AMITY UNIVERSITY
UTTAR PRADESH

L	T	P/S	SW/FW	TOTAL CREDIT UNITS
2	0	0	4	4

Course Title: **Advanced Nuclear Physics** **Credit Units: 04**

Course Level: Ph.D **Course Code:NST901**

Course Objectives:

This course deals with advanced aspects of Nuclear Physics. The students will learn about radioactivity, nuclear force, various decay processes and their mechanisms. Liquid drop model, shell-model, Fermi gas model, collective model, some aspects of nuclear reactions with regards to nuclear structure have been kept. In addition, neutron reactions and Breit-Wigner resonance formula have been included. This course would provide a strong foundation for the NST program.

Pre-requisites: Knowledge of Modern and Quantum Physics concepts

Course Contents/Syllabus:

	Weight age
Module I Properties of nucleus	**10%**
Mass, charge, and constituents of the nucleus, Nuclear size and distribution of nucleons, Energies of nucleons in the nucleus. what holds the nucleon (in a nucleus) together? Bound state of the two-nucleon, the deuteron problem. Spin states of the two nucleon system, effects of the Pauli exclusion principle. Magnetic dipole moment and electric quadrupole moment of deuteron- the tensor force. General properties of nuclear force. Exchange character, velocity dependent forces. Meson theory of nuclear forces, nucleon-nucleon scattering, n-p scattering cross section at low energies (behavior as a function of energy). The nuclear force as we know it. Charge independence of nuclear forces, many body forces (just a mention).	
Module II Radioactivity and Decay Processes	**20%**
Radioactivity – the radioactive decay law. Quantum theory of radioactive decays. Production and decay of radioactivity, growth of daughter Products. Types of decays. Alpha, beta, gamma decays; spontaneous fission and nucleon emission, decay series and its characteristics. Alpha decay, Basic alpha decay processes. Theory of alpha (decay) emission, alpha energy spectra. Beta	

decay- energy release in beta decay. The beta energy spectrum, emission of neutrino, parity violation. Gamma decay, the energetic of gamma decay, transition probability, angular momentum and parity selection rules. Basic idea of gamma ray spectroscopy	
Module III Nuclear Models	**25%**
Nature of nuclear forces, nuclear potential, liquid drop model and its drawbacks. Magic numbers, shell model, evidences of shell model, ground states of nuclei, application of single particle model, collective motion of nuclei, single particle states in deformed nuclei - Nilsson unified model for deformed potential states, pairing force & Quasi particles, Fermi gas model, comparison of nuclear models, Vibrational spectra and vibrations in a deformed nuclei.	
Module IV Nuclear Reactions	**20%**
Types of reactions and conservation laws, energetic of nuclear reactions, Isospin. Reaction cross sections ideas of coulomb and nuclear scattering. Details of scattering and reaction cross sections. Idea of direct and compound nucleus reactions. Nuclear fission and fusion. Neutron reactions and cross sections, Breit-Wigner Resonance formula.	
Module V Interaction of Radiation & its Detection	**25%**
Gas filled system: Ionization chamber, proportional counter, Geiger Muller counter and discharge region. Scintillation Counter, HPGe – Gamma Detection. Interaction of gamma rays with matter, photo electric effect, Compton effect and pair production, General characteristics of energy resolution, response function, response time, detector efficiencies, dead time.	

Student Learning Outcomes:

- Identify properties of the nucleus and other sub-atomic particles
- Sketch the theory and the experimental observations related to subatomic particles

Apply classical, relativistic, and quantum physics to examine and understand the processes and machines which produce and detect subatomic particles

Pedagogy for Course Delivery:

The class will be taught using theory and dummy models and instruments available in laboratories. The course instructor will update himself time to time with the advanced research in the concern field in order to make students aware with the recent trends

Assessment/ Examination Scheme:

Theory L/T (%)	Lab/Practical/Studio (%)	Total (%)

30%	NA	70%

Theory Assessment (L&T):

Continuous Assessment/Internal Assessment					**End Term Examination**
Components (Drop down)	Mid-Term Exam	Seminar/ Home Assignment	Viva/ Quiz	Attendance	
Weightage (%)	10%	7%	8%	5%	70%

Text:

Concepts of Nuclear Physics – B.L. Cohen

Introductory Nuclear Physics – Kenneth S. Krane John Wiley & Sons (1988) Introduction to Nuclear Physics – H.A. Enge

- Nuclear Physics – S.N. Ghoshal
- Nuclear Physics – Theory and Experiment – R.R. Roy and B.P. Nigam Nuclear Physics,

Principles and Applications - John Lilley, John Wiley (2