DEPARTMENT OF PHYSICS
UNIVERSITY OF PESHAWAR
M.PHIL Courses

Updated on 01/07/18

PROPOSED COURSES AS REQUIRED UNDER THE REVISED STATUS AND REGULATIONS RELATING TO M.PHIL DEGREE IN PHYSICS (AC 28-07-2017 and Syndicate 15-08-2018) No. 21/Acad-II dated 21-02-2019

COURSE CODE	TITLE	CREDIT HOURS
	Compulsory Courses for MPhil	
PHY-711	ELECTROMAGNETIC THEORY I	3
PHY-712	MATHEMATICAL METHODS	3
PHY-713	ADVANCED QUANTUM MECHANICS I	3
	Major/Related Courses for MPhil	
PHY-714	CLASSICAL MECHANICS	3
PHY-715	COMPUTATIONAL PHYSICS I	3
PHY-716	ADVANCED SOLID STATE PHYSICS I	3
PHY-717	ATOMIC AND MOLECULAR PHYSICS	3
PHY-718	THE THEORY OF ATOMIC COLLISIONS	3
PHY-719	THE EXPERIMENTAL TECHNIQUES IN ATOMIC COLLISIONS	3
PHY-720	PARTICLE PHYSICS	3
PHY-721	DIGITAL IMAGE PROCESSING I	3
PHY-722	SIGNAL PROCESSING	3
PHY-723	SUPERCONDUCTIVITY	3
PHY-724	LOW TEMPERATURE PHYSICS	3
PHY-725	DIELECTRIC AND OPTICAL PROPERTIES	3
PHY-726	REACTOR PHYSICS	3
PHY-727	ADVANCED C++	3
PHY-728	QUANTUM ELECTRODYNAMICS	3
PHY-729	MEDICAL PHYSICS INSTRUMENTATION	3
PHY-730	PHYSICS OF THIN FILMS	3
PHY-731	SEMICONDUCTOR DEVICES	3
PHY-732	ELECTRON MICROSCOPY I	3
PHY-733	PLASMA PHYSICS I	3
PHY-734	FUNCTIONAL MATERIALS	3
PHY-735	MATERIAL SCIENCE I	3
PHY-736	QUANTUM FIELD THEORY I	3
PHY-737	TRANSMISSION TECHQUES I	3
PHY-738	GROUP THEORY	3
PHY-739	ATOMIC AND MOLECULAR SPECTROSCOPY	3
PHY-740	LASER PHYSICS I	3
PHY-741	ENVIRONMENTAL AEROSOL PHYSICS	3
PHY-742	SURFACE FORCE AND INTERMOLECULAR INTERACTIONS I	3
PHY-743	ORGANIC ELECTRONICS DEVICES	3
PHY-744	MATERIALS PROCESSING	3
PHY-745	CLOUD PHYSICS-**I**	3
PHY-746	INTRODUCTION TO NANOPHYSICS	3
PHY-747	PHYSICS OF MICROFLUIDICS AND SELF-ASSEMBLY	3

Note: Any two of the three compulsory courses are must for every MPhil Student.

MPHIL COURSE CONTENTS

PHY-711 ELECTROMAGNETIC THEORY-I

Coulomb's Law and Electric Field; Gauss's Law; Another Equation of Electrostatics and the Scalar Potential; Surface Distribution of Charges and Discontinuities in the Electric Field (Excluding the part on the Dipole Layer); Poisson and Laplace Equations; Green's Theorem; Uniqueness of the Solution with Dirichlet or Neumann Boundary Conditions; Formal Solution of Electrostatic Boundary-Value Problem with Green Function; Electrostatic Potential Energy and Energy Density

Method of Images; Point Charge in the Presence of a Grounded Conducting Sphere; Point Charge in the Presence of a Charged, Insulated, Conducting Sphere; Point Charge Near a Conducting Sphere at Fixed Potential; Green Function for the Sphere, General Solution for the Potential; Orthogonal Functions and Expansions; Separation of Variables, Laplace Equation in Rectangular Coordinates

Laplace Equation in Spherical Coordinates; Legendre Equation and Legendre Polynomials (Rodrigue's formula, Recurrence relations, Orthogonality - no derivations); Boundary-Value Problem with Azimuthal Symmetry; Associated Legendre Functions and the Spherical Harmonics; Addition Theorem for Spherical Harmonics (no derivation); Expansion of Green Functions in Spherical Coordinates

Multipole Expansion; Multipole Expansion of the Energy of a Charge Distribution in an External Field; Elementary Treatment of Electrostatics with Ponderable Media; Boundary-Value Problems with Dielectrics; Electrostatic Energy in Dielectric Media

Introduction and Definitions; Biot and Savart Law; Differential Equations of Magnetostatics and Ampere's Law; Vector Potential; Magnetic Fields of a Localized Current Distribution, Magnetic Moment; Force and Torque on and Energy of a Localized Current Distribution in an External Magnetic Induction; Macroscopic Equations, Boundary Conditions of B and H; Faraday's Law of Induction; Energy in the Magnetic Field

Maxwell's Displacement Current; Maxwell Equations; Vector and Scalar Potentials; Gauge Transformations, Lorentz Gauge, Coulomb Gauge; Green Functions for the Wave Equation; Retarded Solutions for the Fields: Jefimenko's Generalizations of the Coulomb and Biot-Savart Laws; Poynting's Theorem and Conservation of Energy and Momentum for a System of Charged Particles and Electromagnetic Fields; Transformation Properties of Electromagnetic Fields and Sources under Rotations, Spatial Reflections, and Time Reversal

Recommended Books

1. Jackson J. D, “Classical electrodynamics”. 3rd ed., John Willey & Sons, New York, 1998.
2. David K. Cheng, “Fields and Waves Electromagnetic”. 2nd ed., Addison Wesley, 1989.
3. Mathew N. O. Sadiku, “Elements of Electrodynamics”. 5th ed., Oxford University Press, USA, 2009.
4. Zahn, M, “Electromagnetic Field Theory”. 1st ed., Willey New York, 1979.
5. Sander, K. F. and Reed, “Transmission and Propagation of Electromagnetic Waves”. Cambridge University Press England, 1986.
6. Kong J. A. “Electromagnetic Wave Theory”.1st ed., John Wiley & Sons, New York 1986.

