# अंतर-विश्वविद्यालय त्वरक केंद्र
# INTER-UNIVERSITY ACCELERATOR CENTRE
### अरूणा आसफ़ अली मार्ग, नई दिल्ली-110067/Aruna Asaf Ali Marg, New Delhi-110 067
### वेबसाइट/website: www.iuac.res.in

## पाठ्यक्रम समय-सारणी/Course Schedule

### छमाही- I: Semester-I: सितंबर 2023 – दिसंबर 2023 / September 2023 - December 2023

### एडवांस्ड क्लासिकल एण्ड क्वांटम मैकेनिक्स, एक्सपेरिमेंटल फिजिक्स, एक्सेलरेटर फिजिक्स/
### Advanced Classical & Quantum Mechanics, Experimental Physics, Accelerator Physics

| Inter-University Accelerator Centre (IUAC) conducts specialized lecture courses for Ph.D (Physics) Programme at the Centre. The programme is divided into three periods with several Course Modules. Students doing Ph.D (Physics) and interested young faculty members from any University, College or Research Institute pursuing Ph.D (Physics) Degree may attend the lectures for the modules of their interest. | | Period | | Course Module | Lecturer |
|---|---|---|---|---|---|
| | 1. | 1st Sept. – 10th Oct., 2023 | 611A | Advanced Classical Mechanics | Ms. Indu Bala, IUAC |
| | | | 626A | Ion Sources | Dr. G. Rodrigues, IUAC |
| | | | 626B | Accelerators and their Applications | Dr. P. Sugathan, IUAC |
| | | | 617C | Vacuum Techniques | Dr. Soumen Kar, IUAC |
| The minimum qualification required to attend the course work is M.Sc. (Physics). 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 and a recommendation letter (which is compulsory) from their Ph.D Guide / Supervisor and send / email to: | 2. | 15th Oct. – 5th Nov., 2023 | 617A | Detectors and Transducers | Dr. Akhil Jhingan, IUAC |
| | | | 617B | Signal Processing | Er. Ashish Sharma, IUAC |
| | | | 617D | Data Acquisition System | Ms. Mamta Jain, IUAC |
| **Coordinator (Teaching Programme)** **INTER-UNIVERSITY ACCELERATOR CENTRE** **Aruna Asaf Ali Marg** **New Delhi – 110067** **Tel: 011-24126022 / 24 / 25 / 26 / 29** **E-mail: academic@iuac.res.in,** programphdteaching@gmail.com | 3. | 10th Nov. – 15th Dec., 2023 | 611B | Advanced Quantum Mechanics | Dr. Sugam Kumar, IUAC |
| | | | 626C | Beam Optics and Beam Transport | Dr. Sarvesh Kumar, IUAC |
| | | | 626D | Cryogenics and Superconductivity | Dr. Anup Choudhary, IUAC |
| | | | 617E | Engineering Drawing | Er. Rajeev Ahuja, IUAC |

## 611    ADVANCED CLASSICAL & QUANTUM MECHANICS

**611A ADVANCED CLASSICAL MECHANICS:** Particle motion in 1, 2 & 3 dimensions; conservation laws; non-inertial frames, Generalized coordinates; Lagrangian methods and examples; two body problem; bound states and scattering, Small oscillations; Hamiltonian formalism; canonical transformations; Hamilton-Jacobi theory, Special relativity and relativistic kinematics.

**611B ADVANCED QUANTUM MECHANICS:** One-dimensional Schrödinger equation; particle in a square-well potential; bound states; transmission and reflection from step potentials; W.K.B. method for bound states; tunneling; harmonic oscillator; operator method of solution. Two-level and other finite-dimensional Hilbert space problems. Three-dimensional Schrödinger equation, angular momentum, algebra of angular momentum; square well in 3 dimensions; hydrogen atom. Perturbation theory. Atoms in electric magnetic fields; spin-orbit coupling; scattering theory, General Symmetries in nuclei with special reference to isospin and parity.

## 617    EXPERIMENTAL PHYSICS

**617A DETECTORS & TRANSDUCERS:** Energy loss of charged particles in matter; range & straggling, energy, position & time detection for charged particles with solid state detectors, gas detectors - ionization chamber, multi-wire proportional counter; Interaction of radiation with matter; semi-conductor gamma detector, scintillation detectors, channel electron multipliers and micro-channel plates. Particle identification techniques & time of flight.

**617B SIGNAL PROCESSING:** Transmission lines, impedance matching; Noise, filters, pre-amplifiers, amplifiers, pole-zero cancellation, Base line restoration, Pile up rejection, introduction to NIM Standards. Timing measurement, Leading edge and constant fraction discriminators, coincidence measurements, gates, Time-amplitude converter, analog-digital conversion.

**617C VACUUM TECHNIQUES:** Basic elements of vacuum science, viscous and molecular flow, conductance, pumping speed etc. Displacement & containment pumps, Design of ultra-high vacuum system, vacuum measurement system, vacuum measurement gauges, Control & interlock system, Leak detection techniques.

**617D DATA ACQUISITION SYSTEM:** Data collection using CAMAC and VME; Hardware conditions and configurations; Event mode data collection and multi-dimensional histograms; Software conditions; Analysis of experimental data and extraction of physics results; Available open source software.

**617E ENGINEERING DRAWING:** Projections, Sectional drawing, Representation of fasteners, Tolerance, Welding & drawing. Practical demonstration of fabricating a vacuum component.

## 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.