DEPARTMENT OF PHYSICS
UNIVERSITY OF PESHAWAR
PhD Courses

Updated on 01/07/18

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

COURSE CODE	COURSE TITLE	CREDIT HOURS
	COMPULSORY COURSES FOR PHD	
PHY-811	ELECTROMAGNETIC THEORY II	3
PHY-812	STATISTICAL MECHANICS	3
PHY-813	ADVANCED QUANTUM MECHANICS II	3
	Optional/Additional/Specialization Courses	
PHY-814	COMPUTATIONAL PHYSICS II	3
PHY-815	ADVANCED SOLID STATE PHYSICS II	3
PHY-816	RELATIVISTIC QUANTUM MECHANICS	3
PHY-817	MICROWAVE COMMUNICATIONS	3
PHY-818	MAGNETIC MATERIALS AND MAGNETIC PROPERTIES	3
PHY-819	MAGNETIC RESONANCE IMAGING	3
PHY-820	OPTICAL COMMUNICATIONS	3
PHY-821	DIGITAL IMAGE PROCESSING II	3
PHY-822	MONTE CARLO SIMULATION	3
PHY-823	MODERN OPTICS AND LASER PHYSICS	3
PHY-824	TECHNIQUES IN EXPERIMENTAL SOLID STATE PHYSICS	3
PHY-825	SATELLITE IMAGE PROCESSING	3
PHY-826	FABRICATION OF ELECTROCERAMICS AND THEIR PROPERTY MEASUREMENT TECHNIQUES	3
PHY-827	ION'S SPUTTERING	3
PHY-828	SATELLITE ORBIT DETERMINATION AND SIMULATION	3
PHY-829	ADVANCED COURSE IN RELATIVITY	3
PHY-830	ELECTRON MICROSCOPY II	3
PHY-831	PLASMA PHYSICS II	3
PHY-832	EXPERIMENTAL PLASMA PHYSICS	3
PHY-833	BONDING, CRYSTALLOGRAPHY & CRYSTAL DEFECTS	3
PHY-834	NUCLEAR WASTE MANAGEMENT	3
PHY-835	MATERIALS SCIENCE-II	3
PHY-836	QUANTUM FIELD THEORY-II	3
PHY-837	TRANSMISSION TECHNIQUES-II	3
PHY-838	LASER PHYSICS-II	3
PHY-839	NONLINEAR PHYSICS	3
PHY-840	MODELLING AND COMPUTATION IN FLUID MECHANICS	3
PHY-841	SURFACE FORCES AND INTERMOLECULAR INTERACTIONS-II	3
PHY-842	EXPERIMENTAL PLASMA PHYSICS II	3
PHY-843	ENVIRONMENTAL AEROSOL PHYSICS II	3
PHY-844	CLOUD PHYSICS II	3

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

PhD Course Contents

PHY-811 ELECTROMAGNETIC THEORY-II

Plane Waves in a non-conducting medium; linear and circular polarization; Reflection and Refraction of electromagnetic waves in dielectrics; Total internal reflection; Frequency dispersion in dielectrics, conductors, and plasma; Propagation in ionosphere and magnetosphere; Superposition of waves in one dimension (group velocity); causality in the connection between D and E;

Fields at the surface and inside conductors; Wave guides; Modes in a rectangular waveguides; Energy Flow and attenuation in waveguides; Resonant cavities; Q of a cavity; Earth and ionosphere as resonant cavity; Multimode propagation in optical fibers; Modes in dielectric wave guides.

Fields and radiation of a localized oscillating source; Electric dipoles fields and radiation; Magnetic dipole and electric quadrupole fields; Multipole expansion for localized source; Mulitpole expansion of the electromagnetic fields; Energy and angular momentum of multipole radiations; Sources of multipole radiation; Multipole radiation from a linear antenna.

Scattering of electromagnetic waves at long wave length; Perturbation theory of scattering; Explanation of blue sky; scattering by a sphere; scalar and vector diffraction theory; Babinet's Principle; optical theorem.

The situation before 1900, Einstein two postulates; some recent experiments; Lorentz transformation and basic kinematic results; addition of velocities, 4-velcity; Relativistic momentum and energy of a particle; Mathematical properties of the space time; Matrix representation of Lorentz transformation; Invariance of electric charge; Transformation of electromagnetic fields; notes on notations and units in relativistic kinematics.

Recommended Books

1. Jackson, J. D. "Classical Electrodynamics" John Willey & Sons, Inc., 1999.
2. Stratton, J. A. "Electromagnetic Theory" McGraw-Hill, 2007.

PHY-812 STATISTICAL MECHANICS

Review of laws of thermodynamics. First, second and third law thermodynamics and their applications. The kinetic theory of gases, Binary collisions, Boltzmann transport equation, Transport phenomenon. The mean free path, Conservation laws, Zero order approximation, The first order approximation, Viscosity.

