INTER-UNIVERSITY ACCELERATOR CENTRE

Aruna Asaf Ali Marg, New Delhi-110 067

Website: www.iuac.res.in

PhD TEACHING PROGRAMME

Course Schedule

Semester-II, January 2018 - May 2018

Advanced Condensed Matter Physics, Advanced Nuclear Physics and Accelerator Physics

Inter-University Accelerator Centre (IUAC) conducts specialized lecture courses for PhD (Physics) Programme at the Centre. The programme is divided into four periods with each period having three course modules. Students doing PhD (Physics) and interested young faculty members from any University, College or Research Institute pursuing a PhD (Physics) Degree may attend the lectures for the course modules of their interest. Some financial assistance towards travel and accommodation will be available for a limited number of cases. Those interested may apply with their bio-data, research interest & a recommendation letter (compulsory) from their PhD Guide / Supervisor, and send / email to:

Coordinator (Teaching Programme)
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	Period		Course Module	Lecturer
1.	22nd Jan. - 16th Feb., 2018	622A	Properties of Solids	Prof. Subhasis Ghosh, JNU
		624A	Nuclear Models-I	Dr. S. Muralithar, IUAC
		626A	Ion Sources	Dr. G. Rodrigues, IUAC
2.	19th Feb. - 16th Mar., 2018	622B	Ion Beam Induced Modifications of Solids	Dr. Ambuj Tripathi, IUAC
		624C	Nuclear Reactions	Dr. Subir Nath, IUAC
		626B	Accelerators & their Applications	Dr. P. K. Kulriya, IUAC
3.	19th Mar. - 13th Apr., 2018	622C	Thin Solid Films : Nucleation, Growth & Characterization	Prof. V.D. Vankar, Ex-IIT Delhi
		624B	Nuclear Models-II	Dr. R. P. Singh, IUAC
		626C	Beam Optics & Beam Transport	Mr. Abhishek Rai, IUAC
4.	16th Apr. - 11th May, 2018	622D	Experimental Techniques in Solid State Physics Research	Dr. D. Kabiraj, IUAC
		624D	Heavy Ion Reactions	Dr. N. Madhavan, IUAC
		626D	Cryogenics & Superconductivity	Mr. Anup Choudhury, IUAC

DETAILS OF COURSE MODULE

622 ADVANCED CONDENSED MATTER PHYSICS

622A PROPERTIES OF SOLIDS : Basic condensed matter physics; band theory of solids, impurities and defects in solids. Magnetic properties of materials; dia-, para-, ferro-, antiferro- and ferri-magnetism; soft and hard magnetic materials; Dielectric properties, piezo, pyro and ferroelectricity. Transport properties and Optical properties of solids: metals, insulators and semiconductors: intrinsic and extrinsic.

622B ION BEAM INDUCED MODIFICATIONS OF SOLIDS : Interaction of an energetic charged particle with matters; local density approximation in stopping power theory, electronic stopping cross section; Nuclear energy loss, energy transfer and simulation of range distribution by Monte-Carlo methods; Basic ion beam simulation programs, SRIM, limitations and modifications, Ion implantation, radiation damage and structure change; sputtering, phase transformations; Ion beam mixing; diffusion by vacancies, self-diffusion and impurity diffusion, impurity incorporation; Ion induced epitaxial crystallization, artificially structured materials, buried layers and band structural engineering for new functional devices. Modification of superconducting properties; columnar defects, effects on critical current density.

622C THIN SOLID FILMS: NUCLEATION, GROWTH & CHARACTERIZATION : Homogeneous nucleation of films, critical radius, nucleation rate;Growth modes, island growth, zone models, columnar growth;Thin film deposition methods; Evaporation, point and surface sources; Sputtering: DC, RF;CVD techniques, reaction types, boundaries and flow, PLD, MBE for epitaxial films;Basic characterization; thickness, refractive index, and extinction coefficients measurement, optical and stylus based techniques; spectroscopic reflectance versus ellipsometry.

622D EXPERIMENTAL TECHNIQUES IN SOLID STATE PHYSICS RESEARCH : Basic characterization tools, Structural techniques, XRD; Microscopic measurements, SEM, TEM; analytical attachments EDS,SPM for topographic measurements with variants AFM, STM, MFM, STS;Spectroscopic techniques, Raman, Photoluminiscence, Ionoluminiscence;XPS, Transport measurements, van der Pauw method, two and four probe technique; Hall measurement, carrier density and mobility.

624 ADVANCED NUCLEAR PHYSICS

624A NUCLEAR MODELS-I : Two body forces, Infinite nuclear matter, Effective interactions (pairing + Quadrupole, Skyrme etc.). Single particle motion, Shell model with configuration mixing, Nilsson model, Strutinsky and shell corrections, experimental techniques in nuclear models.

624B NUCLEAR MODELS-II : Liquid drop model and collective motion, Rotation and vibration with particle coupling, Cranking models, Hartree-Fock models, Hartree-Fock Bogoliubov and quasi particles, Pairing and BCS equations.

624C NUCLEAR REACTIONS : Kinematics, optical model of elastic scattering, direct and compound nuclear reactions, nucleosynthesis in nuclear reactions, Hauser-Feshback description of compound nuclear reactions, inelastic scattering and transfer reactions and their descriptions in distorted-waves Born Approximation and in coupled channels formalism, resonances (Isobaric Analogue, Giant and Molecular) break-up reactions.

624D HEAVY ION REACTIONS : Special features of heavy ions scattering (Q-and L-window), semi classical models, deflection functions, rainbow and Glory scattering, quasi elastic and transfer reactions, deep inelastic scattering, complete and incomplete fusion, fission.

626 ACCELERATOR PHYSICS

626A ION SOURCES: Production of charged particles, space charge limitation; extraction & focusing geometries, positive and negative ion sources, radio frequency sources, penning ionization source, Duoplasmatron, sputter ion source, ECR source (room temperature and superconducting).

626B ACCELERATORS & THEIR APPLICATIONS : Electrostatic accelerators - Cockroft-Walton, Van-de-Graaff, Principle of tandem accelerator, Pelletron accelerator; Pulsed accelerators - cyclotron, synchrotron; Radio frequency linear accelerators; Superconducting linac, Radio frequency quadrupole; Drift tube linac; Storage rings; Future trends. Trace element analysis: various methods, RBS - measurement of elemental ratios & concentrations, channeling RBS, ERDA - depth resolution & sensitivity, high resolution sub monolayer thickness studies, Nuclear Reaction Analysis (NRA), Particle Induced X-ray emission (PIXE) studies, Accelerator Mass Spectrometry (AMS), Medical applications of accelerators.

626C BEAM OPTICS AND BEAM TRANSPORT : Motion of charged particles in electric and magnetic fields; Phase space - longitudinal and transverse, and Liouville's theorem, Focusing devices: Einzel lens, solenoid magnet, quadrupole; magnetic and electric sector fields; Matrix method, Aberrations, Design of a beam line for beam transport; Computer simulations.

626D CRYOGENICS & SUPERCONDUCTIVITY : Introduction to cryogenics and its application to accelerators, achieving low temperature, liquifaction of gases; Basic thermodynamic processes, various thermodynamic cycles, commercial liquifiers/refrigeration, critical components. Heat transfer at low temperature: conduction, convection, radiation processes, insulation, LN2/ LHe storage vessels, cryostat design-properties of materials at low temperature, heat load calculation; Basic superconductivity, superconducting magnet; Cryogenic instrumentation - temperature sensor, liquid helium / nitrogen level, flow sensors.