PHY-712 MATHEMATICAL METHODS

Vector analysis, Scalar Vectors dot and cross product gradient, Divergence curl vector integration, Gauss’s Theorem, Stokes’s Theorem, Potential theory, Gauss’s Law, Poisson Equation, Helmholtz’s Theorem, Coordinate systems, Rectangular Cartesian special Coordinate systems, Circular cylindrical coordinates, Spherical polar coordinates, Tensor analysis, Determinants, Matrices and group theory, Infinite series, Function of a compels variables, Cauchy Riemann Conditions, Cauchy’s integral theorem and formula, Function of a compels variable II, Calculus of residues, Differential equations, Sturm-Lowville theory, Orthogonal functions, The Gamma function (Factorial function), Beta function, The incomplete gamma function and related functions, Bessel functions, Hankel function, Asymptotic expressions, Spherical Bessel functions, Legendary function, Spherical harmonics, Angular momentum, Ladder operator, Legendre function of second kind, Special functions, Hermit function, Laguerre function, Fourier series, Applications of Fourier series, Gibb’s phenomenon, Discrete orthogonality and discrete Fourier transform, Convolution.

Laplace theorem, Laplace transformation of derivatives, Integral equations, Green's Function in One, two and three dimensions, Calculus of variations, Application of Euler equation, Lagrange multipliers, Rayleigh-Rits variation techniques.

Recommended Books

1. George B. Arfken, & Hans J. Webber, "Mathematical Methods for Physicists" 5th ed., Academic Press, London (1985).
2. Erwin Kreyszic., "Advanced Engineering Mathematics". 6th ed., John-Willey & sons 1993.
3. James T. Cushing., "Applied Analytical Mathematics for Physical Scientists", John Willey 1978
4. Courant R. and Hilbert D., "Methods for Mathematical Physics", Vol I & II, New York Wiley Inter Science, 1989
5. Epstein B., "Partial Differential Equations: An Introduction", Malabar McGraw Hill 1983
6. Thomas G. B., and Finney R. L., "Calculus and Analytical Geometry", Addison Wesley 1992

PHY-713 ADVANCED QUANTUM MECHANICS-I

Objectives: This course will introduce students with the broad field of quantum physics at advanced level.

Pre-requisites: The students are assumed to have quantum mechanics at BS/MSc level and all well-versed about the failure of classical physics, wave-particle duality, uncertainty principle, The Schrodinger equations,

Course contents: Brief overview of wave mechanics, Schrodinger equation, quantum mechanics in one dimension, unbound particles such as potential step, barriers and tunnelling, bound states such as rectangular well, ,Operator methods such as uncertainty principle, time evolution operator. Ehrenfest's theorem, Heisenberg representation, quantum harmonic oscillator, coherent states, Quantum mechanics in more than one dimension, Rigid rotor, angular momentum, raising and lowering operators, Charged particle in an electromagnetic field, normal Zeeman effect, gauge invariance and the Aharonov-Bohm effect, Landau levels. Spin, Stern-Gerlach experiment, spinors, spin operators and Pauli matrices, spin precession in a magnetic field, parametric resonance, addition of angular momenta. Time-independent perturbation theory,,first and second order , perturbation, degenerate perturbation theory, Stark effect, nearly free electron model, ,,,Identical particles,, Particle indistinguishability and quantum statistics, space and spin wave functions. Atomic structure,, Relativistic corrections– spin-orbit coupling, Darwin structure, Lamb shift, hyperfine structure. Multi-electron atoms, Helium, Hartree approximation and beyond, Hund's rule.

Reference Books

1. Cohen-Tannoudji, C., Diu, B. and Laloe, F., Quantum Mechanics Vol. 1, John Wiley & Sons, 1977.
2. Merzbacher, E., Quantum Mechanics, John Wiley & Sons, 1968
3. B. H. Bransden and C. J. Joachain, Quantum Mechanics, (2nd edition, Pearson, 2000).
4. S. Gasiorowicz, Quantum Physics, (2nd edn. Wiley 1996, 3rd edition, Wiley, 2003).

PHY-714 CLASSICAL MECHANICS

Survey of elementary principles, Mechanics of a particle and a system of particles, Constraints, D'Alembert principle and Lagrange's equation, Variational principle and Lagrange's equation, Hamilton's principle, Derivation of Lagrange's equation from Hamilton's principle, The two body central force problem, Center of mass and relative coordinates, The center of mass frame, Elastic collision, CM and Lab cross sections, The Kepler's problem, The Laplace-Runge-Lenze vector, The kinematics of rigid body motion, The Euler angles, The Cayley-Klein parameters and related quantities, The rigid body equation of motion, Small oscillations, Special relativity in classical mechanics, Lorentz transformations in real four dimensional space, The Hamilton equation of motion, Cyclic coordinates and conservation theorem, Canonical transformations, Hamilton-Jacobi

theory, Canonical perturbation theory, The Lagrangian and Hamiltonian formulation for continuous systems and fields, Proof of Bertrand's theorem, Noether's theorem, Euler angles in alternate convention.

Recommended Books

1. Herbert Goldstein, "Classical Mechanics". 2nd ed., Addison-Wesley USA, 1989
2. Vernon D Barger, "Classical Mechanics" McGraw Hill, New York, 1973
3. Kibble T. W., "Classical Mechanics" Longman, New York, 1985
4. James H Bartlett, "Classical and Modern Mechanics", Alabama Press, 1985
5. Fetter A.L., "Theoretical Mechanics of Particles and Continua", McGraw Hill, New York, 1989
6. Chow T. L., "Classical Mechanics", John Wiley and Sons, New York, 1995
7. Arya A. P., "Introduction to Classical Mechanics", Allyn and Bacon, USA 1990
8. Bhatia V. B "Classical Mechanics", Narosa Publishing House, 1997

PHY-715 COMPUTATIONAL PHYSICS-I

Finite differences, Interpolation formulae, Difference quotients, Finite difference in two dimensions, Sample applications, Linear algebra, Exact methods, Iterative methods, Eigen values and Eigen vectors, Sample applications, Stochastic, Equidistributed random variates, Other distributions, Random sequences, Ordinary differential equations, Initial value problems of first order, Initial value problems of second order, Boundary value problems, Partial differential equations, Initial value problems (hyperbolic), Initial value problems (parabolic), Elliptic differential equations, Discrete Fourier transform, Fast Fourier transform, Hough transform.