Statistical mechanics, Postulates of classical statistical mechanics, Micro-canonical ensembles, Equipartition theorem, Classical ideal gas, Gibb's Paradox, Canonical ensembles, Energy fluctuation in the canonical ensemble grand canonical ensemble, Equivalence of the Canonical ensemble and the grand canonical ensemble, the meaning of Maxwell construction.

Quantum statistical mechanics, Quantum model of matter, Canonical distribution in quantum statistics, The quantum oscillator, Plank's formula for the equilibrium radiation of a perfectly black body, Heat capacity of solids, Heat capacity of solids, Heat capacity of a diatomic ideal gas, Quantum statistics of a system of similar particles, Bose-Einstein and Fermi-Dirac statistics, Application of Bose-Einstein statistics to the photon gas, Application of Fermi-Dirac statistics to the electron gas in metal, Condensation of an ideal Bose-Einstein gas.

Recommended Books

1. Kerson Huang, "Statistical Mechanics". 2nd ed., John Wiley and Sons, New York, 1963
2. Francis W. Sears, & Gerhard L. Salinger., "Thermodynamics, Kinetic Theory, and Statistical Mechanics". 3rd ed., Narosa Publishing House. New Delhi (1998).
3. Frederick Reif, "Fundamentals of Statistical and Thermal Physics". 1st ed., McGraw Hill 1965.
4. Gould H, & Tobochnik J., "Thermal and Statistical Physics". 1st ed., John Wiley and Sons, New York (1995).
5. Terletskii Ya. P. "Statistical Physics", North Holland Publishing Co., 1971.

PHY-813 ADVANCED QUANTUM MECHANICS

Pre-requisites, Advanced Quantum Mechanics I

Course contents: Molecular structure, Born-Oppenheimer approximation, H^{+2} ion, H_2 molecule, ionic and covalent bonding, solids, molecular spectra, rotation and vibrational transitions, Field theory, from phonons to photons, from particles to fields, classical field theory of harmonic atomic chain, quantization of atomic chain, phonons. Classical theory of the EM field, waveguide, quantization of the EM field and photons. Time-dependent perturbation theory, Rabi oscillations in two level systems, perturbation series, harmonic perturbations and Fermi's Golden rule, Radiative transitions, Light-matter interaction, spontaneous emission, absorption and stimulated emission, Einstein's A and B coefficients, dipole approximation, selection rules, lasers, Scattering theory, Elastic and inelastic scattering, Born approximation, scattering of identical particles, Relativistic quantum mechanics, Klein-Gordon equation, Dirac equation, relativistic covariance and spin, free relativistic particles and the Klein paradox, coupling to EM field, minimal coupling and the connection to non-relativistic quantum mechanics, field quantization.

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. K. Konishi and G. Paffuti, Quantum Mechanics: A New Introduction, (OUP, 2009).
4. L. D. Landau and L. M. Lifshitz, Quantum Mechanics: Non-Relativistic Theory, Volume 3, (Butterworth-Heinemann, 3rd edition, 1981).
5. F. Schwabl, Quantum Mechanics, (Springer, 4th edition, 2007).
6. S. Gasiorowicz, Quantum Physics, (2nd edn. Wiley 1996, 3rd edition, Wiley, 2003).

PHY-814 COMPUTATIONAL PHYSICS-II

Simulation and statistical mechanics, Model system of statistical mechanics, Carlo method, Molecular dynamics simulation, Evaluation of simulation experiments, Particles and fields, Stochastic dynamics, Quantum mechanics simulations, The diffusion Monte Carlo, Path integral Monte Carlo, Wave packet dynamics, Density functional molecular dynamics, Hydrodynamics, Compressible flow without viscosity, Incompressible flow with viscosity, Cellular automata and hydrodynamics, Modeling equations in aerodynamics, Some computational examples, Simulation of phonon dispersion curves and density of states, Electron energy bands in one dimensional particle potential, Computer simulation, Electron behavior in semiconductors, Computational study of diffraction by microcrystalline and amorphous materials, Computer assisted tutorials in perturbation.

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-815 ADVANCED SOLID STATE PHYSICS-II

Surface effects, Classification of solids, Cohesive energy, Failure of the static lattice model, Classical theory of the Harmonic crystals, Quantum theory of the Harmonic crystals, Measuring the phonon dispersion relations, Anharmonic effects in crystals, Phonons in metals, Dielectric properties of insulators, Homogeneous semiconductors, Inhomogeneous semiconductors, Defects in crystals, Diamagnetism and paramagnetism, Electron interactions and magnetic structures, Magnetic ordering, Superconductivity.

