PHT-2.3: Nuclear Physics (General)

Unit – I

Basic properties of Nucleus: **6 Hours**

Nuclear constitution, The notion of nuclear radius and its estimation from Rutherford's scattering experiment; the coulomb potential inside the nucleus and the mirror nuclei. The nomenclature of nuclei and nucleon quantum numbers. Nuclear spin and magnetic dipole moment. Nuclear electric moments and shape of the nucleus.

Nuclear forces: **7 Hours**

General features of nuclear forces. Bound state of the deuteron with square well potential. Binding energy and size of deuteron. Deuteron electric and magnetic moments –evidence for no-central nature of nuclear forces. Yukawa's meson theory of nuclear forces.

Unit- II

Nuclear reactions: **7 Hours**

Reaction scheme, types of reactions and conservation laws, reaction kinematics, threshold energy and Q-value of nuclear reaction. Energetics of exoergic and endoergic reactions. Reaction probability and cross section. Bohr's compound nucleus theory of nuclear reactions.

Nuclear models: **6 Hours**

The shell model; evidence for magic numbers, energy level, scheme for nuclei with infinite square well potential and ground state spins. The extreme single particle prediction of nuclear spin and magnetic dipole moments Schmidt limits. The liquid drop model nuclear binding energy, Bethe Wizsacker's semi empirical mass formula; stability limits against spontaneous fission and nuclear decay.

Unit – III

Nuclear decays: **8 Hours**

Alpha decay: Quantum mechanical barrier penetration, Gammow's theory of alpha decay and alpha half-life systematic. Beta decay: continuous beta spectrum, neutrino hypothesis, and Fermi's theory of beta decay, beta comparative half-life systematics. Gamma decay: Qualitative consideration of multipole character of gamma radiation and systematics of mean lives for gamma multipole transitions.

Interaction of radiation with matter. **5 Hours**

Interactions of charged particles with matter, ionization energy loss, stopping power and range energy relations for charged particles. Interactions of gamma rays; photoelectric, Compton and pair production processes. Nuclear radiation detectors- GM counter and scintillation detector.

Unit – IV

Nuclear energy **5 Hours**

Fission process, fission chain reaction, four factor formula and controlled fission chain reactions, energetics of fission reactions, fission reactor, fusion process, energetics of fusion reactions; controlled thermonuclear reactions; fusion reactor. Stellar nucleo synthesis.

Fundamental interactions and elementary particles: **5 Hours**

Basic interactions and their characteristic features. Elementary particles, classification conservation laws in elementary particle decays. Quark model of elementary particles.

Nuclear techniques: **3 Hours**

Radioisostope tracer method, Neutron activation analyses.

References:

1) The atomic nucleus :RD Evans, Mc Graw Hill
2) Nuclear and particle physics : WE Burcham and M Jobes ,Adison Wesley, 1998, ISE
3) Nuclear physics: R R Roy and V P Nigam ,Wiley Eastern
4) Physics of nuclei and particles : P Mermier and E Sheldon ,Academic Press
5) Subatomic physics: nuclei and particles: L Valentin
6) Nuclei and particles: E Segre, Benjamin
7) Nuclear physics : D C Tayal ,Himalay Publishers
8) Nuclear physics : R C Sharma, Khanna Publishers
9) Introduction to nuclear physics: S B Patel ,Wiley Eastern

POE-3.6: Biophysics

Unit – I **13 Hours**

Cell biophysics: Cell doctrine: general organization and composition of the cells.

Bioenergetics: The biological energy cycle and energy currency. Thermodynamic concepts; free energy of a system – Gibb's free energy function, chemical potential and redox potentials. Energy conversion pathways - Kerb's cycle, respiratory chain, oxidative phosphorylation. Photosynthesis apparatus; mechanisms of energy trapping and transfer photophosphorylation.

Unit – II

Membrane biophysics: **7 Hours**

Cell membranes – structure, function and models; transport across membranes – passive and active processes; chemiosmotic energy and transduction – van't Hoff equation ; ionic equilibrium electrochemical potential; Nernst's equation; flow across membranes-membrane permeability.

Neuro physics: **6 Hours**

The nervous system. Synaptic transmission information processing in neuronal systems. Physical basis of biopotentials; action potential; Nernst Planck equation. Nerve excitation and conduction; Hodgkin – Huxley model.

Unit – III

Physiological biophysics **13 Hours**

Physics of sensory organs – the transmission of information generator potentials. Visual receptor – mechanism of image formation, auditory receptor, mechanism of sound perception; mechanisms of chemical somatic and visceral receptors. Mechanism of muscle contractility and motility. Temporal organization basis of biorhythms.

Unit – IV

Biophysics of the immune system: **13 Hours**

The immune system; cellular basis of immunal responses antibodies and antigens immunological memory. **Genetic Engineering:** Gene, structure, expression and regulation; genetic code genome organization; recombinant technology. Transgenic systems. Cybernetics – genetic information and the brain; neural nets.

References:

1) An introduction to biophysics C Sybesma, Academic 1977
2) Biophysics, V Pattabhi and N Gautham, Narosa 2002
3) Essential of biophysics P Narayan, New Age 2001.
4) Molecular biophysics R B Setlow and E C Polland ,Addn Wesley 1962
5) Biophysics W Hope, W Lohmann H Markl H Ziegler ,Springer Verlag 1983
6) Biophysics and human approach I W Sherman and V G Sherman ,Oxford 1979
7) Molecular biology of the cell B Alerts D Bray, J Lewis M Raft, K Roberts and J D Watson ,Garland 1984
8) Molecular cell biology H Lodish A Berk S L Zipursky P Matsudaira, D Baltomore and J Darnel ,Freeman 2000
9) Biophysical principles of structure and function F M Snell S Shulman R P Spensor and C Moos ,Addn Wesley 1965
10) Principles of neural science E R Kendel J G Schwar ,Elsevier 1982.

