types of electron energy analyzers and electron detector, signal processing and spectral analysis, theory and practice3 of Auger electron spectroscopy, quantification of Auger spectra, Auger depth, profiling

7. Atomtion Surface Interactions: Comparison of particle scattering techniques, an introduction to the theory and practice of SIMS, SIMS imaging and depth profiling, Auger depth profiling, theory and practice of Rutherford, back scattering

8. Surface Microcopy: Classification of microscopy techniques, basic concepts in surface imaging and localized spectroscopy, images XPS, optical microscopy, STEM, SEM, SPM, An introduction to the theory and practice of scanning tunneling microscopy, scanning probe microscopy techniques, atomic force microscopy

BOOKS:

1. D.P. Woodruff and T.A. Delchar "**Modern Techniques of Surface Science",** Second Edition,Cambridge Univ. Press, (1994).
2. A. Zangwill "**Physics at Surfaces**," Cambridge Univ. Press, (1988).
3. M. Prutton, **Introduction to Surface Physics**, Oxford University Press (1994).
4. T. A. Delchar, **Vacuum Physics and Techniques**, Chapman and Hall (1993).
5. G. Ertl and J. Küppers,. **Low Energy Electrons and Surface Chemistry**, Weinheim, Germany (1985).
6. M. A. Van Hove, W.H. Weinberg, C.-M. Chan, **Low-Energy Electron Diffraction : Experiment, Theory, and Surface Structure Determination**, Springer-Verlag, Berlin, (1986).

7. G. A. Somorjai, **Introduction to Surface Chemistry and Catalysis**, Wiley, New York (1994).

OPTICAL FIBER COMMUNICATION: (03) **Phy-718**

1. General Discussion: Historical perspective, measurement of information and capacity of a telecommunication channel, communication system architecture, basic optical communication system

2. Optical Fiber: Step index and graded index fiber, numerical aperture and multipart dispersion, dispersion in multimode and monomode fiber, attenuation, mechanism in optical fiber

3. Light Source and detectors: Selecting the wavelength region, light emitting diodes and laser diode for optical communications, modulation of light sources, photodiode detectors, power launching and coupling efficiency

4. System Components and Aspects of System Design: Optical fiber cables, splices and connectors, optical isolators, multiplexing, repeater distance and link budget

5. Coherent Optical Fiber Systems: Basic principles of coherent optical systems, signal to noise ratio, methods of modulation, homodyne receiver, heterodyne receiver, phase diversity receiver

6. Optical Fiber Communication Systems: Digital telecommunication systems, data communication networks, network topology, analog systems

BOOKS:

1. Joh Gover, **Optical Communication System**, Prentice Hall, 1996
2. W V Elten and J V der Plantts, **Fundamentals of Optical Fiber Communication**, Prentice Hall, 1991
3. D Baily and E Wright, **Fiber Optics**, Elsevier, 2003
4. W S Chang, **Principles of Laser and Optics,** Cambridge University Press, 2007
5. S C Gulta, **Optical Fiber Communication and its Application**, Prentice Hall, 2003

CELLULAR MOBILE SYSTEM (03) **Phy-719**

1. **Introduction to Cellular Mobile Radio Background and History:** Conventional Mobile Radio Versus Cellular Mobile Radio, Features of Cellular Radio, Digital Cellular Radio, Trends in the Use of Cellular Services

2. **The Mobile Radio Environment:** Lowpass Equivalent Representation: Band pass Signals and Linear Bandpass Systems, Multipath Propagation: Path Loss, Doppler Effect, Rayleigh Fading and Rician Fading, Statistics of Slow and Fast Fading, Classification of Channels: Time Dispersion and Frequency-Selective, Fading, Frequency Dispersion and Time-Selective Fading , Mathematical Modeling of Fading Multipath Channels: Bello Functions, Description of Random Time-Variant Channels, Discrete-Time Representation of Channels, Computational Channel Models: Gaussian, Rayleigh, Rician and Wideband Channel, Diversity Schemes: Space, Frequency, Polarization, Field Component, Angle, Time and Multipath Diversity, Combining Techniques: Selective, Switched, Maximal-Ratio, Equal-Gain and Baseband Combining

3. Co-channel and Adjacent Channel Interference: Noise-Limited Interference-Limited Environments, Cochannel Interference, Adjacent Channel Interference, Near-End-To-Far-End Ratio, Cellular Traffic **(**Channel Assignment, Capacity of Cellular Systems, Trunking Theory, Components of Cellular Systems,Handover)

