PANJAB UNIVERSITY CHANDIGARH- 160014 (INDIA)

(Estted. under the Panjab University Act VII of 1947-enacted by the Govt. of India)

FACULTY OF SCIENCE

SYLLABI

FOR

P.G.DIPLOMA IN ACCELERATOR& DETECTOR PHYSICS

(SEMESTER SYSTEM)

NEP -2020

SESSION 2025- 2026

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PANJAB UNIVERSITY, CHANDIGARH

Outlines of tests, syllabi and courses of reading in the subject of P.G. Diploma in Accelerator& Detector Physics in Semester System for the session 2025-2026.

Seats:

Total number of seats is 20 with the reservation policy of the university

Regulation:

Regulation is same as approved earlier for the old Post-M.Sc. Diploma in Accelerator Physics

Eligibility:

The eligibility may be kept as Two years M.Sc. Physics, B.E / B. Tech in any discipline and four years B.Sc. Physics programme.

Fee Structure:

The fee structure is same as that of the M.Sc. 1st year Physics class of the Department revised time to time by the university

FIRST SEMESTER

Paper Code	Subject	Credits (20)	Marks (500)
PHY-AP-01	Beam Dynamics and Transport System	4	100
PHY-AP-02	Accelerators	4	100
PHY-AP-03	Detectors	4	100
PHY-AP-04	Vacuum techniques and workshop training	4	100
PHY-AP-05	Accelerator Physics Laboratory	4	100

SECOND SEMESTER

Paper Code	Subject	Credits (20)	Marks (500)
PHY-AP-06	Dissertation	8	200
PHY-AP-07	Accelerator based Analytical technique	4	100
PHY-AP-08	Detector Physics Lab	4	100
PHY-AP-09	μP and PC interfacing laboratory	4	100

FIRST SEMESTER

PHY-AP- 01: Beam Dynamics and Transport System (40 Hours)

Review – Charged Particle dynamics – non-relativistic and relativistic formulas, Electric and Magnetic fields, modifications of fields by materials, Particle motion in electric and magnetic fields, Beam transport system.

Linear Beam Dynamics: Transverse beam control, Paraxial approximation for electric and magnetic fields, Electric and magnetic field lenses - Focussing properties of linear fields, Chromatic properties, Achromatic Lattices, Isochronus systems, Electrostatic aperture lens, Electrostatic immersion lens, Solenoidal Magnetic lens, Magnetic sector lens, Edge focussing, Magnetic quadrupole lens, Calculation of particle orbits in focusing fields- Transverse orbits in continuous linear focussing force, Betatron Oscillations, Azimuthal motion of particle in cylindrical beams, Paraxial ray equation.

Beam transport system: Transfer matrices of quadrupole lens, quadrupole doublet and triplet lenses, focussing in a thin lens array, quadrupole focussing channels, Periodic Focussing system: FODO Lattice, scaling of parameters, Non-linear dynamics.

Beam pulsing and bunching techniques, Particle beam parameters.

Books:

1. Particle Accelerator Physics, Vol. I and II, H.J. Wiedman, Springer Verlag.
2. Accelerator Physics, S.Y. Lee, World Scientific.
3. An Introduction to the Physics of Particle Accelerators – Mario Conte and William W. MacKay, World Scientific.
4. Principles of charged particle Acceleration; Stanley Humphries, John Willey & Sons.

PHY-AP -02: Accelerators (40 Hours)

Ion sources: Production of heavy negative ions, RF ion source, SNICS, charge exchange canal, Duoplasmatron ion source, heavy – ion stripping using Carbon foil and gas strippers.

Electrostatic accelerators: Electrostatic generators, charging system, insulating column, high voltage multiplier and rectifier system, voltage measurements, Van-de-Graff accelerator, Tandem electrostatic accelerator Pelletron, Trandetron.

Radiofrequency accelerators – Linear accelerators – Resonance acceleration and phase stability, electron and proton LINACs. Circular accelerators – Cyclotron, Frequency Modulated Synchrocyclotron, AVF Cyclotron, Alternating- gradient accelerators, Betatron, Proton synchrotron, Colliding accelerators.

Superconducting Accelerators, Various accelerator combinations, Radioactive ion beams, Polarized beams, Acceleratorsfor Meson production.

Synchrotron radiation sources – Electromagnetic radiation from relativistic electron beams, Synchrotrons radiation spectrum, Spatial distribution, beam divergence, Temporal and Spatially coherent synchrotron radiation, Spectral brightness, Insertion devices – bending magnet radiation, wavelength shifter, Wiggler magnet radiation, Undulator radiation.

Books:

1. Particle Accelerators, M.S. Livingston and J.P. Blewel, McGraw-Hill Book Press.
2. Particle Accelerator Physics, Vol. I and II, H.J. Wiedman, springer Verlag (1998)
3. Principles of Charged Particle Acceleration, Stanley Humphries, John Wiley and Sons.
4. Handbook of accelerator Physics and engineering, Alexander Wu Chao and Maury Tigner, World Scientific.
5. Theory of Resonance Linear Accelerators by I.M. Kapchenkey, Harwood Academic Publishers.

PHY-AP - 03: Detectors (40 Hours)

Basics of detector physics and introduction to modern detectors

PHY- AP - 04: Vacuum Techniques and Workshop Training (40 hours)

(a). Students will be introduced to vacuum techniques and will be trained in the vacuum systems of the Cyclotron Accelerator Laboratory.

(b). The students will be trained in the Electronics, Electrical and Mechanical Workshops.

PHY-AP-05: Accelerator Physics Laboratory (9 Hours per week)

Experiments based on (a) Vacuum techniques (b) Cyclotron operation (c) Target preparation techniques and (d) Accelerator based analytical techniques.

SECOND SEMESTER

PHY- AP -06: Dissertation

The candidate is expected to do project work (duration = 10 weeks) at one of the National institutes having Accelerator facility or in the Dept. Cyclotron laboratory. Project work will be carried out with the supervision of a faculty members. Going to a different Institutes for the project is optional.

PHY-AP-07: Accelerator based Analytical Techniques and Applications (40 Hours)

Analytical Techniques: RBS, PIXE, PIGE, ERDA, NRA, RSA, Micro beam applications, AMS, Use of accelerator for Neutron generation, ADS. Medical applications- spot scanning system by proton therapy, Neutron

radiation therapy, Isotope production, radioactive beam therapy, BNCT, X-ray radiography, neutron radiography.

Industrial applications – Ion implantation, Nuclear-filters, material testing, radiation processing.

Detection of radiation and electronics (Seminar based) – Interaction of γ –rays, neutrons, electrons and heavy charged particles with matter, gas-filled detectors, Organic and inorganic scintillators, Semiconductor detectors for X-rays, γ-rays and charged particles, Associated electronics for singles and coincidence measurements. NIM and CAMAC instrumentation standards.

Books:

1. Radiation detection and Measurements by Glenn F. Knoll, John Wiley and Sons.
2. Techniques for Nuclear and Particle Physics experiments by W.R. Leo, Springer Verlag.
3. Nuclear Spectroscopy and Reactions Part – A, Ed. J. Cerny, Academic Press.

PHY-AP-08: Detector Physics Lab.

Students need to perform at least six experiments involving various detectors available at the Department and Cyclotron Accelerator Lab.

PHY- AP-09: μP and PC interfacing Laboratory

Experiments based on interfacing of μP and Personal Computer to control electronic gadgets necessary for Accelerator.

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