PARVATHANENI BRAHMAYYA
SIDDHARTHA COLLEGE OF ARTS & SCIENCE
Autonomous
Siddhartha Nagar, Vijayawada–520010
Re-accredited at 'A+' by the NAAC

Paper – 1: NUCLEAR AND PARTICLE PHYSICS

Offered to : M.Sc.(PHYSICS)	Course Code : 22PH4T1
Course Type : Core	Course : Nuclear and particle physics
Year of Introduction : 2004	Year of offering : 2022
Year of Revision : 2022	Percentage of Revision : Nil
Semester : IV	Credits : 4
Hours Taught: 60 hrs. per Semester	Max.Time : 3 Hours

CourseDescription:

Nuclearand Particle Physics course describesthe structure ofnuclei—theirformation,stability, and decay. It aims to understand the fundamental nuclear forces in nature, their symmetries, andthe resulting complex interactions between protons and neutrons in nuclei and among quarks insidehadrons, including the proton

Course Objectives:

1. To know the basic properties of nucleus and their properties.

2. To visualize the nuclear characteristics through different nuclearmodels.

3. To understand nuclear reactions in nuclear reactors for generation of nuclearenergy.

4. To learn classification of elementary particles and gain knowledge on basic concepts of particle physics.

5. To demonstrate the mechanism of particle accelerators and creation of novelparticles.

Course Outcomes: At the end of this course, students should be able to:

CO1: Remember the concepts of fundamentals of nuclear physics including nuclear forces, nuclear models,nuclear reactions and reactors, fundamentals of particle physics and Particle Accelerators.
CO2: Understand the characteristics of nuclear forces and the different nuclear model tocalculate the radioactivity decayprocess.
CO3: Understand the process in nuclear reactors for generation of energy.
CO4: Understand the fundamentals of particle physics.
CO5: Analyze the particle accelerators technologies and their role as nuclear medicine andDetectortechnologies.

CO-POMATRIX								
22PH4T1	**CO-PO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**
	CO1	M					L	M
	CO2	H					L	M
	CO3	H					L	M
	CO4	H					L	M
	CO5		H	M			L	M

Syllabus		
Unit	**LearningUnits**	**Lecture Hours**
I	**Introduction and Nuclear Forces** **Introduction**: Objective of studying Nuclear Physics, Nomenclature, nuclear radius, Mass & Binding energy, Angular momentum, Magnetic dipole moment, Electric quadrupole moment, parity and symmetry, Domains of instability, Energy levels, Mirror nuclei. **Nuclear Forces:** Characteristics of Nuclear Forces- Ground state of deuteron, scattering cross - sections, qualitative discussion of neutron-proton scattering at low energies – charge independence, spin dependence and charge symmetry of nuclear forces – exchange forces and tensor forces – Meson theory of nuclear forces (Yukawa's Potential).	12
II	**Nuclear Models and Nuclear Decay** **Nuclear Models:** Weizsacker's semi-empirical mass formula - mass parabolas- Liquid drop model - Bohr–Wheeler theory of nuclear fission – Nuclear shell model: magic numbers, spin-orbit interaction, prediction of angular momenta and parities for ground states. **Nuclear Decay:** Alpha decay process, Energy release in Beta-decay, Fermi's theory of Beta- decay, selection rules, parity violation in Beta-decay, Detection and properties of neutrino, selection rules, angular correlation.	12
III	**Nuclear Reactions and Nuclear Energy** **Nuclear Reactions:** Types of reactions and conservation laws, nuclear kinematics – the Q–equation, threshold energy - Nuclear cross section **Nuclear Energy:** Nuclear fission- energy release in fission- Stability limit	12

	against spontaneous fission, Characteristics of fission, delayed neutrons, nuclear fusion, prospects of continued fusion energy. Four factor formula for controlled fission (nuclear chain reaction) - nuclear reactor- types of reactors.	
IV	**Elementary Particle Physics** Classification - Particle interactions and families, symmetries and conservation laws (energy and momentum, angular momentum, parity, Baryon number, Lepton number, isospin, strangeness quantum number) Discovery of K-mesons and hyperons (Gell-Mann and Nishijima formula) and charm, Elementary ideas of CP and CPT invariance, SU(2), SU(3) multiplets, Quark model.	12
V	**Accelerators and Applications** **Accelerators:** Electrostatic accelerators, cyclotron accelerators, synchrotrons **Applications:** Trace Element Analysis, Rutherford Back-scattering, Mass spectrometry with accelerators, Concepts of Diagnostic Nuclear Medicine and Therapeutic Nuclear Medicine.	12

TextandReferenceBooks:

1. NuclearPhysics,D.C.TAYAL(HimalayapublishingCo.).
2. IntroductoryNuclearPhysics,KENNETHS.KRANE(JohnWiley&Sons).
3. IntroductiontoNuclear Physics, HARALD A.ENGE(AddisonWesley).
4. ConceptsofNuclear Physics, BERNARDL.COHEN(McGraw-Hill).
5. IntroductiontoHighEnergyPhysics, D.H.PERKINS(CambridgeUniversityPress).
6. IntroductiontoElementaryParticles,D.GRIFFITHS(Wiley-VCH).
7. NuclearPhysics,S.B.PATEL(WileyEasternLtd.).
8. FundamentalsofNuclearPhysics,B.B.SRIVASTAVA(RastogiPublications).