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-816 RELATIVISTIC QUANTUM MECHANICS

Relativistic quantum mechanics of spin ½ particles, Probability conservation in relativistic quantum mechanics, The Dirac equation, Simple solutions, Non-relativistic approximations, Plane waves, Covariant perturbation theory, Natural units and dimensions, S-matrix expansion in the interaction representation, First order processes, Mott scattering and hyperon decay, Two photon annihilation and Compton scattering, The electron propagator, Mass and charge renormalization, Radiative corrections, Green’s function and field theory (Fermions), Pictures, Green’s Functions, Wick’s theorem, Diagrammatic analysis of perturbation theory, Fermi systems, Hartree-Fock approximation, Imperfect Fermi gas, Degenerate electron gas, Linear response and collective modes, General theory of linear response to an external perturbation, Bose systems, Perturbation theory and Feynman rules, Weakly interacting Bose gas, Finite Temperature formalism, Field theory at finite temperature, Physical systems at finite temperature, Imperfect Bose gas near T_c, Specific heat of an imperfect Fermi gas at low temperature, Electron gas, Real time Green’s function and linear response.

Recommended Books

1. Sakurai J. J., “Advanced Quantum Mechanics”, Addison Wesley 1980
2. Fetter A. L., and Walecka J. D., “Quantum Theory of Many Particle Systems”, McGraw Hill 1978
3. Bjorken J. D., and Drell S. D., “Relativistic Quantum Mechanics”, McGraw Hill 1984
4. Dicke R. H., “Introduction to Quantum Mechanics”, Addison Wesley 1980

PHY-817 MICROWAVE COMMUNICATIONS

Microwave spectrum, Microwave applications, Elementary fields and waves, Maxwell’s equations and boundary conditions, Wave propagation in perfect insulators, Transmission line theory, The impedance transformation, The smith chart, Impedance matching and tow port network analysis, Microwave transmission line, The open two wires line, The coaxial line, Rectangular and circular wave-guides, Coaxial and strip line components, TEM to TEM transmissions, Attenuators and phase shifters, Wave-guide components, Reciprocal multiport junctions, Microwave resonators and filters, Narrowband and wideband microwave filters.

Recommended Books

1. Malherbe J. A. G., “Microwave Transmission Line Filters", Artech House, Dedham, MA, 1979.
2. Howe Jnr. H., “Strip Line Circle Design”, Artech House, Dedham, MA, 1974
3. Peter A Rizzi., “Microwave Engineering Passive Circuits”, Prentice Hall, 1988
4. Ghose R. N., “Microwave Circuit Theory and Analysis”, McGraw Hill, 1993

PHY-818 MAGNETIC MATERIALS AND MAGNETIC PROPERTIES

Origins of magnetic moments, Basic concepts and magnetic properties (Magnetic poles, Permeability, Retentivity, Hysteresis and its causes, Saturation magnetization, Remanence, Coercivity, Differential permeability, Curie temperature).

Classification of materials on the basis of magnetic properties, Classification of soft and hard magnetic materials, Instances of magnetic materials.

Diamagnetism, Ionic and Covalent materials, Metals, Paramagnetism, Classical theory, Quantum theory, Temperature and field dependence of paramagnetic susceptibility, Pauli Paramagnetism, Paramagnetic cooling.

Physical significance, exchange integral, exchange energy, variation in heat capacity, B – H curves, Band structures, Applications of ferromagnetic materials (Electromagnets, Transformers, Electromagnetic relays, magnetic recording, permanent magnets, Inductance cores, Ceramic magnets, etc).

Magnetic domains, domain walls and their properties, Bubble domains, Block walls, Properties of domain boundaries (exchange energy, anisotropy energy, width), 180° and non-180° domain walls and the effects of stress on them. Antiferromagnetism and Molecular Field Theory, Néel temperature, Ferrimagnetism and Molecular Field Theory.

Recommended Books

1. David Jiles., "Introduction to Magnetism and Magnetic Materials", 1st Ed., Chapman and Hall, 1991.
2. Daniel D. Pollock., "Physics of Engineering Materials", Prentice Hall, Inc. Englewood Cliffs, New Jersey, 1990.
3. Moulson A. J., and Herbert J. M., "Electro ceramics", 2nd Ed., John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex, England.
4. Michel W Barsoum., "Fundamentals of Ceramics: Series in materials science and engineering", Institute of Physics Publishing Bristol and Philadelphia, 2003.

PHY-819 MAGNETIC RESONANCE IMAGING

PHY-820 OPTICAL COMMUNICATIONS

Band pass for Wavelength Division Multiplexing (WDM) systems, Edge filter for rejection of pump radiation from an Erbium doped fiber amplifier, Gain equalization coatings for an Erbium doped fiber amplifier that functions in the reflective mode, Gain equalization coatings for an Erbium doped fiber amplifier that functions in transmissive mode, Realities in Mirages, Identification of distant objects by the use of optical images, Effect of non-homogeneous medium on images of distant objects, viewed through optical telescope, Sodha theory of rays tracing in a medium with a refractive index, Optical ray propagation under arctic mirages conditions and Sodha model, Dynamic holography and phase conjugation in photo refractive crystals, Optical fiber sensors, Non-linear dynamics of beams of various spatial profiles and polarization.

