

अंतर-विश्वविद्यालय त्वरक केंद्र

INTER-UNIVERSITY ACCELERATOR CENTRE

अरुणा आसफ अली मार्ग, नई दिल्ली-110067/

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पाठ्यक्रम समय-सारणी/Course Schedule

छमाही- II: Semester-II: जनवरी – जून, 2026/ January – June, 2026

एडवांस्ड कंडेंस्ड मैटर फिजिक्स, एडवांस्ड न्यूक्लियर फिजिक्स, कम्प्यूटेशनल टेक्निक्स/

Advanced Condensed Matter Physics, Advanced Nuclear Physics, Computational Techniques

	Period		Course Module	Lecturer
1	Jan. 30 to Feb. 28, 2026	622A	Properties of Solids	Dr. V.V. Sivakumar
		624C	Nuclear Reactions	Dr. K.S. Golda
		628A	Computational & Programming Techniques	Dr. Joby Antony
2	Mar. 5 – 28, 2026	622B	Ion Beam Induced Modifications of Solids	Dr. Fouran Singh
		624A	Nuclear Models-I	Ms. Indu Bala
		628B	Numerical analysis	Dr. Pankaj Kumar
3	Apr. 1 - 22, 2026	622C	Thin Solid Films: Nucleation, Growth & Characterization	Dr. Indra Sulania
		624B	Nuclear Models-II	Prof. B.K. Nayak, HBNI, Mumbai
4	Apr. 24 – May 21, 2026	622D	Experimental Techniques in Solid State Physics Research	Dr. R.C. Meena
		624D	Heavy Ion Reactions	Dr. N. Saneesh
		628C	Research Methodology	Prof. Shikha Varma
5.	May 15 – June 13, 2026	629	Research Publication & Ethics	Dr. C.P. Safvan

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, Photoluminescence, Ionoluminescence; 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 model, Hartree-Fock model, 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.

628 COMPUTATIONAL TECHNIQUES

628A COMPUTATIONAL & PROGRAMMING TECHNIQUES: Basic concepts, microprocessors, standard buses, operating systems, multitasking, networking, Ethernet TCP/IP. Basic structure of a program, data structures, object oriented programming, optimization of program, introduction to C and Python.

628B NUMERICAL ANALYSIS: Errors - systematic & random, Mean & standard deviations, statistical distributions, propagation of errors, least square fit - straight line, polynomials, goodness of fit-chi-squared, errors in fitted parameters & reliability. Interpolations, numerical integration and differentiation, matrix inversion and diagonalization, solution of linear and non-linear equations, solution of ordinary differential equations, concept of Monte-Carlo method. Introduction to numerical analysis package (MATLAB or equivalent).

628C RESEARCH METHODOLOGY: Objectives and types of Research, Research Formulation, Research Design, Statistical Treatment of data and errors, Writing thesis and Research papers, Intellectual Property rights.

629 RESEARCH PUBLICATION & ETHICS

629A THEORY: Philosophy and Ethics, Scientific Conduct, Publication Ethics,

629B PRACTICE: Open Access Publishing, Publication Misconduct, Databases and Research Metrics