Recommended Books

1. Walter S Brainerd., "Theory of Computation", McGraw Hill 1998
2. Thomas J Myers., "Equations, Models and Programs: A Mathematical Introduction to Computer Science", McGraw Hill 1999
3. Mik Wisniewski., "Mathematical Programming Optimization Models", Addison Wesley 1999
4. Vessely F. J., "Computational Physics: An Introduction", Plenum Press, New York 1994
5. Koonin, S. E., "Computational Physics", Benjamin, New York 1985
6. Hoover W. G., "Computational Statistical Mechanics", Elsevier, Oxford, UK 1991
7. Boardman A. D., "Physics Programs", John Willey and Sons New York 1980

PHY-716 ADVANCED SOLID STATE PHYSICS-I

The Drude theory of metals, The Somerfield theory of metals, Failure of free electron model, Crystal lattices, The reciprocal lattice, Determination of crystal structure by X-ray diffraction, Classification of Bravais lattices and crystal structures, Electron levels in a periodic potential: general properties, Electron in a weak periodic potential, The tight binding approximation, Other methods for calculating band structure, the semi-classical theory of conduction in metals, Measuring the Fermi surface, Band structure of selected metals, Beyond the relaxation time approximation, Beyond the independent electron approximation.

Recommended Books

1. Kittle C., "Introduction to Solid state Physics". John Wiley and sons. New York 1989.
2. Blakemore J.S., "Solid state Physics". 2nd ed., Cambridge University press UK 1985.
3. Ashcroft N. W, and Mermin N. D., "Solid State Physics". 1st ed., Saunders College 1976
4. Levy, R. A., "Principles of Solid State Physics". Academic Press, London 1968
5. Mckalvey., "Solid State and Semiconductor Physics", McGraw Hill 1990

PHY-717 ATOMIC AND MOLECULAR PHYSICS

Historical development in atomic spectra, Classification of series in Hydrogen, Alkali metals and periodic table, The vector model of an atom, Multiplets in complex spectra, The Russell Saunders coupling scheme, Landes theory of multiplet separation and the Zeeman effect, General theory of multiple structure, Elementary theory of multiplets, Matrix components of the Hamiltonian for central field problem, Energy values for simple multiplets, Closed shells and average energies, The average energy of a configuration, Formulation of multiplet calculations in terms of average energy.
Rotation and vibration of diatomic molecules, The rigid rotator, The harmonic oscillator, The Raman spectrum of rigid rotator and harmonic oscillator, The anharmonic oscillator, The symmetric top, Thermal distribution of

quantum states, Symmetry properties of the rotational level, The electronic states and electronic transitions, Electronic energy and total energy, Vibrational structure of electronic transitions, Rotational structure of electronic bands.

Recommended Books

1. Slater J. C., "Quantum Theory of Atomic Structure", Vol. I, McGraw Hill, New York 1988
2. Herzberg C., "Spectra of Diatomic Molecules",2nd Ed., Van Nostrand Reinhold Co. London 1987
3. Rajam J. B., "Atomic Physics", S. Chand & Company 2000

PHY-718 THE THEORY OF ATOMIC COLLISIONS

Collisions, Populations, Energy Distribution, Theoretical Background-Classical and Quantum, The experimental methods employed in collision Physics, The Elastic Scattering of Electrons in Gases, Excitation of atoms and molecules by electrons, Ionization by electrons, Positive ion recombination, Electron attachment and detachment, Photon emission and absorption, Elastic collisions between atomic particles, Ionization and excitation by atomic particles, Charge transfer processes, Collisions of excited atoms and molecules, Ion-atom interchange.

Recommended Books

1. Hasted J. B., "Physics of Atomic Collisions", Butter worth London, 1984.
2. Massey H. S. W., "Atomic and Molecular Collisions", Taylor and Francis, London, 1979.
3. Mott N. F., and Massey, "Theory of Atomic Collisions", Oxford Press, 1989.

PHY-719 THE EXPERIMENTAL TECHNIQUES IN ATOMIC COLLISIONS

The experimental methods employed in collision physics, Sources of atomic and molecular beams, Sources of atomic hydrogen and similar beams, Sources of electrons, Sources of photons in visible and ultra violet, Sources of ions, Sources of excited atoms and molecules, Velocity selection of atomic and molecular beams, Velocity selection of electrons, Detection and wavelength measurement of photons, Velocity and mass selection of ions, Detection and counting of charged particles and fast neutrons, Detection of atomic and molecular beams, Detection of metastable atoms molecules, Some relevant vacuum problems, The use of quadropole fields, Experimental methods of charge transfer measurement, Ion-atom interchange, Mass spectrometer source experiments, Ion atom interchange experiments at thermal energies.

Recommended Books

1. Hasted J. B., "Physics of Atomic Collisions", Butter worth London, 1984.
2. Massey H. S. W., "Atomic and Molecular Collisions", Taylor and Francis, London, 1979.
3. Mott N. F., and Massey, "Theory of Atomic Collisions", Oxford Press, 1989.

PHY-720 PARTICLE PHYSICS

History and basic concepts, Classification of particles-Fermions and Bosons, Basic Fermions constituents, Quarks and Leptons, Hadron-Hedron interactions, Cross-sections and decay rates, Particle detectors and accelerators, Interaction of charged particles and radiations with matter, Accelerators, Detectors of single charged particle, Shower detectors and calorimeters, Examples of the applications of detection techniques to experiments, Invariance principle and conservation laws, Invariance in classical and quantum mechanics, Parity, Positronium decay, Time reversal invariance, Hadron-Hedron interactions, Isospin G-parity, Dalitz plots, Wave optical discussion of Hadrons scattering, The Regge-Pole model, Static quarks model of Hadrons, The vector mesons, Electromagnetic mass differences and Isospin symmetry, Heavy mesons spectroscopy and quarks model, Weak interactions, Classification of weak interactions, Nuclear β-decay-Fermi theory, Lepton-quark interaction, Parton model of Hadrons, Fundamental interactions and their unification, Renormalizability in quantum electrodynamics, Quantum electrodynamics predictions of electron an muon magnetic moments.

Recommended Books

1. Donald H. Perkins., "Introduction to High Energy Physics", Addison-Wesley, 1982.
2. Gasiorowicz S., "Elementary Particle Physics", John Wiley and Sons, New York, 1986.
3. Kallen G., "Elementary Particle Physics", Addison-Wesley, 1984.

PHY-721 DIGITAL IMAGE PROCESSING-I

Continuous image characterization, Mathematical characterization of continuous images, Psychophysical properties of vision, Photometry colorimetry, Digital Image characterization, Image sampling and reconstruction, Mathematical characterization of discrete images, Image humanization, Sample image quality measures, Discrete two dimensional linear processing, Linear operators, Superposition operators, Two dimensional unitary transforms, Two dimensional linear processing techniques.

Recommended Books

1. William K. P., "Digital Image Processing".3rd ed., John Wiley and Sons New York, 2001.
2. Ganzalez, R.C. and Wintz P., "Digital Image Processing". Addison-Wesley, Reading, Massachusetts, 1977.