Recommended Books

1. Raj Kamal R.I., "Laser Optics", Sawhney Willey Eastren Limited, New Delhi, 1992.
2. Zemike F., and Midwinter J., "Applied Non-linear Optics", Wiley Inter Science, New York, 1983.
3. Akhmanov S. A., and Khokhlov R. V., "Problems of Non-linear Optics", Moscow, 1978.

PHY-821 DIGITAL IMAGE PROCESSING-II

Image enhancement and restoration, Image enhancement, Image restoration models, Algebraic spatial image restoration techniques, Specialized spatial image restoration techniques, Luminance, Colours and spectral image restoration, Image analysis, Image feature extraction, Symbolic image description, Image detection and registration, Image understanding systems, Image coding, Analog processing image coding, Digital point processing image coding, Digital spatial processing image coding, Image coding performance analysis.

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-822 MONTE CARLO SIMULATION

Monte-Carlo, Random number generation, Monte-Carlo integration, Monte-Carlo simulation method and its application introduction, Monte-Carlo methods modeling and simulation of surface chemical reactions, Elementary steps in surface chemical reaction process outlook of some specific reaction models, Monte-Carlo simulation of catalytic reactions.

Recommended Books

1. George S. F., "Monte-Carlo Concepts and Applications". McGraw Hill New York, 1999.
2. Herman D.W., "Computer simulation methods in Theoretical Physics". Addison-Wesley, 1986.
3. Albano E. V., "Computational Methods in Surface and Colloid Science". M. Bowroko ed. Marcel & Dekker Inc. New York, 2000.

PHY-823 MODERN OPTICS AND LASER PHYSICS

Realities in mirages, Maximum and minimum in the range of observations and height of objects, Maximum range for vertical objects, Maximum range for looming, Photo refractive two beam and related phenomena, Coupled wave formulations of DTWM and DFWM, Reflective optic fiber sensor, Non-linear propagation of two degenerate transverse modes of a laser beam, Non-linear dynamics of polarized laser beam, Moment theory of self focusing.

Recommended Books

1. Terhune R. W. and Maker P. D., "Advances in Lasers". Hill, New York, 1988
2. Arecchi F. T. and Du Boils E. O. S., "Self-Focusing, Self-Defocusing and Self Modulation Laser Hand Book". North Holland Publishing Co., Amsterdam, 1999.

PHY-824 TECHNIQUES IN EXPERIMENTAL SOLID STATE PHYSICS

PHY-825 SATELLITE IMAGE PROCESSING

PHY-826 FABRICATION OF ELECTROCERAMICS AND THEIR PROPERTY MEASUREMENT TECHNIQUES (Practical)

Synthesis and evaluation of electroceramic compositions, electrical characterization techniques, dielectric spectroscopy and its frequency dependence, piezoelectric properties (d_{33}, d_{31}, d_h and g_h coefficients) of available electroceramic samples, measurement of electromechanical properties of ferroelectrics (resonant and ultrasound methods, Hysteresis loop testing etc.). Ultrasonic measurement, the velocity of ultrasonic wave in solid state, the pulse echo method, the determination of elastic constants.

Recommended Books

1. IEEE Std. 176-1987 Standard on Piezoelectricity, 1987
2. Royer D. and Dieulesaint, E., "Elastic Waves in Solids I, II", Springer-Verlag Berlin, Heidelberg, New York, 2000.
3. Setter N., "Piezoelectric Materials Devices". Lausanne: EPFL Swiss Federal Institute of Technology, Switzerland, 2002
4. Uchino K., "Ferooelectric Devices". Marcel Dekker, Inc., New York, 2000
5. Jeackson J. D., "Classical Electrodynamics". 3rd ed. John Wiley & Sons, 1998.

PHY-827 ION'S SPUTTERING

PHY-828 SATELLITE ORBIT DETERMINATION AND SIMULATION

Fundamentals, Equations of motion, Two body problem, Astrodynamics, Coordinate systems, Analytics of the two body problem, Determination of an orbit from two position vectors and time, Determination of an orbit from angles only, Mixed data determinations, Differential correction orbits, Secular perturbations.

Recommended Books

1. Escobal P. R., "Methods of Orbit Determination". John Wiley Sons, 1975.
2. Kenneth I. D. and Joseph, "Orbital Mechanics for Remote Sensing". John Wiley Sons, 1982.
3. Gray T. I. and Cray M., "Metrological Satellite Data". McGraw Hill, 1989.
4. Smith, "Orbital Mechanics and Analytic Modeling of Metrological Satellite Orbits". McGraw Hill, 1980.

