MANGALORE UNIVERSITY

Department of Physics

MSc Physics

PHS 558: NUCLEAR PHYSICS IV

(52 Hrs.)

Course outcome

CO1 The student will know about various types of nuclear reactors.

CO2 The student will have good understanding of neutron physics.

CO3 The student will know about basics of particle physics.

CO4 The student will know about basics of QED, QCD and weakinteractions.

Unit I Reactor physics

Fundamentals of nuclear fission – fission fuels. Neutron chain reaction , multiplication factor. Condition for criticality – Breeding phenomena. Different types of reactors – Fusion – Nuclear fusion in stars. Slowing down of neutrons by elastic collisions - logarithmic decrement in energy - number of collisions for thermalisation.

Elementary theory of diffusion of neutrons - spatial distribution of neutron flux (1) in an infinite slab with a plane source at one end and (2) in an infinite medium with point source at the centre. Reflection of neutrons - Albedo.

Slowing down density - Fermi age equation. Correction for absorption - resonance escape probability. The pile equations - Buckling. Critical size for spherical and rectangular piles.

Condition for chain reaction - the Four-factor formula. Thermal neutron reactor - Fast breeder reactor. [13 hrs]

Unit II Neutron physics

Classification of neutrons according to their energy - neutron sources. Ultrafast neutrons, slow neutron detection through nuclear reaction and induced radio activity - slow neutron cross section measurements - neutron monochromators.

Nuclear fusion - basic fusion processes - characteristics of fusion - fusion in stars. Controlled thermonuclear reactions. Hydromagnetic equations. magnetic pressure, pinch effect, magnetic confinement systems for controlled thermonuclear fusion.

[13 hrs]

Unit III Particle physics

Conservation laws and basic interactions relating to elementary particles - particles and antiparticles

Leptons - neutrinos, muon production and decay - muon capture, spin and magnetic moments of muons.

Pions - the Yukawa interaction, spin of pions - intrinsic parity - isotopic spin of pions. Pion-nucleon scattering and resonance. Nuclear collision, production and photo production of Pions. Rho, Omega and Eta mesons. [13 hrs]

Unit IV Strange particles and weak interactions

Strange particles: associated production – strangeness quantum number; GellMann-Nishijima formula – Kaons and Lambda, Sigma, Xi and Omega hyperons.

The Quark model – quark composition of particles.

Weak interactions: neutral Kaons. The K° - K° systems. Regeneration of the short lived component of neutral Kaons. CP violation – the CPT theorem

Verification of electromagnetic and weak interactions – intermediate vector bosons.

[13 hrs]

Text Books:

1. Goshal S N, `Atomic & Nuclear Physics', Vol. II (S Chand & Company, 1994)
2. Wong, `Introduction to Nuclear Physics' (Prentice Hall, 1997)
3. Marmier D and Sheldon E, 'Physics of Nuclei and Particles', Vol. I, II (Academic Press, 1969)
4. Zweifel P F, 'Reactor Physics', International student Edn. (McGraw Hill, 1973)
5. Emilio Segre, 'Nuclei and Particles', II Edn. (Benjamin, 1977)

Reference Books:

1. Kenneth S Krane, ‘Introductory Nuclear Physics’ (John Wiley, 1986)
2. Glasstone S and Sesonske A, ‘Nuclear Reactor Engineering’ (CBS, Delhi, 1986)
3. Little field T A and Thorley N ‘Atomic and Nuclear Physics’, II Edn. (Nostrand Co., 1988)