PHY-722 SIGNAL PROCESSING

Characterization of signals, Characterization of linear time-invariant system, Sampling of signals in time and frequency, Algorithms for convolution and DFT, Multi rate digital signal, Applications of ulti rate signal processing, Linear prediction and optimum linear filters, Least squares method for system modeling and filter design, Adoptive filters, Recursive least squares algorithms for array signal processing, Power spectrum estimation, Signal analysis with higher order spectra.

Recommended Books

1. Proakis J. G., "Advanced Digital Signal Processing". Maxwell Macmillan International, 1999.
2. Oppeheim A. V., "Signals and Systems". Prentice Hall, USA, 1995.
3. Blahut R. E., "Fast Algorithms for Digital Signal Processing". Addison-Wesley, 1985.

PHY-723 SUPERCONDUCTIVITY

Phenomenon of superconductivity, The thermodynamic transition, The Meissner Ochsenfeld Effect, The critical field, The energy gap, Coulomb interactions between electrons, The Bose-Einstein gas model, The quasi-chemical equilibrium theory, The concept of electron pair as quasi molecules, Thermodynamic of chemical equilibrium, Treatment of ground state, The BCS and Bogoliubov theories at zero temperature, Thermodynamics in the quasi equilibrium theory, The Meissner effect, Persistent currents, Quantum theory of normal conductivity.

Recommended Books

1. Blatt J. M., "Theory of Superconductivity". Academic Press, New York, 1984.
2. Von L. M., "Theory of Superconductivity". Academic Press, New York, 1994.
3. Kohara "Superconductivity Electronics". Prentice Hall, 1987.
4. Grag K. B., and Bose S. M, "High Temperature Superconductivity Ten Years After its Discovery". Narosa Publishing, London, 1998.

PHY-724 LOW TEMPERATURE PHYSICS

Low temperature Physics: Experimental techniques, Obtain in low temperature experimental setup, Knowledge of insulation, Handling Liquid Nitrogen and liquid Helium gases, and lowering temperature by magnetic ordering, Specific cases of phase transformation studies.

Recommended Books

1. Timmerhaus K. D., "Low Temperature Physics LT 13, Quantum Crystals and magnetism". McGraw Hill, 1999.
2. Uhrig R. E., "Low Temperature Physics". John Wiley and Sons, New York, 1997.
3. Biryukov I. P., "Low Temperature Physics". John Wiley and Sons, New York, 1989.

PHY-725 DIELECTRIC AND OPTICAL PROPERTIES

Dielectrics, Polarization in dielectrics, dielectric losses, relaxation models, permittivity tensor, magnetic permeability, magnetic losses, ferrites, permeability tensor, and Faraday rotation.

Conduction, free charges, Ohm and Fick law, charges relaxation and currents diffusion, dielectric medium, dielectric dipoles, polarization, susceptibility and permittivity, Interfacial, ionic and electronic polarization.
Capacitive and inductive structures, capacity and inductance matrices, reciprocity theorem, Foster and Slater theorems.
Theory of transmission lines and wave guides, elements of the antenna theory, gain and impedance, capacitive and inductive antennas.
Multiple moments of a charge distribution and energy in an external field, relation of microscopic electrostatics to macroscopic fields, dielectric materials E & M waves, boundary conditions, polarization, reflection and refraction. Waves in general dielectric medium, phase and group velocities and the uncertainty relation. Dispersion, absorption and the Kromers-Kronig relation. Waves in a conduction medium. Wave guides: conducting and dielectric. Fiber optic modes. Novel dielectric materials, high temperature polymers and composites, Nano-dielectrics.

Recommended Books

1. Moulson A. J. and J.M. Herbert J. M., "Electro ceramics: Materials, Properties, and Applications". 2nd ed. John Wiley & Sons Ltd, England, 2003.
2. Jackson J. D., "Classical Electrodynamics". 3rd ed. John Wiley & Sons, 1998.
3. Griffiths D. J., "Introduction to Electrodynamics". 2nd ed. Prentice Hall, USA, 1989.
4. Jones D. S., "The Theory of Electromagnetism". Macmillian, New York, 1984.

PHY-726 REACTOR PHYSICS

Principles concepts in the Physics of nuclear systems, Radiations, Radioactive decay, Buildup and depletion of isotopes in nuclear systems, Neutron-Nucleus interactions and nuclear cross-sections, Transport or radiation using one-group and two-group diffusion theory, Concept of criticality and time dependant reactors, Neutron-Nucleus interactions and nuclear cross-section calculations, Neutron transport theory, Heterogeneous reactor calculations.

Recommended Books

1. Robert E., "Random Noise Techniques in Nuclear Reactor". McGraw Hill, New York, 1996.
2. Baranger M., "Advances in Nuclear Physics". 1st ed. McGraw Hill, 1999.
3. Grotz K., "Weak Interactions in Nuclear Particles and Astrophysics". John Willey and Sons, 1998.
4. Warren J. B., "Nuclear and particle Physics at Intermediate Energies". McGraw Hill, 1997.

PHY-727 ADVANCED C++

Introduction to computers and C++ programming, History of C and C++, Basics of a typical C++ environment, Introduction to C++ programming, Control structures, Functions, Arrays, Pointers and strings, Pointer variable declarations and initialization, Pointer operators, Classes and data abstractions, Classes, Const (Constant) objects and const member functions, Friend functions and friend classes, Static class members, Operator overloading, Inheritance, Virtual functions and polymorphism, C++ stream input/output, Templates, Exception handling, File processing, Data structures, Bits, Characters, Strings and structures, The pre-processor, C legacy code topics, Class string and string stream processing, Standard template library (STL), ANSI/ISO C-Standard language additions.

Recommended Books

1. Deitel H. M. and Deitel P. J., "C++ How to Program". Prentice Hall, New Jersey 1998.
2. Christian K., "Borland C++ Techniques and Utilities". B.P.B. Publications, 1994.
3. Smith N. E., "Illustrated Borland C++ Complete Command Reference with Tutorial". McGraw Hill, New York, 2000.
4. John M. and Hughes J. M., "Programming in Zortech C++ with Version 2". McGraw Hill, New York, 1999.
5. Riley C. A., "Programming Online Help Using C++, Wordware". Har/Dis ed.1993

PHY-728 QUANTUM ELECTRODYNAMICS

Classical field theory, Canonical quantization of Klein-Gordon, Dirac and Maxwell fields, Interacting fields, Perturbation theory and Feynman diagrams, Elementary processes of quantum electrodynamics, Radiative corrections, Divergences, Regulations and renormalization, Gauge field theories and functional integral formulation, Systematic of renormalization, Renormalization group, Non-Abelian gauge theories and their quantization, Quantum chromo dynamics, Anomalies, Gauge theories with spontaneous symmetry breaking.