PHY-829 ADVANCED COURSE IN RELATIVITY

Geometrical foundation for space time theories, Geometrical structures, Affine geometry, Metrical geometry, Structure of space time theories, Absolute space time theories, Newtonian mechanics, Special relativity, Relativistic particle dynamics, Relativistic continuum mechanics, Microscopic theory, Relativistic continuum mechanics, Macroscopic theory, Dynamical space time theories, Foundations of general relativity, Solutions of Einstein equations, Experimental tests for general relativity, Further consequences of general relativity, Cosmology.

Recommended Books

1. Anderson J. L., "Principles of Relativity Physics". Academic Press, New York, 1997.
2. de Witt C., "Gravitational Radiations Experiments in Relativity". New York 1984.
3. Landau L. D., "The Classical Theory of Fields". Addison Wesley 1982.

PHY-830 ELECTRON MICROSCOPY II

Practical standard sample preparation procedures and use of scanning and transmission electron microscopes. Training in initial alignment of the instrument, sample insertion, imaging and interpretation of results, Technical/scientific report based on phase and microstructural analysis of samples investigated. Atomic lattice fringe image recording (when possible) and spectra using Energy-dispersive X-ray spectroscopy in SEM & TEM.

Recommended Books

1. Goldstein J. I., "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-831 PLASMA PHYSICS-II

Introduction to Inertial Confinement Fusion (Icf): Basic requirements of ICF. Laser plasma interaction. Ablation physics. Hydrodynamics compression. Energy transport. Nonlinear Plasma Theory: Introduction. Quasilinear theory. Conservation of particles, momentum and energy. Coherent three waves interaction with random phase. Nonlinear landau damping. Fluctuations, Correlations and Radiations: Shielding of a moving test charge. Electric field Fluctuations in maxwellian and nonmaxwellian plasmas. Emission of electrostatic waves. Electromagnetic fluctuations and radiations. Scattering of incoherent radiation from plasma density fluctuations . Emission of radiation from a plasma. Blackbody radiation. Cyclotron radiation. The source theory of radiation from a plasma.

Recommended books

1. Duderstadt, J. J. and Mosses, G. A. “Inertial Confinement Fusion”. John-Wiley and Sons, 1982.
2. Hagler, M. O. and Kristiansen, M. “An Introduction to Controlled Thermonuclear Fusion”. Lexington, 1977.
3. Hasegawa, A. “Plasma Instabilities and Nonlinear Effects”. Spring-Verlag, 1975.
4. Krall, N.A. and Trivelpiece, A.W. “Principles of Plasma Physics”. McGraw-Hill, 1967.

PHY-832 EXPERIMENTAL PLASMA PHYSICS

Energy Storage and Transfer for Laser and Plasma Devices: Electric circuit theory, Capacitate energy storage and transfer, pulse shaping and switching, fast drivers. Preliminary Measurements: Current, voltage and magnetic field measurements. Plasma Radiations and Their Detection: Neutrons, electrons and ion beams and X-rays detection and evaluation of plasma parameters. Laser as a Diagnostic Tool: Shadowgraphy and Schlieren imaging, holography and interferometry, Faraday rotation, Thomason and Rayleigh scattering. Plasma Spectroscopy: Radiative processes in plasmas, collisional processes in plasmas, statistical plasma models, plasma optical spectroscopy, evaluation of plasma parameters. Recent Trends in Fusion Plasma Research: Pinch devices, tokamak, stellarator and magnetic mirrors. Recent developments and results

Recommended books

1. Knoll, G.F. “Radiation Detection and Measurement”. John-Wiley and Sons New York, 1974.
2. Lochte-Holtgreven,W. “Plasma Diagnostics”. North-Holland Publishing Company Amsterdam, 1960.
3. Grien, H.R. “Plasma Spectroscopy”. McGraw Hill Book Company New York, 1964.
4. Brown, R. and Lang, J. “Astrophysical and Laboratory Spectroscopy”. Edinberg University press, Edinberg, 1988.
5. Dunlep, R.A. “Experimental Physics, Modern Methods”. Oxford University press, Oxford, 1988.
6. Hutchinson, I.H. “Principles of Plasma Diagnostics”. Cambridge University Press New York, 1987.
7. Stacey Weston, M. “Fusion: An Introduction to the Physics and Technology of the Magnetic confinement Fusion”. Jr. John Wiley and Sons, 1984.
8. Glastone, S. and Loverberg, R. “Controlled thermonuclear reactions”. Van Nastrand Company Inc. New York, 1960.

