Lesson Plan 2023-24 (Odd Semester)
Dr. Alka
B Sc III Semester V- NM & CS
Paper: PH -502 Nuclear Physics

Syllabus

Max. Marks: 40
Internal Assessment: 10
Time for theory paper: 3 hours

Unit I

Nuclear Structure and Properties of Nuclei, Nuclear composition (p-e and p-n hypotheses), Nuclear properties; Nuclear size, spin, parity, statistics, magnetic dipole moment, quadruple moment (shape concept). Determination of mass by Bain-Bridge, Bain-Bridge and Jordan mass spectrograph. Determination of charge by Mosley Law. Determination of size of nuclei by Rutherford Back scattering, mass and binding energy, systematic of nuclear binding energy, nuclear stability

Unit II

Nuclear Radiation decay Processes Alpha-disintegration and its theory. Energetics of alpha-decay, Origin of continuous beta spectrum (neutrino hypothesis), types of beta-decay and energetics of beta-decay. Nature of gamma rays, Energetics of gamma rays. interaction of heavy charged particles (Alpha particles); Energy loss of heavy charged particle (idea of Bethe formula, no derivation), Range and straggling of alpha particles. Geiger-Nuttal law. Interaction of light charged particle (Beta-particle), Energy loss of beta-particles (ionization), Range of electrons, absorption of beta-particles. Interaction of Gamma Ray; Passage of Gamma radiations through matter (Photoelectric, Compton and pair production effect) electron-positron annihilation. Absorption of Gamma rays (Mass attenuation coefficient) and its application.

Unit III

Nuclear Accelerators, Linear accelerator, Tendem accelerator, Cyclotron and Betatron accelerators. Nuclear Radiation Detectors: Gas filled counters; Ionization chamber, proportional counter, G.M. Counter (detailed study), Scintillation counter and semiconductor detector.

Unit IV

Nuclear reactions, Nuclear reactions, Elastic scattering, Inelastic scattering, Nuclear disintegration, Photonuclear reaction, Radiative capture, Direct reaction, Heavy ion reactions and spallation Reactions. Conservation laws, Q-value and reaction threshold. Nuclear Reactors, General aspects of Reactor Design. Nuclear fission and fusion reactors, (Principle, construction, working and use).

References:

1. Kaplan I, Nuclear Physics, 2nd Ed (1962), Oxford and IBH, New Delhi
2. Sriram K, Nuclear Measurement Techniques, (1986), AEWP, New Delhi
3. Tayal D C, Nuclear Physics (1994), HPH, Bombay
4. Ghoshal S N, Atomic and Nuclear Physics Vol II (1994), S Chand & Co New Delhi
5. Srivastava B N, Basic Nuclear Physics, (1993), Pragati Prakashan Meerut
6. Halliday, Introductory Nuclear Physics, Asia Publishing House, New Delhi
7. Cohen B L, Comcepts of Nuclear Physics (1998), Tata Mc Graw Hill, New Delhi
8. Roy R R and Nigam B P, Nuclear Physics (1993), Wiley Eastern Ltd New Delhi.

Course Objectives:

The objectives of this course are listed below

- To impart knowledge about basic nuclear properties and various theories proposed for its constitution.
- To understand radiation decay processes and their interaction with matter.
- To understand various types of nuclear radiation accelearators and detectors.
- To develop an understanding of nuclear reactions, their types, nuclear reactors and their applications.

Course Outcome

After the completion of this course, students will be able to

- Describe the structure of nuclei and its properties by using different methods for the determination size, mass and binding energy.
- Explain radiation decay like alpha-decay, Beta-decay, gamma-decay, mechanism of their emission and their respective spectra. Understand the interaction of different nuclear radiations with matter and energy loss due to ionization
- Understand the role of nuclear accelerators and nuclear detectors in accelerating and detecting charged as well as uncharged particles
- Understand the basics aspects of nuclear reactions, Q value of reactions, conservation laws and principle, construction and working of nuclear reactors.

Week No.	Dates	Topics to be covered
1.	26th July 23 – 29 July 23	Introduction to Nuclear Physics, Determination of size of nuclei by Rutherford Back Scattering expt.
2.	31st July 23 – 5th August 2023	Nuclear composition (p-e and p-n hypotheses) Nuclear properties: Nuclear charge, mass, size, density
3.	7th August 2023-12 August 2023	Nuclear spin (Total angular momentum of nuclei), magnetic dipole moment, quadrupole moment (shape concept)
4.	14th Aug. 2023-19 August 2023	Parity, statistics, Determination of mass by Bain-Bridge, Bain-Bridge and Jordan mass spectrograph. Determination of charge by Mosley Law
5.	21st Aug. 2023 – 26th Aug. 2023	Nuclear composition (p-e and p-n hypotheses) Nuclear properties: Nuclear charge, mass, size, density
6.	28th August 2023-2nd September 2023	Binding energy, systematic of nuclear binding energy, nuclear stability, Numerical Problems
7.	4th September 2023 – 9th September 2023	Alpha-disintegration and its theory , Energetics of alpha-decay, Origin of continuous beta spectrum (neutrino hypothesis), types of beta-decay and energetics of beta-decay
8.	11th September 2023 – 16th September 2023	Nature of gamma rays, Energetic of gamma rays. Interaction of heavy charged particles (Alpha particles); Energy loss of heavy charged particle (idea of Bethe formula, no derivation)
9.	18th September 2023 – 23th September 2023	Range and straggling of alpha particles. Geiger-Nuttal law. Interaction of light charged particle (Beta-particle), Energy loss of beta-particles (ionization)
10.	25th September 2023 – 30th September 2023	Range of electrons, absorption of beta-particles. Interaction of Gamma Ray; Passage of Gamma radiations through matter (Photoelectric, Compton and pair production effect)
11.	2nd October 2023- 7th October 2023	Electron-positron annihilation. Absorption of Gamma rays (Mass attenuation coefficient) and its application.
12.	9th October 2023- 14th October 2023	Linear accelerator, Tendem accelerator. Cyclotron, Betatron accelerator, Gas filled counters; Ionization chamber
13.	16th October 2023- 21st October 2023	Proportional counter, G.M. Counter (detailed study), Scintillation counter and semiconductor detector.
14.	23rd Oct. 2023- 28th Oct 2023	Nuclear reactions, Elastic scattering, Inelastic scattering, Nuclear disintegration Photonuclear reaction, Radiative capture, Direct reaction.
15.	30th October 2023- 4th November 2023	Heavy ion reactions and spallation Reactions. Conservation laws, Q-value and reaction threshold.

16.	6th November 23 to 9th November 23	Introduction to Nuclear Reactors , General aspects of Reactor Design Nuclear fission and fusion reactors, (Principle, construction, working and use)
17.	10th -16th November 23	Diwali Break
18.	17th November – 25th November 23	Revision, Doubts of students and discussion of previous years Question Papers