Recommended Books

1. Balanis C.A., "Advance Engineering Electromagnetics". Wiley, New York 1989.
2. Jeackson, J. D., "Classical Electrodynamics". 3rd ed. John Wiley & Sons, 1998.
3. Griffiths D. J., "Introduction to Electrodynamics". 2nd ed. Prentice Hall, USA, 1989.
4. Jones D. S., "The Theory of Electromagnetism". Macmillian, New York, 1984.

PHY-729 MEDICAL PHYSICS INSTRUMENTATION

Radiation fields/sources; techniques in neutron and photon attenuation, Transport description of radiation penetration, Nuclear energy generation and heat removal, Thermodynamic cycles, Environmental effects, Quantification of exposure to ionizing radiation mathematics and physics of sources, Interactions, Spectrometry and dosimetery of ionizing radiations, Dispersion and environmental significance of radionuclides released into the environment including deposition, Environmental transport uptake and biological effects, Operational radiological safety and radiation measurements.

Recommended Books

1. Rubeshka I., "Medical Physics". McGraw Hill, 1999.
2. Ram K. S., "Nuclear Energy Generation". John Wiley & Sons, 1998.
3. Tomizawa, "Medical Physics". McGraw Hill, 1998.

PHY-730 PHYSICS OF THIN FILMS

Thin film; an introduction, Thermodynamics of thin film growth, nucleation and growth, *chemisorption and physisorption,* wetting angle, stability of the surface, growth modes; Frank-Van Der Merwe, *Volmer-Weber*, *Stranski–Krastanov*, Step formation and step motion. Growth modems; BCF and Mullins. Structure of thin film (internal and external), Thin film deposition techniques (PVD, CVD). Criteria for selection of deposition techniques, Thin film characterization, Post-deposition treatment, Application of thin films, Properties of thin film (thermal, optical, electrical, magnetic, mechanical etc)

Recommended Books

1. Seshan K., "Hand Book of thin film deposition processes and techniques". Novyes Publication, USA 2002.
2. Online materials, research papers
3. Heavens O. S., "Thin Film Physics". Methuen and Co. Ltd, 1989.
4. Holland L., "Vacuum Deposition of Thin Films". Chapman and Hall, 1986.
5. Beams J.W., "Structure and Properties of Thin Films". Wiley, New York, 1989

PHY-731 SEMICONDUCTOR DEVICES

Semiconductor Principles, Survey of semiconductor chemistry, Semiconductor crystal growing, Control of composition in semiconductors, Defect interactions in semiconductors, Diffusion process Germanium and Silicon, The chemistry of some compound semiconductors, Group IV semiconductors, Properties of some covalent semiconductors, Infrared absorption of semiconductors, Recombination and trapping, Effect of imperfections.

Recommended Books

1. Hannay N. B., "Semiconductors". Reinhold Publishing Corporation, 1989.

2. Shockley W., “Electrons and Holes in Semiconductors”. Princeton D. Van, 1988.

PHY-732 ELECTRON MICROSCOPY I

Basic electron optics and working principle of scanning and transmission electron microscopes (SEM & TEM), Mechanisms of Image formation, Modes of contrast and resolution in SEM and TEM, Electron diffraction, Images of perfect crystals and defects, two beam diffraction contrast, Analytical microscopy, SEM and TEM Specimen preparation techniques and in-situ microscopy.

Recommended Books

1. Goldstein J. I. and Yokowitz H., “Practical Scanning Electron Microscopy”. Plenum Press, New York, 1997.
2. Grundy P. J. and Jones G.A., “Electron Microscopy in the Study of Materials”. Edward Annold Limited 1976.
3. Thomas G. and Goringe M. J., “*Transmission Electron Microscopy”.* John Wiley & Sons New York, 1979.
4. William D. B. “Practical Analytical Electron Microscopy in Material Science”. Philips Electronics Instruments, 1983.

PHY-733 PLASMA PHYSICS-I

Controlled Fusion: Introduction to confinement scheme. Magnetic confinement and stability. Description of tokamaks, mirror machines and pinch devices. Supplementary heating. Diffusion: Diffusion in weakly ionized gases. Diffusion across a magnetic field. Diffusion in fully ionized plasmas. Bohm diffusion and neoclassical diffusion. Equilibrium and Stability (With Fluid Model): Hydromagnatic equilibrium. The concept of **□**. Diffusion of magnetic field into a plasma. Classification of instabilities. Two stream instability. The gravitational instablity. Resistive drift waves. The Vlasov Theory Of Plasma Waves: Solution of linearized Vlasov equation. Time asymptotic solution. Vlasov theory of small amplitude waves in field-free uniform/nonuniform magnetized cold/hot plasmas. The Vlasov theory of plasma-stability.

Recommended Books:

1. Hagler, M.O. and Kristianson, M. “An Introduction to Controlled Thermonuclear Fusion”. Lexington Books, 1977.
2. CHEN, F. F. “Introduction to Plasma Physics”. Plenum press,1974.
3. Kran, N.A. and Trivelpiece, A.W. “Principles of Plasma Physics”. McGraw-Hill, 1973.
4. Glasstone, S. and Lovberg, R.H. “Controlled Thermonuclear Reactions”. D. Van Nustrand, 1960.

PHY-734 FUNCTIONAL MATERIALS

Electrostatics, dielectric constant, polarization mechanisms, atomic theory of dielectrics, spontaneous polarization, Clausius-Mossotti expression
Dielectrics: dielectric loss, dissipation factor.
background, piezoelectric parameters, PZT and other important commercial piezoelectric**,** applications.
background, IR detection, circuit noise, materials and measurement, applications.
Electro-Optic Ceramics: background, PLZT, applications.
Microwave Ceramics: microwaves, microwave telecommunications, quality factor, temperature coefficients, measurement, commercial resonators, current research, future trends.
Magnetic Materials: background, ferrites, magnetic properties, processing ferrites, applications.
history, properties, applications.
liquid crystals, High-temperature heating elements, Ohmic resistors, varistors, fast-ion conductors for fuel cells, gas sensors

Recommended Books

1. Moulson, A. J. and Herbert, J. M. “Electro-ceramics: Materials, Properties, and Applications”. John and Wiley and Sons, 2003.
2. Course notes available on-line.