PHY-833 BONDING, CRYSTALLOGRAPHY & CRYSTAL DEFECTS

Descriptors, symmetry, bonding, coordination number, packing fraction, order-disorder, structural roadmap

Short-range order, glass transition, pair-distribution function, hard-sphere models, random-walk models, network models, fractal models

Rotation, reflection, inversion, roto-inversion, glide, screw, lattices, unit cells, point groups, Laue groups, space groups, Miller indices, zone axes, the International tables, relation of symmetry to properties, packing, quasi-crystals

Vacancies, interstitials, mobility of point defects, solid solutions, dislocations, dislocation motion, declinations, stacking faults, APBs, grain boundaries, domain walls

Structural hierarchies, deformation microstructures, crystallographic texture, pole figures, transformation microstructures, case studies, MSE 305 Bonding, Crystallography and Crystal Defects.

Recommended Books

1. Alien, S. M. and Thomas, E. L. “The Structure of Materials”. John Wiley & Sons, 1999.
2. De-Graef, M. and McHenry, M.E. “Structure of Materials: An Introduction to Crystallography, Diffraction and Symmetry”, Cambridge University Press, 2007
3. Tilley, R. J. D. “Crystals and Crystal Structures”. John Wiley & Sons, 2006

PHY-834 NUCLEAR WASTE MANAGEMENT

Radioactive waste, recycling, waste minimization and immobilization, nuclear decay law, contaminants and hazard, heavy metal contaminations, naturally occurring radioactive materials, and background radiation

Nuclear waste regulations, principles of nuclear waste management, sources of nuclear waste, short-lived waste radio-nuclides, long-lived waste radio-nuclides

Basic management approaches and characterization of radioactive waste, pretreatment of radioactive wastes, treatment of liquid radioactive wastes, treatment of solid wastes

Hydraulic cement in waste immobilization, cementation technology, immobilization of radioactive waste in bitumen, glasses for radioactive waste immobilization, vitrification technology, ceramic and metallic matrices, nuclear waste transportation and storage, nuclear waste disposal, performance assessment.

Recommended Books

1. Ojovan, M. I. and Lee, W. E. "Introduction to Nuclear Waste Management". Elvaster Publications, 2004.
2. Ojovan, M. I. and Lee, W. E. "New Developments in Glassy Nuclear Waste Forms". Nova Science Publishers, 2007.
3. Wison, P. D. "The nuclear Fuel Cycle". Elvaster Publications, 1996.

PHY-835 MATERIALS SCIENCE-II

Imperfections in crystals. Impurities. Vacancies. Grain boundaries. Dislocations. Stacking faults. Frenkel and Schottky disorder. Electrons and holes. Color centres. Mechanical properties of metals. Polymers and ceramics. Elastic and plastic deformation. Fracture, creep and fatigue phenomena. Strengthening mechanism. Annealing. Effect of imperfections on the mechanical properties of materials. Modulation spectroscopy for optical properties in solids. Modulation techniques. Wavelength modulation. Temperature modulation. Stress modulation,

piezo-absorption and piezo-reflectance. Electric field modulation.

Recommended Books

1. Barrett, C. S. "Structure of Metals". Horney press, 2008.
2. Tobolsky, A. V. "Properties and Structure of Polymers". John-Wiley and Sons, 1960.
3. Phillips, F. C. "An Introduction to Crystallography". Longmans Green, 1972.
4. Cottrell, A. H. "Theory of crystal dislocations". Gordon and Breach, 1964.

PHY-836 QUANTUM FIELD THEORY-II

Heisenberg picture. Axiomatic formulations. LSZ formulation of field theory. Analyticity properties of four-point functions. Dispersion relations.

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.
1.

PHY-837 TRANSMISSION TECHNIQUES-II

Information theory. Ideal noiseless channel. Signalling speed (Shannon's sampling theorem). The information capacity of noiseless channel. The effect of noise on information capacity. The optimum filter. Exchange of bandwidth for signal to noise ratio. Redundancy. Source rate and matching of the source to the channel. Information capacity in the bandpass case. Multiplexing fundamentals. Frequency division multiplexing (FDM). Time division multiplexing (TDM). Multiplex systems. Open-wire system. Cable system. radio and co-axial cable system. Pulse-code modulation system. Data transmission system. Codes. Error detection and correction. Telecontrol. Telemetry.

Recommended Books:

1. Young, J. F. "Information Theory". Wiley Inter science, 2007.
2. Stein, S. and Johns, J. J. "Modern Communication Principles with application to Digital signaling". McGraw-Hill, 1967.
3. Schwartz, M. B., Bennet, W. R., and Stein, S. "Communication Systems and Techniques". McGraw-Hill, 1996.
4. Cattermole, R. W. "Principles of Pulse Code Modulation". LLIFFE, 2008.

PHY-838 LASER PHYSICS-II

Amplification of signals and spontaneous emission in laser media. Semiclassical laser theory. Single-mode operation. Multi-mode operation. Gas laser theory . The ring laser.Coherent pulse propagation. Photon echos. Self-induced transparency. Super-radiance. Quantum theory of radiation. Coherent states. Quantum theory of the laser. Photon statistics. Introduction to nonlinear optics. Second harmonic generation. Parametric amplification.