4. Analog FDMA Systems and the Analog Cellular Environment: Analog Modulation: Frequency Modulation, Transmission bandwidth, Signal-to-Noise Ratio, Capture Effect, Effect of Multipath Fading, Modulators and Demodulators for FM, Fading Channel Issues in Analog Systems, AMPS: Network Aspects, Control Channels, Supervision, Call Origination and Receipt, Handover, Call Termination, Power Control, The NMT-900 System: Control Channels, Call Origination and Receipt, Handover and Location Updating, Security, NMT Mobile Station

5. **Digital TDMA Systems and Digital Modulation:** The Digital Cellular Environment, Intersymbol Interference and Nyquist Filter, Nonlinear Distortion: AM/AM and AM/PM conversion, Fading Channel Issues in Digital Systems, Linear Modulation Nonlinear Modulation Methods: Continuous Phase Modulation, Digital Phase Modulation and Digital Frequency Modulation, Actual Modulations Used in Mobile Communications: Gaussian Minimum Shift, Keying and p/4-Shifted Differential Quadrature Phase Shift Keying, Receiver Structures: Coherent, Differential, and Noncoherent

Detection, Detection in Presence of Frequency-Flat or Frequency-Selective Fading, Bit Error Rates: Gaussian Noise and Rayleigh Fading Environment , Channel Equalization: Zero-Forcing Equalizer, Discrete-Time Wiener Filter, Adaptive Linear Equalizer, Decision-Feedback Equalizer Carrier, Symbol and Frame Synchronization, Capacity Analysis of Multiple Access Methods, 3rd Generation CDMA Systems, 4th Generation Mobile Systems

BOOKS:

1. T. S. Rappaport, **Wireless Communications: Principles and Practice**, Prentice Hall, 1996
2. William C.Y. Lee, "**Wireless and Cellular Telecommunications"**, Third Edition, 2005.
3. Krzysztof Wesolowski, **" Mobile Communication Systems**", John Wiley & Sons, Ltd, 2002

RENEWABLE ENERGY SOURCES: (03) **Phy-720**

1. Renewable Scenarios: Defining renewable, promising renewable energy sources, their potential, availability, present status, existing technologies and availability. Sun-Earth relationship, geometry, sun path and solar irradiance, solar spectrum, solar constant, atmospheric effects, global distribution, daily and seasonal variations, effects of till angle, resource estimation, experimental, global, direct, diffused radiation, sun shine hours, air mass, hourly, monthly and annual mean, radiation of tilt surface, measuring instruments.

2. Photovoltaic: PV effect, materials, solar cell working, efficiencies, different types of solar cells, characteristics, (dark, under illumination), efficiency limiting factors, power, spectral response, fill factor, temperature effect; PV systems, components, packing fraction, models, arrays, controllers, inverters, storage, PV system sizing, designing, performance and applications

3. Principles of Photovoltaic: History of solar cell, photovoltaic effect, photovoltaic cells, modules and systems for power generations, characteristics of photovoltaic cells, types of solar converters, basic concept in bonds and bands in crystals, extreme holes & conductivity, electron status in semiconductors (band structure, valence band etc), impurities and doping, photo generation rate, recombination, metal semiconductor junction semiconductor- semiconductor junction

4. Mono-crystalline Solar Cells: Introduction, properties of cell design, material and design issues, silicon material properties and solar cell design, GaAs solar design

5. Sources of renewable Energy: Wind, hydropower, Biogas, Geothermal, Nuclear

BOOKS:

1. Nelson Jimmy, **Physics of Solar Cells**, Imperial College Press, 2003
2. Rolf Brenold, **Thin film Crystalline Silicon solar cells**: Physics and Technology, Publisher, Willey 2003
3. Manfred Grathwhol '**World Energy Supply: Resources, Technologies and Prospective'** Walter deGruyter Berlin (1982)
4. J.W. Twidell and A.D. Weir **'Renewable Energy Resources'** E & F.N. Spon Ltd, London. (1986
5. M Iqbal **'An introduction to Solar Radiation'** Academic Press, Canada. (1983)

DIGITAL AND ANALOG CIRCUIT DESIGN (03) **Phy-721**

1. **Introduction:** Semiconductor Devices, Transistor Amplifiers

2. **Design of Transistor Circuits:** Transistor Biasing, High frequency response of the Amplifiers, Switches and Amplifiers, Discrete Flip-Flops and the Schmitt Trigger