PHY-735 MATERIALS SCIENCE-I

Structure of materials. Ionic bond. Covalent bond. Metallic bond. Van der Waal's bond. Crystallography. Translational periodicity. Crystal classes. Crystal forms. Point and space groups. Crystal growth. Methods of purification. Zone refining. Zone leveling. Impurity control. Methods of perturbing the concentration of impurities in semiconductors. Formation of n-p and n-p-n junctions. Different techniques of growing single crystals. Polymer chains. Polymerization. Polymer processing. Ceramics. Oxide and silicate structures. Phase transformations. Fabrication technology of semiconductor electronic devices

Recommended Books

1. Barrett, C. S. “Structure of Metals”. McGraw-Hill, 1952.
2. Kingery, W. D. “Introduction to Ceramics”. John-Wiley and Sons, 1976.
3. Buckley, H. E. “Crystal Growth”. John-Wiley and Sons, 1951.
4. Tobolsky, A. V. “Properties and Structure of Polymers”. John-Wiley and Sons, 1960.
5. Phillips, F. C. “An Introduction to Crystallography”. Longmans Green, 1972.
6. Cottrell, A.H. “Theory of crystal dislocations”. Gordon and Breach, 1964.

PHY-736 QUANTUM FIELD THEORY-I

Second quantization. Quantization of Scalar, Dirac and electromagnetic fields. Interaction between fields. Formal theory of scattering. Reduction of S-Matrix. Feynman diagrams. Elements of renormalization.

Recommended Books

1. Bjorken, J. D. and Drell, S. D. “Relativistic Quantum Field Theory”. Dover Publications,2012.
2. Schweber, S. S. “Introduction to Relativistic Quantum Field Theory”. Harper and Row, 2007.
3. Bogoliubov, N. N. and Shirkow, D. V. “Introduction to the Theory of Quantized Fields” Inter science, 1960.
4. Jauch, J. M. and Rohrlich, E. M. “Theory of Photons and Electrons”. Springer-Verlag, 1976.

PHY-737 TRANSMISSION TECHNIQUES-I

The nature of information signals. Analogue and digital signals. Binary coding. The time and frequency forms of signals. Frequency spectrum of a digital pulse. Frequency spectrum of a unit step. Frequency spectrum of a unit impulse. Comparison of pulse spectra. The sampling of analogue waveform and its recovery from the sampled signal. Modulation methods (analogue pulse and digital) and their features. Effect of noise on different types of modulations. Quantising noise in PCM. Companding

Recommended Books

1. Goodyear, C. C. “Signals and Information”. Butterworth, 1971.
2. Burdic, W. S. “Radar Signal Analysis”. Prentice-Hall, 1968.
3. Lathi, B. P. “Communication systems”. John-Wiley and Sons, 2007.
4. Panter, P. F. “Modulation Noise and Spectral Analysis”. McGraw-Hill, 2007.
5. King, R. A., “Electrical Noise”. Chapman & Hall, 2007.

PHY-738 GROUP THEORY

Linear vector spaces. Groups. Representations of groups. Characters. Schur's Lemmas. Lie groups. Representation of lie groups. Rotation group and SU(3). Clebsch-Gordon coefficients. Rotation matrices. Wigner-Eckart theorem. Kronecker product of irreducible representations. Spinor representations of Lorentz roup. Elementary theory of Wigner's unitary representations of Poincare group.

Recommended Books

1. Hamermesh, M. “Group Theory and its application to physical problems”. Addison-Wesley, 1962.
2. Wigner, E. P. “Group Theory and its application to quantum mechanics”. Academic press, 1959.

PHY-739 ATOMIC AND MOLECULAR SPECTROSCOPY

Quantum mechanical treatment of one and two electron systems. Perturbation and variation methods. Q.M.treatment of many electron systems. Self-consistent field method. Derivation of Hartree-Fock equations. Application of Hartree-Fock equations to many electron systems. Atoms and radiation field. Probability of radiative transition. One photon absorption and emission. Multiple transitions. Two photon absorption and emission. Hyperfine structure and isotope shift. Magnetic dipole hyperfine structure. Electric quadrupole hyperfine structure. Mass dependent isotope shift. Volume dependent isotope shift. Line shape and broadening. Diatomic molecules. H like systems. Many electron systems.

Recommended Books

1. Slater, J. C. “Quantum Theory of Atomic Structures”. McGraw-Hill, 1960.
2. Bethe, H. A. and Jackiw, R. W. “Intermediate Quantum Mechanics”. Benjamin, Pub. Co., 1986.
3. Bethe, H. A. and Saltpeter, E. E. “Quantum Mechanics of One and Two Electron Atoms” Dover Publication, 2008.

PHY-740 LASER PHYSICS-I

Review of quantum mechanics. Interaction of radiation and atomic systems. The density matrix. Homogeneous and inhomogeneous broadening of atomic transitions. Gain and saturation effects. Hole burning. Optical resonators. Gaussian beams. Laser oscillation. Rate equations for a laser oscillator. Amplitude fluctuations and spiking. Some specific laser systems. Q-switching and mode locking. Focusing of laser beams.

Recommended Books

1. Yariv, A. “Quantum Electronics”. John Willey & Sons, Inc., 1989.
2. Sargent III, M., Scully, M. O. and Lamb Jr. W. E. “Laser Physics”. Westview press, 1978.
3. Maitland, A. and Dunn, M. H. “Laser Physics”. North-Holland Pub. Co., 1970.
4. Siegman, A.E. “An Introduction to Lasers and Masers”. McGraw-Hill, 1971.
5. Chang, W. S. C. “Principles of Quantum Electronics”. Addison-Wesley, 1969.

PHY-741 ENVIRONMENTAL AEROSOL PHYSICS

Definitions, size distribution, shape, and structure of aerosol particles, combustion aerosols, marine aerosols, laws of radiation, electromagnetic radiation.

Isokinetic sampling, Sampling from still air, Transport losses, measurement of number and mass concentration.

Brief history of air pollution, Air pollution sources, Composition of pollution, Primary and secondary pollutants, Transformation of pollutants during transport, Effects of the pollutants.

Brief summary of the theory of nucleation, condensation and coagulation, examples of particle formation in different environments, vehicle exhaust, marine environment.

Absorption and scattering of particles in the atmosphere, scattering geometry, Lambert-Beer's law, Intensity and refractive index, phase function, Asymmetry factor, Extinction cross sections and efficiencies, Single scattering albedo, Rayleigh scattering, Mie scattering.

Atmospheric aerosol, formation of clouds in the presence of aerosol, cloud condensation nuclei, formation of cirrus clouds, aerosol-cloud interaction, warm and cold clouds, satellite derived cloud properties.

Direct and indirect radiative forcing, the atmospheric heat budget, cooling versus heating, aerosol optical depth, aerosol and cloud impact on climate, indirect effect of absorbing aerosols.