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. Zernike, F. and Midwinter, J. E. "Applied Nonlinear Optics". Dover Pub.2006.

PHY-839 NONLINEAR PHYSICS

Basic Equations and Methods, terminology and classification of interactions, multiples time scale perturbation analysis of the Van Der Pol equations, derivation of the Kortewege-de Vries (KdV) equation for nonlinear ion sound waves, solution of the KdV equation, examples and general properties of the solution, nonlinear theory of ion sound waves with the collision less dissipation, one dimensional Cold Plasma Model, exact solution in Lagrangian variables, Large amplitude oscillations at the upper hybrid frequency, modification due to collisional drag, modification due to finite electron temperature, collision less damping of electron plasma oscillation, review of linear theory, breakdown of linearization effects of particles trapping on the damping of a monochromatic wave, localized electric field disturbances, wave-wave coupling in microscopic plasma models, wave-wave coupling in Vlasov plasma models, nonlinear theory of resonant three wave coupling.

Recommended Books

1. Ronald C. Davidson. " Methods in Nonlinear Plasma Theory", Vol. 37 Academic Press London 1972
2. Kadometsev B. B., "Plasma Turbulence", Academic Press New York 1965
3. Vedenov A. A., "Theory of Turbulence ", Am. Elsevier New York 1968
4. Sagdeev R. Z., and Gakeev A. A., "Nonlinear Plasma theory", Benjamin New York 1970
5. Tsytovich V. N., "Nonlinear Effects in Plasmas", Plenum New York 1970.
6. Infeld E., and Rowlands G., "Nonlinear Waves: Solution and Choes", Cambridge University Press 1990.

PHY-840 MODELLING AND COMPUTATION IN FLUID MECHANICS

Flow topics governed by ordinary differential equations: Initial-value problems, numerical solution of ordinary differential equations, free falling of a spherical body, computer simulation of some restrained motions, fourth order Runge-Kutta method for computing.
Two dimensional motions of a body through a fluid, ballistics of a spherical projectile, initial-value problems , in viscid fluid flows: Incompressible potential flows, numerical solution of second order ordinary differential equations: Boundary value problems, Von K'am'an's method for approximating flow past bodies of revolution, viscous fluid flows: governing equations for viscous flows, self-similar Laminar boundary-Layer flows, Numerical solutions of the incompressible Navier-Sokes Equation, Flow around a rotating sphere at finite Reynolds numbers, convective and absolute instabilities, flow around a rotating cylinder.

Recommended Books

1. Curle S. N and Davies H. J., "Modern Fluid Dynamics", Vol. I & II. Van Nostrand Reinhold co. 1986
2. Landau L. D., and Lifshitz E. M., Fluid mechanics" Pergamon Press 1979
3. Milne L. M., " Theoretical Hydrodynamics", Thomson MacMillan and Co. 1982
4. Howarth L., "Modern Developments in Fluid Dynamics", Oxford Clarendon Press 1984
5. Biringen S., and Chow C. Y., "An Introduction to computational Fluid Mechanics by Examples", John Willey & Sons 2011.
6. Bers A., "Linear Waves and instabilities", In Physiques Des Plasmas (chapter 4).

PHY-841 SURFACE FORCES AND INTERMOLECULAR INTERACTIONS II

Surface and Interfacial Energy, Unlike surfaces in a third medium, Particle – surface interactions, Adsorbed surface Films, Wetting and Non Wetting.
Interaction potentials between macroscopic bodies, Effective interaction area, the Langbein approximation, Derjaguin Approximation, measurements of surface and intermolecular forces.
Bodies of different geometries (The Hamaker Constant), Vander Waals forces between macroscopic bodies in air, Lifshitz continuum theory of Van der Waals forces, Surface and Adhesion energiues, Retardation effects, Surface energies of metals.
The charging of surfaces in liquids: the double layer effect, The Poisson-Boltzmann equation, Counter ions concentration profile, The pressure between two surfaces in water: the contact value theorem, Charged surfaces in electrolyte solution, The DLVO theory (the double layer and Van der Waals forces).
Non DLVO forces, Origin and properties of solvation forces, Repulsive Hydration forces, solvation forces in liquids, Forces in polymer liquids, Adhesion and surface energies of clusters, contact angle, Hysteresis in contact angle and adhesion measurements. Adhesion forces between solid particles.

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-842 EXPERIMENTAL PLASMA II

Pre-requisite: Experimental Plasma I

Aim and Objectives

To enable the PhD students to the advance level of experimental plasma, this can help them working in an advanced lab of plasma physics.

Intended Outcomes

The students will be able to:

- apply the advanced plasma physics used in industries as well as for medical purposes.
- apply the advanced tools used in national and international laboratories.

