

FOUR YEAR UNDERGRADUATE PROGRAM (2024 – 28)
DEPARTMENT OF PHYSICS
COURSE CURRICULUM

| PART-A: INTRODUCTION | | | |
|---|--------------------------------|---|--|
| Program: Bachelor in Science (Degree/Honors) | | Semester - V | Session: 2024-2025 |
| 1 | Course Code | PHSE-03 | |
| 2 | Course Title | Nuclear Physics | |
| 3 | Course Type | Discipline Specific Elective | |
| 4 | Pre-requisite (if, any) | As per Program | |
| 5 | Course Learning Outcomes (CLO) | <ul style="list-style-type: none"> ➤ Describe nuclear constituents and their intrinsic properties. Analyze binding energy variations with mass number and understand the N/Z plot. ➤ Explain and apply nuclear models for clear understanding of stability of nuclei and nuclear processes. Differentiate alpha, beta, and gamma decay and interpret energy spectra. ➤ Apply conservation laws to compute Q-values, and analyze reaction mechanism. Explain significance of scattering and reaction cross section. ➤ Calculate and compare nuclear fission and fusion energy. Describe nuclear detectors and particle accelerators. ➤ Gain insights into cutting-edge research, accelerator technology, and interdisciplinary applications and apprehend the role of accelerators in advancing scientific knowledge and contributing to societal well-being. | |
| 6 | Credit Value | 4 Credits | Credit = 15 Hours - learning & Observation |
| 7 | Total Marks | Max. Marks: 100 | Min Passing Marks: 40 |

PART -B: CONTENT OF THE COURSE

| Total No. of Teaching-learning Periods (01 Hr. per period) – 60 Periods (60 Hours) | | |
|--|---|---------------|
| Unit | Topics (Course Contents) | No. of Period |
| I | General Properties of Nuclei: Constituents of nucleus and their Intrinsic properties, quantitative facts about mass, radii, charge density (matter density), binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/A plot, angular momentum, parity, magnetic moment, electric moments. | 15 |
| II | Nuclear Models: Liquid drop model approach, semi empirical mass formula and, significance of its various terms, condition of nuclear stability, two nucleon separation energies, Fermi gas model, evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model, concept of mean field. | 15 |

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|------------------------|--|-----------|
| <p>III</p> | <p>Nuclear decay and Reactions: Alpha, beta, gamma decay, energy spectrum, Geiger-Nuttel law, disintegration energy, quantum theory of alpha decay, types of beta decay and energy spectrum, Pauli's prediction of neutrino. Types of Reactions, Conservation Laws, kinematics of reactions, Q-value, reaction rate, reaction cross section, Concept of compound and direct Reaction, resonance reaction, Coulomb scattering (Rutherford scattering).</p> <p>Nuclear Energy Reactions: Nuclear Fission, Calculation of energy released, Nuclear fusion, Energy released in Fusion, Comparison of Fission and fusion energy, Fusion as source of stellar Energy, Nuclear reactors in India, Contribution of nuclear energy in total energy requirement.</p> | <p>15</p> |
| <p>IV</p> | <p>Nuclear Detector and Particle Accelerators: Interaction of charge particle through matter, Gas detectors: estimation of electric field, mobility of particle, for ionization chamber and GM Counter. Basic principle of Scintillation, Detectors and construction of photo-multiplier tube (PMT), Semiconductor Detectors. Accelerator facility available in India: Van-de Graaff generator, Pelletron accelerator, Linear accelerator, Cyclotron accelerator</p> <p>Nuclear Accelerators in India: RRCAT, VECC, BARC TIFR Pelletron Facility, IUC : working, evolution and contribution.</p> | <p>15</p> |
| <p><i>Keywords</i></p> | <p>Properties of Nucleus, Nuclear forces, Nuclear Models, Decay reaction, detectors and accelerators</p> | |

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Signature of Convener & Members (CBoS) :

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PART-C: Learning Resources

Text Books, Reference Books and Others

Text Books Recommended –

1. Introduction to Nuclear and Particle Physics V.K. Mittal, R. C. Verma, S. C. Gupta, Eastern Economy Edition.
2. Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (IOP-Institute of Physics Publishing, 2004)
3. Nuclear Physics by S.N. Ghoshal, S. Chand Publishing, 2019
4. Unified Physics-III by R P Goyal, Shivlal Agrawal & Sons Publication
5. Nuclear Physics -6Ed by D. C. Tayal, Himalaya Publishing House

Reference Books Recommended –

1. Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
2. Concepts of nuclear physics by Bernard L. Cohen. (Tata Mc-Graw Hill, 1998).
3. Introduction to the physics of nuclei & particles, R.A. Dunlap. (Thomson Asia, 2004).
4. Nuclear Physics An Introduction S. B. Patel New Age International Publishers.

Online Resources– e-Resources / e-books and e-learning portals

1. [NPTEL :: Physics - NOC:Nuclear and Particle Physics](#)
2. [NPTEL :: Physics - Nuclear Physics: Fundamentals and Applications](#)
3. [Fundamentals of Nuclear Power Generation - Course \(nptel.ac.in\)](#)
4. [eGyanKosh: Unit-13 Nuclear Physics](#)
5. [eGyanKosh: Block-4 Nuclear Physics](#)
6. [NPTEL :: Physics - Nuclear Science & Engineering](#)
7. Official Websites of Raja Ramanna Centre for Advanced Technology (RRCAT), Variable Energy Cyclotron Centre (VECC), BARC–TIFR Pelletron Facility, Inter-University Accelerator Centre (IUAC)

PART -D: Assessment and Evaluation

Suggested Continuous Evaluation Methods:

Maximum Marks: 100 Marks

Continuous Internal Assessment (CIA): 30 Marks

End Semester Exam (ESE): 70 Marks

| | | | |
|---|--|----------|---|
| Continuous Internal Assessment (CIA): (By Course Teacher) | Internal Test / Quiz-(2): | 20 & 20 | Better marks out of the two Test / Quiz + obtained marks in Assignment shall be considered against 30 Marks |
| | Assignment / Seminar - Total Marks - | 10 30 | |
| End Semester Exam (ESE): | Two section – A & B Section A: Q1. Objective – 10 x1= 10 Mark; Q2. Short answer type- 5x4 =20Marks Section B: Descriptive answer type qts., 1 out of 2 from each unit-4x10=40 Marks | | |

Name and Signature of Convener & Members of CBoS:

