

Subject: Physics

Semester: Six

Course Name: NUCLEAR & PARTICLE PHYSICS

Existing Base Syllabus: HS Physics, Chemistry and Mathematics

Course Level: PHY351

Syllabus showing each unit against class number and marks

Unit no.	Unit content	No. of classes	Marks/Credit
Theory			
Unit I: Basic Properties of Nuclei	Constituents of a nucleus: proton-electron hypothesis -Thompson atom model, failure of proton-electron hypothesis, discovery of neutrons, Rutherford gold foil experiment (qualitative) and atom model- mass, radius, volume, matter density of nuclei and their units. Binding energy, binding energy per nucleon, stability of a nucleus- neutron to proton ratio, stability line, stability limit against beta decays.	8	Credit - 4
Unit II: Radioactivity and Radioactive Laws	Types of Radioactivity – alpha, beta, and gamma decay. Laws of radioactive decay, disintegration constant, half-life and mean life. Activity of a radioactive source, units of radioactivity. Alpha decay: range, ionization and stopping power, range-energy relation, Geiger-Nuttall law, Fine structure of alpha energy spectrum. Beta decays: types of beta decays, essential conditions of beta decays, beta ray spectra, end point energy, Pauli's neutrino hypothesis. Gamma decay: origin of gamma radiation, its property, attenuation of gamma radiation in matter	10	
Unit III: Nuclear Instrumentation	Detectors: Interaction of Radiation with Matter: Energy loss by a charged particle due to ionization (Bethe- Block formula), energy loss of electrons, Cerenkov radiation. Interaction of photon with matter – Photoelectric effect, Compton effect, and Pair production. Gas filled detectors: Ionization chamber,	10	

	proportional counter, and GM counter – construction and working principle. Charged particle accelerators: Need of charged particle accelerators, Linear accelerator (LINAC) – Construction and working principle.		
Unit IV: Fission and Fusion	Energy consideration in Nuclear Reaction, Mass defect and Q-value of a nuclear reaction, Einstein’s mass-energy equivalence principle and generation of nuclear energy. Nuclear Fission: Spontaneous and induced fission – definition and examples, Fission chain reactions and nuclear reactor: peaceful use of fission energy. Fusion and thermonuclear reactions: Energy production in stars (brief qualitative discussions).	10	
Unit V: Elementary Particles	Classification of elementary particles and their quantum numbers, conservation laws, Allowed and forbidden reactions, Types of interactions – strong, electro-magnetic and weak interactions.	7	

Reading list

1. Basic ideas and concepts in Nuclear Physics: An introductory approach by K Heyde, third edition, IOP Publication, 1999. 87
2. Nuclear Physics by S N Ghoshal, First edition, S. Chand Publication, 2010.
3. Introductory Nuclear Physics by K S Krane, Wiley-India Publication, 2008.
4. Nuclear Physics: principles and applications by J Lilley, Wiley Publication, 2006.
5. Radiation detection and measurement, G F Knoll, John Wiley & Sons, 2010.
6. Schaum's Outline of Modern Physics, McGraw-Hill, 1999.
7. Concept of Modern Physics by Arthur Beiser, McGraw Hill Education, 2009.
8. Nuclear Radiation Detector by S S Kapoor and V S Ramamurthy , 1st edition, New Age international publisher.

Graduate Attributes

i. Course Objective

- basic knowledge about the nucleus and other subatomic particles and their properties.
- knowledge about the radioactive disintegration of a nucleus and the laws of radioactive decays
- Knowledge on basic nuclear instrumentation and experimental techniques of nuclear physics.
- Basic knowledge of particle physics.

ii. Learning outcome

On successful completion of the course, the students shall be able to understand the structure and properties of a nucleus. They will also know about the properties of strong nuclear force that keeps the nuclei bound. They will learn about the radioactive decays and various laws of radioactive disintegration. Students will have adequate knowledge on the construction and working principles of particle accelerators and detectors. Moreover, students will be introduced to the world of particle physics – types and interactions. The acquired knowledge can be applied in the areas of nuclear medicine, medical physics, archaeology, geology and other interdisciplinary fields of Physics and Chemistry. It will enhance the special skills required for these fields.

Theory Credit: 04 (Three)

Practical Credit: 01 (One)

No. of Required Classes: 45

No. of Contact Classes: 45

No. of Non-Contact Classes:

Particulars of Course Designer (Name, Institution, email id):

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