Course Contents:

Introduction to plasma physics, dc and pulsed dc plasma, Bulk properties of dc plasma, Introduction to RF plasma, Langmuir probe diagnostics, Introduction to plasma emission spectroscopy, Energy storage and transfer, Pinch effect, Plasma focus, Current voltage and magnetic probes, X-rays detection and analysis, Charged particles and neutrons diagnostics, Plasma diagnostics by a laser beam.

Recommended Books:

1. Chen, F. F., "Lecture Notes on: Langmuir probe diagnostics". Mini-Course on Plasma Diagnostics, IEEE-ICOPS meeting, Jeju, Korea, June 5, 2003
2. Fantz, U. (2006). Basics of plasma spectroscopy. *Plasma sources science and technology*, *15*(4), S137.
3. Roth, J. R. "Industrial Plasma Engineering: Applications to Nonthermal Plasma Processing". Vol. 2, CRC press, 2001.
4. Lieberman, M. A., & Lichtenberg, A. J., "Principles of Plasma Discharges and Materials Processing". John Wiley & Sons, 2005.
5. Chabert, P., & Braithwaite, N., "Physics of Radio-Frequency Plasmas". Cambridge University Press, 2011
6. Fujimoto, T., "Plasma Spectroscopy". Vol. 123, Oxford University Press, New York, 2004

PHY-843 ENVIRONMENTAL AEROSOL PHYSICS II

Aims & Objectives

This course is designed to demonstrate the many aspects of atmospheric physics from radiative transfer to satellite remote sensing of aerosol optical properties. The course is based on satellite and ground sensors retrieval algorithms over different land surfaces.

Intended Outcomes

By the end of this course, a student will be able to:

- Apply basics of satellite and ground sensors
- know how to apply radiative transfer equations for the aerosol retrieval, and
- know how to use satellite/ground data for air quality, human health and climate studies

Course Contents

Brief overview of environmental physics I. Land surface reflectance effects, Aerosol retrieval method and techniques, Radiative transfer, characteristics of optical instrument used in aerosol retrieval. Aerosol remote sensing from Moderate Resolution Imaging Spectro-radiometer (MODIS), MODIS dark-target algorithm, MODIS Level-2 and Level-3 aerosol product, Aerosol retrieval methods from Multi Angle Imaging Spectro-radiometer (MISR), Total Ozone Monitoring Instrument (OMI), Total Ozone Mapping Spectro-radiometer (TOMS), and Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO), Satellite remote sensing of aerosol properties, aerosol

retrieval algorithms over bright and dark surfaces. Aerosol retrieval method from Aerosol Robotic Network (AERONET), AERONET direct and inversion aerosol products, and Comparison of MODIS and AERONET aerosol products. Satellite and ground sensors observation for air quality, human health and climate studies.

Recommended Books

1. Kokhanovsky, A. A. and Leeuw, G. "Satellite Aerosol Remote Sensing Over Land". Praxis Publishing Ltd, Chichester, UK, 2009.
2. Seinfeld, J.H. and Pandis, S.N. "Atmospheric Chemistry and Physics: From Air Pollution to Climate Change". John Willey & Sons, Inc., 1998.
3. Charlson, R. J. and Heintzenberg, J. "Aerosol Forcing of Climate". John Wiley & Sons, Chichester, 1995.

PHY-844 CLOUD PHYSICS II

Aims & Objectives

This course is designed to illustrate the advanced aspects of cloud physics in the earth atmosphere system. The course is based on thermodynamicall equations, cloud microphysical and optical properties for both warm and cold clouds.

Intended Outcomes

By the end of this course, a student will be able to:

- Know about cloud formation mechanism
- Describe microstructures of warm and cold clouds
- Explain classification of solid/liquid precipitation

Course Contents

Brief overview of cloud physics-1. General aspects of cloud and precipitation formation, Nucleation of liquid water in water vapor, Atmospheric condensation nuclei. General theory of nucleation, Microstructures of warm clouds, Cloud liquid water content and Entrainment, Growth of cloud in warm clouds. Nucleation of ice particles, Ice Nuclei, Concentrations of Ice particles in clouds, Ice multiplication. Growth of ice particles in clouds, Formation of precipitation in cold clouds, Classification of solid precipitation.

Recommended Books

1. Wallace, J. M., & Hobbs, P. V., " Atmospheric Science: An introductory survey". 2nd ed., Elsevier (AP), 2006.
2. Rogers, R. R. & Yau, M. K. " A short course in cloud physics". 3rd ed., Pergamon Press, Oxford, New York, 1989.
3. Andrews, D. G. " An Introduction to Atmospheric Physics". 2nd ed., Cambridge University Press, New York, 2000.
4. Seinfeld, J. S. & Pandis, S. N" Atmospheric Chemistry and Physics". 2nd ed., John Wiley & Sons, USA, 1998.