Recommend Books

1. Hinds, W.C. “Aerosol Technology: Properties, behaviour, and measurement of airborne particle”. John Willey & Sons, Inc., 1999.
2. Seinfeld, J.H. and Pandis, S.N. “Atmospheric Chemistry and Physics: From Air Pollution to Climate Change”. John Willey & Sons, Inc., 1998.
3. Reist, P.C. “Aerosol Science and Technology”. McGraw-Hill, Inc., 1983.
4. Cadle, R. D. “The measurement of airborne particles”. Wiley, New York, 1975.

PHY-742 SURFACE FORCES AND INTERMOLECULAR INTERACTIONS I

The Four forces of Nature, First successful phenomenological theories, Modern view of intermolecular forces. Interaction energies of molecules, The Boltzmann distribution, the distribution of molecules and particles in equilibrium. The Vander Waals equation of state, Thermal energy as a gauge of the strength of an interaction.
Covalent or chemical bonding forces, Physical and Chemical Bonds, Ionic crystals, Range of Coulomb forces and Born Energy, Specific ion-solvent effects, Continuum approach.
Polar molecules and ion-dipole interactions. Solubility of ions in different solvents, specific ion solvent effect, continuum approach
Polar molecules interaction, dipole self-energy, ion dipole interactions, solvation forces, structural forces, hydration forces. Interaction between ions and neutral molecules, Dipole-induced dipole interaction, polarization forces.
Origin of Van der Waals dispersion forces, the London equation, Vander waal forces between polar molecules, Van der Waals forces in the presence of medium
Repulsive potentials, intermolecular pair potentials, Role of repulsive forces in non covalently bonded solids, Repulsive forces in liquids, Lenard jones potentials.
Hydrogen bonding, Strength of interactions in liquids, hydrophobic forces, hydrophilic forces.

Recommended Books:

1. Intermolecular and Surface forces; Jacob N. Israelashvili, 3rd edition, Elsiviour, New York, 2011.
2. Surface and Interfacial Forces; Hans-Jürgen Butt, Michael Kappl, Wiley, 2010.
3. Principles of Colloid and Surface Chemistry, Hemenz Paul, Marcel Dekker, New York, 1997.

PHY-743 ORGANIC ELECTRONIC DEVICE

Organic Semiconductors; History and Applications, Small Molecules organic semiconductors, Polymer organic semiconductors, Electron Delocalization in Molecules with π-Conjugated Systems, tunneling transport, Hopping Charge Transport in Disordered Materials via Localized States, Nearest-neighbor hopping, Variable-range hopping, Conductivity and Mobility of nearly-free Charge Carriers, Charge Carriers in Organic Semiconductors (Polarons, Shallow Traps and Deep Traps), deposition techniques (PVD and CVD), fabrication and characterization of organic Schottky diode, space charge limited current, electrical characteristics, History of OPV cells, photo-induced excitons and charge carriers, energy generation and transport in organic semiconductors, basic types of organic photovoltaic devices (single layer OPV cells, Bilayer OPV cells, bulk heterojunction OPV cells), and their operation, mechanism and fabrication, Organic field-effect transistors (OFETs).

Recommended Books

1. Organic Semiconductors, Part A., F. Gutman and L.E. Lyons, Robert E. Krieger Publishing Company, Malabar, 1981.
2. Physics of Organic Semiconductors, edited by W. Brutting, Weinheim: Wiley-VCH Verlag Gmbh & Co. KgaA, Germany, 2005.
3. An Introduction to Molecular Electronics, edited by Michael C. Petty, Martin R. Bryce and David Bloor. Published in Great Britain, 1995.
4. Charge transport in disordered solids with applications in electronic, edited by S. Baranovski, John Wiley & Sons, Ltd, 2006.
5. Organic molecular solid, M. Schwoerer, H. Christoph Wolf, Wiley-VCH Verlag GnbH & Co. KGaA. 2007.
6. Organic Photovoltaics, C.J. Brabec, V. Dyakonov, J. Parisi, N.S. Saricftci, Springer, 2003.

PHY-744 MATERIALS PROCESSING

Objectives: This course is aimed at developing an understanding of laboratory scale materials processing and underlying principles.

General introduction to materials and their classification, selection and analysis of the required raw materials for processing of metals, polymers, ceramics and composites, an introduction to the processes involved in the preparation of metals, alloys, plastics, ceramics, and composites such as batch preparation, melting, casting, milling, calcining, sintering, hot pressing, rapid solidification, shaping, annealing, controlled crystallization, the associated physio-chemical principles, experimental conditions for processing of materials, characterization of final product materials and their properties, health and safety issues.

Recommended Books:

1. Ellwood, D. (2000). Engineering design: a materials and processing approach. Boston, Mass: McGraw-Hill.
2. Flinn, R. Trojan K. (1994). Engineering materials and their applications. 4th Edition. New York, New York: Wiley & Sons.
3. Helsel, L. Liu. P. (2001). Industrial materials. Tinley Park, Illinois: Goodheart-Willcox.
4. Kuang, Y. (2001). Modeling for casting and solidification processing. New York New York: Marcel Dekker.
5. Richardson T. Lokensgard, E. (1997) Industrial plastics. Albany, New York: Delmar Publishing Co.
6. Walker, J. (2000). Modern metal working. Tinley Park, Illinois: Goodheart-Willcox.
7. Walker, J. (1996). Handbook of manufacturing engineering. New York, New York: Marcel Dekker.
8. William, D. (2004). Fundamentals of materials science and engineering: an integrated approach. 2nd.New York, New York: Wiley &Sons
9. Wright, R. (1999). Processes of manufacturing. Tinley Park, Illinois: Goodheart-Willcox.
10. Wright, R. (1996). Introduction to materials & processes. Albany, New York: Dept of Education

PHY-745 CLOUD PHYSICS I

Aims & Objectives

This course is designed to understand the aspects of cloud physics in the earth atmosphere. This is a descriptive course with the cloud thermodynamics and is necessary for formation of clouds, various effects of clouds on the environment raining caused.

Intended Outcomes

By the studying the course, a student will be able to:

- understand cloud types and their importance for the environments
- understand how to apply basic thermodynamics to the formation of clouds
- understand cloud microphysical properties, and
- understand principles of radar and its equation for precipitation rate.

