MANGALORE UNIVERSITY

Department of Physics

MSc Physics

PHH 453: NUCLEAR AND RADIATION PHYSICS

[52 hrs]

Course outcome

CO1 The students are able to demonstrate a knowledge of fundamental aspects of the structure of the nucleus and radioactive decay.

CO2 Student will be able to explain the interaction of radiation with matter and explain different types of radiation detectors.

CO3 Student will have good grasp on the topic of ionizationradiation and applications of ionization radiations.

CO4 Student will have good grasp on nuclear reactions and reactor physics.

CO5 Able to discuss nuclear and radiation physics connection with other physics disciplines, geology, archelogy and medical diagnostics and therapy etc.

Unit I General properties of the nucleus and nuclear decay

Constituents of nucleus and their properties. Mass of the nucleus-binding energy. Charge and charge distribution. Estimation of nuclear radii by different methods. Spin statistics and parity. Magnetic moment of the nucleus. Quadrupole moment. **[**13 hrs]

Nuclear decay - Alpha decay - quantum mechanical tunnelling - wave mechanical theory. Beta decay - continuous beta ray spectrum - neutrino hypothesis. Fermi's theory of beta decay - Kurie plots and ft-values - selection rules. Detection of neutrino - non-conservation of parity in beta decay. Gamma decay - selection rules - multipolarity - Internal conversion (qualitative only).

Unit II Interaction of radiations and radiation detectors: Interactions of electrons with matter - Specific energy loss, Coulombic mode of interactions, radiative mode of energy loss, electron range and transmission curves.

Interaction of gamma rays with matter - Elastic scattering, photoelectric effect, Compton scattering, Klein-Nishina formula (qualitative) and pair production processes, cross section, gamma ray attenuation, linear and mass absorption coefficients.

Radiation detectors - Gas filled counters - general features - ionization chamber, proportional counter and GM counter.

Radiation quantities and units - radiation exposure, absorbed dose, equivalent dose and effective dose [13 hrs]

Unit III Ionising radiations and applications: Sources of ionising radiations in the environment – terrestrial radiation sources and radionuclides, cosmic radiations and cosmogenic radionuclides. Technologically enhanced radiation sources. Artificial radiation sources artificial radionuclides. Production of radioisotopes using reactors. Application of radioisotopes in medicine, agriculture and industry. Radiation shielding (qualitative treatment).

Nuclear Models: Liquid drop model - semi empirical mass formula, stability of the nuclei against beta decay, mass parabola. Shell model (qualitative) [13 hrs]

Unit IV Nuclear reactions - Cross section for a nuclear reaction. 'Q' equation of a reaction in laboratory system - threshold energy for a reaction. Centre of mass system for nucleus-nucleus collision. Non-relativistic kinematics. Relation between angles and cross sections in lab and CM systems.

Reactor physics: fission chain reaction. Slowing down of neutrons - moderators. Conditions for controlled chain reactions in bare homogeneous thermal reactor. Critical size. Effect of reflectors. Brief introduction of nuclear fuel cycle. Breeder Reactors. [13 hrs]

Text Books:

1. Segre E, 'Nuclei and Particles', II Edn. (Benjamin, 1977)
2. Knoll G F, Radiation Detection and Measurement', II Edn. (John Wiley, 1989)
3. Eisenbud M, 'Environmental Radioactivity' (Academic Press, 1987)
4. Ghoshal S N, 'Atomic and Nuclear Physics', Vol. I & II (S Chand & Company, 1994)

Reference Books

1. Patel S B, 'Nuclear Physics - An Introduction' (Wiley Eastern, 1991)
2. Krane K S, 'Introductory Nuclear Physics' (John Wiley, 1988)

3. Roy R K and Nigam P P, ‘Nuclear Physics - Theory and Experiment’ (Wiley Eastern Ltd., 1993)
4. Singru R M, ‘Experimental Nuclear Physics’ (Wiley Eastern, 1972)
5. Zweifel P F, ‘Reactor Physics’, International Student Edn. (McGraw Hill, 1973)
6. Kapoor S S and Ramamurthy V S, ‘Radiation Detectors’ (Wiley Eastern, 1986)
7. Henry Semat& John R AlBright, ‘Introduction to Atomic and Nuclear Physics’ V Edn. (Chapman & Hall, 1972)
8. Burcham W E, ‘Nuclear Physics’, II Edn. (Longman, 1963)
9. Mann W B, Ayres R L and Garfinkel, ‘Radioactivity and its Measurements’ (Pergamon Oxford, 1980)
10. Little field T A and Thorley N ‘Atomic and Nuclear Physics’, II Edn. (Nostrand Co., 1988)