POE-4.5: Atmospheric Science

Unit – I **13 Hours**

Meteorology: Atmospheric composition, laws of thermodynamic of the atmosphere. Adiabatic process, potential temperature. The Clausis Clapyeron equation, laws of black body radiation, solar and terrestrial radiation, albedo Green house effect, Heat balance of earth atmosphere system.

Dynamic meteorology: Fundamental forces, non-inertial reference frames and apparent forces, structure of static atmosphere. Momentum, continuity and energy equations. Thermodynamics of the dry atmosphere, elementary applications of the basic equations. The circulation theorem, voracity, potential vorticity, vorticity and potential vorticity equations.

Unit – II **13 Hours**

Monsoon dynamics: Wind, temperature and pressure distribution over India in the lower, middle and upper atmosphere during pre, post and mid-monsson season, monsoon circulation in the meridonal (Y-Z) and zonal (X-Y) planes, energy cycle of monsoon. Dynamics of monsoon depressions and easterly waves. Intra seasonal and internal variability of monsoon. Quasi- bc weekly and 30-60 day oscillations. Enso and dynamical mechanism for their existances.

Unit – III **13 Hours**

Numerical methods for atmospheric models: Flitering of sound and gravity waves, filtered forecast equations, basic concepts of quasi geostropic and primitive equation models, one level and multi level models. Basic concepts of initialization and objective analysis for wave equation, advection equation and diffusion equation.

Atmospheric pollution: Role of meteorology on atmospheric pollution atmospheric boundary layer, air stability, local wind structure, Ekman spiral, turbulence boundary layer scaling, residence time and reaction rates and of pollutants, sulphur compounds, nitrogen compounds, carbon compounds, organic compounds, acrosols, toxic gases and radio active particles trace gasses.

Unit – IV **13 Hours**

Atmospheric instrumentation systems: Ground based instruments for the measurement of temperature. Pressure, humidity wind and rainfall rate. Air borne instruments-radisonde, rawinsode, rockestsonde-satelite instrumentation (space borne instruments)

Radar meteorology: Basic meteorology radar principles and technology radar signal processing and display -weather radar observation of precipitating systems estimation of precipitation radar observation of tropical cyclones, use of weather radar in aviation, clear in air radars-observation of clear in phenomena- other radar systems and applications.

References:

1) The Atmosphere by Frederick K I Utgens and Edward K Turbuk (for chapter I and VI)
2) The Physics of Monsoons by R V Keshwamurthy and M Shankar Roy: Allied publishers, 1992(for chapter 3)
3) Dynamic meteorology by Holton J R edition 3rd academic press N.yf 1992.
4) Numerical weather prediction by G J Haltiner and R T Villians, John Wiley and Sons. 1980 (for chapter 4)
5) Principles of Air pollution meteorology by Tom Layons and Prillscott, CBS publishers and distributors (P) Ltd Radar Meteorology by Henry Sangagcot

PST-1.5(b): Astrophysics

Unit – I **13 Hours**

Basic concepts, Michelson's stellar interferometer, binary stars and their masses, radial and transverse velocities types of optical telescopes and their characteristics, modern telescopes like Gemini Keck etc.

Unit – II **13 Hours**

Properties of stars: Spectra of stars, spectral sequence –temperature and luminosity classifications, H-R diagram, Saha's ionization formula and application to stellar spectra, virial theorem, stellar structure equations, star formation and main sequence evolution, mass luminosity relation, White dwarf's, Pulsars, magnetars, Neutron stars and Black holes, variable stars.

Unit – III **13 Hours**

The solar system: The surface of the sun, solar interior structure, solar rotation, sun spots, the active sun, properties of interior planets and exterior planets, satellites of planets, comets, asteroids, meteorites, Kuiper Belt Objects and Oort Cloud, Theories of formation of the solar system.

Unit – IV **13 Hours**

Star clusters, Galaxies and the Universe: open and global clusters, the structure and contents of milky way galaxy, Hubble's classification of galaxies, galactic structure and dark matter, galactic motions, hubble's law, Olber's paradox. Big bang theory and the origin of the early universe, nucleosynthesis, cosmic microwave background radiation and evolution of the universe.

References

1) The new cosmos A unsold, Springer Verlag 1977
2) Introduction to stellar astrophysics E Bohm Vitense 3rd volume ,CUP 1989
3) Astrophysics and stellar astronomy T L Swihart: Wiley 1968
4) The stars ; their structure and evolution R J Taylor , Cambridge University Press 1993
5) Introduction to Cosmo Log J V Narlikar Y, Cambridge University Press 1993
6) Principles of physical cosmology Peebles P J E, Princeton U P 1993
7) Galaxies their structure and evolution R J Taylor, Cambridge University Press 1993
8) Solar system astrophysics Brandt J C and Hodge, Mc graw Hill 1964
9) The physical universe, F Shu So press 1987
10) Introduction to modern astrophysics Ostlie and Caroll, Addn Wesley 1997
11) Astrophysics concepts M Herwit, John wiley 1990
12) An introduction to astophysics Baidyanath Basu, PHI
13) A textbook of astrophysics and cosmology V B Bhatia, New Age International
14) Our solar system, Rana
15) Stars and galaxies K D Abyankar, Cambridge University Press
16) Astrophysics, Krishanswamy
17) Pulsar Astronomy A G Lyne and G Smith, Cambridge University Press