3. **Digital-Integrated Circuit Building Blocks:** Basic Structure of TTL, CMOS and ECL Circuits, Gates, Flip-Flops, and Schmitt Triggers, Combinational Logic Circuits, Sequential Logic Circuits, Digital Memory Circuits (ROM, PROM, EPROM, RAM), Programmable Logic Arrays and Related Circuits

4. **Amplifier Circuits and Systems:** Frequency Response of Amplifiers, the Use of Feedback in Amplification, Operational Amplifiers, Control Using Operational Amplifiers

5. **Additional Electronic Building Blocks:** Stabilized Power Supplies, Filters, Oscillators, Timers, Comparators, Sample-Hold Circuits, D/A and A/D Converters

6. **Analog and Digital Measurements:** Transducers, Feedback Control Circuits, Analog Instruments, Digital Instruments

BOOK:

1. D.L. Schilling, C. Belove: **Electronic Circuits – Discrete and Integrated**, McGraw-Hill, 1989.
2. R. Jaeger and T. Blalock, **Microelectronic Circuit Design** , (3rd Edition) 2007
3. J. Allison: **Electronic Engineering Semiconductors and Devices**, McGraw-Hill, 1990.
4. R. Boylestad, L. Nashelsky: **Electronic Devices and Circuit Theory**, 9th Edition, Prentice-Hall, 2005.

DIGITAL INTEGRATED CIRCUIT DESIGN (03**)** **Phy-722**

1. Introduction: Design of static CMOS, nMOS and BiCMOS inverters, Calculation of noise margins, power dissipation and gate delays

2. Review of Logic Design Fundamentals: Combinational Logic Design, Logic Simplification and Synthesis, Sequential Logic Design, Finite State Machine Design and Implementation

3. Design of Combinational Circuits: Static CMOS Design, Dynamic CMOS Design, Power Consumption in CMOS Gates

4. Design of Sequential Circuits : Static Sequential Circuits, Dynamic Sequential Circuits

5. Design of Memory : Memory Core, Memory Peripheral Circuits, Memory Faults and Test Patterns

6. Rapid Prototyping and Implementation of Digital Systems: Field Programmable Gate Arrays (FPGA), Complex Programmable Logic Devices (CPLD), Logic Synthesis for FPGA and CPLD

BOOKS

1. J. M. Rabaey, **Digital Integrated Circuits - A Design Perspective**, 2nd Ed., Prentice-Hall, 2002
2. N. Weste and K. Eshraghian, **Principles of CMOS VLSI Design - A Systems Perspective**, Prentice-Hall, 1993

PLASMA PHYSICS-I (03) **Phy-723**

1. Relation between fluid equations and guiding center drifts, diamagnetic drift in uniform and non-uniform magnetic fields, polarization current in the fluid model and parallel pressure balance.
2. Single fluid magnetohydrodynamic equations, quasi-neutrality approximation, small Larmor radius approximation, approximation of infinite conductivity of plasma, conservation of magnetic flux and energy, MHD equilibrium, magnetic pressure: the concept of plasma beta, the cylindrical pinch: the cylindrical tokamak.
3. Diffusion in fully and partially ionized plasmas, diffusion as a random walk, the diffusion equation, steady state solutions, diffusion across a magnetic field, diffusion in fully ionized plasma, Bohm diffusion and solution of diffusion equation.
4. Classification of instabilities, two-streaming instability, the Rayleigh-Taylor and flute instabilities, the gravitational R-T instability, physical mechanisms of R-T instability, Flute instability due to field curvature, MHD stability of the tokamak.
5. Kinetic theory of plasmas, the need for a kinetic theory, the particle distribution function, the Boltzmann-Vlasov equation, the Vlasov-Maxwell equations, kinetic effects on plasma waves: Vlasov's treatment, the linearized Valsov equation for electrostatic perturbations, time asymptotic solutions, simplified derivation for electrostatic waves for Maxwellian and nonMaxwellian plasmas: Langmuir waves, ion-sound waves and Landau damping.

BOOKS:

1. R. J. Goldston and P. H. Rutherford, *"***Introduction to Plasma Physics***"*, publisher: IoP, Bristol and Philadelphia; 1st edition, (1995).
2. N. A. Krall and A. W. Trivelpiece, **" Principles of Plasma Physics"** McGraw-Hill Book Company, New York; 1st edition, (1973).