Course Contents

Introduction to cloud physics, importance of clouds, types of clouds, scale of clouds. Equation of the state for water vapor, Clausius- Clapeyron equation, Moist air and its vapor content, Thermodynamics of unsaturated moist air, Pseudo-adiabatic process, Adiabatic liquid water content, Reversible saturated adiabatic process. Hydrostatic equilibrium, Dry adiabatic lapse rate, Buoyant force on a parcel of air, Stability criteria for dry air, the pseudo-adiabatic lapse rate, Stability criteria for moist air, Convective instability, Horizontal restoring forces, Geostrophic wind, Symmetric and baroclinic instability. Mixing of air masses, Convective condensation level, Convection elemental parcel theory, Modification of the elementary theory. Sizes of clouds and cloud systems, Microstructure of cumulus clouds, Cloud droplet spectra, Ice and precipitation in clouds, Microstructure of large continental storm clouds. Artificial modification of clouds and precipitation, Thunderstorm electrification, Cloud-chemistry, Aerosol-cloud interaction, Principles of radar, The radar equation, Relation of Z to precipitation rate.

Recommended Books

1. Rogers, R. R. & Yau, M. K. " A short course in cloud physics". 3rd ed., Pergamon Press, Oxford, New York, 1989.
2. Andrews, D. G. " An Introduction to Atmospheric Physics". 2nd ed., Cambridge University Press, New York, 2000.

3. Seinfeld, J. S. & Pandis, S. N" Atmospheric Chemistry and Physics". 2nd ed., John Wiley & Sons, USA, 1998.

PHY-746 INTRODUCTION TO NANOPHYSICS

Aims and Objectives

- To introduce students to the basic ideas and techniques in Nanoscale Physics
- To study applications that involve nanostructured materials
- To develop capabilities and skills for interdisciplinary communications
- To develop capabilities to critically evaluate nanotechnology related news or claims

Intended Outcomes

On completion of the course the students will be able to:

- Identify properties that emerge on the nanoscale
- Explain the quantum nature of matter and its macroscopic realization
- Describe experimental approaches to nanofabrication (bottom-up and top-down)
- Discuss in an informed way the current possibilities and limitation of nanotechnology

Course Contents:

Introduction to nanophysics and nanotechnology – scaling laws and limits to smallness; quantum nature of nanoworld; Nano fabrication (top-down and bottom-up process); nanoscopy (electron microscopy, atomic force microscopy, scanning tunneling microscopy). Properties and application of dielectric and metal nanostructures - individual nanoparticles and nanoclusters; nanostructured materials; carbon nanostructures; nanomagnets. Properties and application of semiconductor nanostructures - fabrication of semiconductor nanowires and quantum dots; electronic and optical properties (2D and 3D quantum confinement); optical spectroscopy of semiconductor nanostructures (local probe techniques); quantum dots nanowire- and quantum-dot-based electronic and photonic devices.

Recommended Books:

1. Charles P. Poole, Jr., Owens, F. J. "Introduction to Nanotechnology". 1st ed., John Wiley & Sons, Inc., USA, 2003.
2. Edward L. Wolf., "Nanophysics and Nanotechnology: An Introduction to Modern Concepts in Nanoscience". 3rd ed., Wiley-VCH, Germany, 2015.
3. Daniel Minoli., "Nanotechnology Applications to Telecommunications and Networking". 1st ed., John Wiley & Sons, Inc., USA, 2005.
4. Pradeep, T., "Nano, The Essentials: Understanding Nanoscience and Nanotechnology" 1st ed., Tata McGraw-Hill Publishing Company Limited, USA, 2007.
5. Reich, S., Thornsen, C., Maultzsch, J., "Carbon Nanotubes: Basic Concepts and Physical Properties". 1st ed., Wiley-VCH, Germany, 2004.

PHY-747 Physics of Microfluidics and Self-Assembly

Aims and Objectives

This course will provide a basic understanding of the physics of microfluidics; self-assembled systems, colloid and surface science as well as how these are related to nanoscience. It will enable the students to critically appraise cutting edge characterization techniques used in nanoscience; to plan, implement and report on an open-ended collaborative experimental activity; to develop practical skills in surface chemistry and nanoscience.

This course covers the syntheses of various shapes and their self-assembly mechanism that have been developed in recent years considering numerous technological applications. To understand the properties of nanostructures in isolation as well as in assembled arrays, the limitations of basic physical laws that are important at the nanometer length scale are introduced. Self-assembly mechanism in microfluidic systems induced either by contact line dynamics associated with the surface design or/and by evaporation on various wettability properties are introduced and discussed. Properties that exhibit size effects (including electronic, magnetic, photonic) at the nanometer length scale will be presented so that nanomaterials which are becoming increasing relevant to modern technologies can be well understood.

Intended outcome:

At the end of the course the students should be able to:

- Describe colloidal systems and interfacial phenomena

- Describe fundamental principles and theories for stabilization/destabilization of colloidal systems
- Analysis and quantitative determination of the interfacial phenomena and behavior of colloidal systems, using fundamental principles and theories, as well as basic knowledge within chemistry, physics and mathematics
- Identify problems in industrial processes with origin in surface and colloid chemistry.

Course Contents:

Brief introduction to advanced materials & nanotechnology; colloids of various shapes; their syntheses and optical properties; state-of-art characterization techniques; chemistry of surfaces; physics of aligned arrays; properties & novel applications; confined arrays, and deposits at various scales; collective response of assembled superstructures; Van Der Waals, electrostatic, depletion, entropic, steric and hydrodynamic interactions at nanoscale; Influence of various physical and chemical conditions on self-assembly; droplet drying techniques; motion of the three phase contact line during drying on various surfaces and their effect on self-assembly; coffee-stain effect; gradient, hydrophobic, hydrophilic etc. surfaces.

Recommended Books:

1. Richard A. L. J., "Soft Machines: Nanotechnology and Life". 1st ed., Oxford University Press, UK, 2004.
2. Kotov and Nicholas "Nanoparticle Assemblies and Superstructures". 1st ed., CRC Press 2016.
3. Zhiqun L., "Evaporative self-assembly of ordered complex structures". 1st ed., World Scientific, 2012.

- Nguyen N. T. and Wereley S. T., "Fundamentals and Applications of Microfluidics" 1st ed., Artech House, 2002.
- Jean B., "Micro-Drops and Digital Microfluidics" 2nd ed., Elsevier, 2013.
- John B., "An Introduction to Interfaces & Colloids: the bridge to nanoscience" 1st ed., World Scientific, 2010.
- Frank C., "Colloids and Colloid Assemblies" 1st ed., Wiley-VCH, Germany, 2004.
- Tibbits S., "Self-Assembly Lab: Experiments in Programming Matter" 1st ed., Routledge 2017.

Note: Any two of the three compulsory courses are must for every MPhil Scholar.