MSc(Medical Physics) 1st year

Course Number	Course Name	Instructor	Credits	Segment	Slot	Room
MP5010	Nuclear and Radiation Physics and Radiation Sources	Prof Anjan Giri	3	16	G	PH3
PH5210	Electrodynamics	Dr Srikanth Hundi	3	16	B	PH1
PH5120	Mathematical Physics	Dr Anurag Tripathi	3	16	S	PH1
PH5130	Quantum Mechanics	Dr Atanu Rajak	3	16	F	PH1
MP5001	Lab	Prof Surya J	2	16	AN1, AN4	PHY LAB

MSc(Medical Physics) 2nd year

Course Number	Course Name	Instructor	Credits	Segment	Slot	Room
MP6000	Radiological Mathematics	Saranya Ghosh	2	14	Q	PH3
MP6010	Lasers and Photonics in Medicine	Nithyanandan Kanagaraj	2	14	R	PH3
MP6020	Computational modeling of biological systems (PHY)	Anupam Gupta	2	14	P	PH3

MP5010	Nuclear and Radiation Physics and Radiation Sources

Nuclear and Radiation Physics and Radiation Sources [PH/MP5100] (3credits)

Natural Radioactivity: Basic nuclear processes and introduction to various radiation sources, isotopic masses and abundances, the disintegration constant, half-life,mean-life, successive radioactive transformation, units of radioactivity. General properties of alpha, beta and gamma rays - Laws of radioactivity - Laws of successive transformations - Natural radioactive series - Radioactive equilibrium –Alpha ray spectra - Beta ray spectra - Theory of beta decay - Gamma emission –Electron capture - Internal conversion - Nuclear isomerism - Artificial radioactivity -Nuclear cross sections - Elementary ideas of fission and reactors – Fusion.Interaction of photon with Matter (orientation towards radiology): Coherent Scattering- Absorption of Gamma rays by matter, photoelectric absorption, Compton scattering, electron-positron pair production, Linear and mass absorption coefficient of gamma rays in matter. Total attenuation coefficient - Importance of Various Types of Interactions- Exponential law, half value layer & simple calculations. Interaction of Heavy Charged Particles with Matter: Energy loss of Heavy Charged Particles by Atomic Collisions, Stopping Power of Heavy Charged Particles, The Bragg Curve,Bethe Bloch Formula, Energy and Range Straggling, Delta Rays, Cerenkov radiation Interaction of electrons and positrons with Matter: Classical theory of inelastic collisions with atomic electrons - Collision loss , Energy loss per ion pair by primary and secondary ionization - Dependence of collision energy losses on the physical chemical state of the absorber, multiple coulomb scattering, Stopping Power and Range for Electrons, Synchrotron Radiation. Cerenkov radiation – Electron absorption process – Scattering Excitation and Ionization - Radiative collision -Bremsstrahlung – Range energy relation - Continuous slowing down approximation (CSDA) - straight ahead approximation and detour factors - transmission and depth dependence methods for determination of particle penetration - empirical relations between range and energy - Back scattering.Interaction of neutrons with matter - scattering - capture - Neutron induced nuclear reactions - elastic and inelastic scattering of neutrons, neutron activation,radioisotope production. Slow Neutron Interactions, Fast Neutron Interactions, Neutron cross-sections, slowing down of neutrons. Radiation Sources: Sources of electromagnetic radiation, Natural and artificial radioactive sources - Large scale production of isotopes - Reactor produced isotopes -Cyclotron produced isotopes – Fission products - Telecobalt and Brachy sources – gold seeds- Beta ray applicators -Preparation of tracers and labelled compounds-Preparation of radiocolloids, Neutron Sources. Radiation quantities & units Particle flux and fluence – Energy flux and fluence –Cross Section – Linear and mass attenuation coefficients - Mass energy transfer and mass energy absorption coefficients - Stopping power - LET – Radiation chemical yield -W value - Dosimetry - Energy imparted - Absorbed dose - Kerma -Exposure -

Air kerma rate constant - Charged particle equilibrium (CPE) –Relationship between Kerma, absorbed dose and exposure under CPE – Dose equivalent - Ambient and directional dose equivalents [(H*(d) and H'(d)] – Individual dose equivalent penetrating Hp(d) - Individual dose equivalent superficial Hs(d),Given dose, Incident Dose, Skin Dose,Model Dose, Integral dose

Reading Material:

1. R R Roy; B P Nigam, Nuclear physics theory and experiment, New York, Wiley[1967]

2. M A Preston; Rajat K Bhaduri, Structure of the nucleus, Boca Raton, FL : CRC Press, 2018.

3. Radiation Detection and Measurement: Glenn F. Knoll, 4 th Ed, John Wiley (2010)

4. Techniques for Nuclear and Particle Physics Experiments: W. R. Leo, Springer-Verlag (1987)

5. Nuclear Physics: D C Tayal

6. Nuclear Radiation Detectors: SS Kapoor and VS Ramamurthy

7. Nuclear Physics: Irving Kaplan

PH5210	Electrodynamics

Electric field, Divergence and curl of electrostatic fields, electric potential, work and energy in electrostatics, conductors, Special techniques to solve Laplace's equations, separation of variables and Multiple expansion, Polarization, Field of a polarized object, Electric displacement and linear dielectrics, Lorentz force law, Biot-Savart Law, magnetic vector potential, magnetization, field of a magnetized object, linear and nonlinear media. Electromotive force, Electromagnetic induction, Maxwell's equations, conservation laws, Poynting theorem, Maxwell's stress tensor, conservation of momentum, Electromagnetic waves, Electromagnetic waves in vacuum and matter, Absorption and Dispersion, Wave Guides, Potentials and fields, Gauge transformations, Dipole radiation, Power radiated by point charge, Maxwell's equations in matter, Boundary conditions, Poynting's theorem, Newton's third law in Electrodynamics, Maxwell's stress tensor, Conservation of Momentum, Electromagnetic waves in vacuum, and matter, absorption and dispersion, Guided waves.

Reading Material:

● Introduction to Electrodynamics, 3rd Edition, by David J. Griffiths.

● Classical Electrodynamics : John David Jackson

PH5120	Mathematical Physics

Linear vector space, Metric space, Function space, Hilbert space, linear operators, N-dim. Vector space, Tensors, Transformation of basis, Invariant subspaces, Hermitian and Unitary

matrices. Analytic functions, Cauchy theorem, Cauchy's integral representations, Taylor and Laurent series, Calculus of residues, Analytic continuation, conformal mapping, Fourier series, Fourier transforms, Convolution theorem, Laplace transforms, Applications of Fourier and laplace transforms, Series solution, separation of variables, SturmLiouville theory, Bessel equation and function, Legendre equation and function, Spherical harmonics, Green function and Nonhomogeneous differential equations, Special functions such as hermite, Laguerre, Chebyshev etc.

Reading Material:

- P. Dennery and A. Krzywicki; Mathematics for Physicists; Dover Publications
- Arfken and Weber; Mathematical methods for Physicists; Academic Press
- J. D. Jackson; Classical Electrodynamics

PH5130	Quantum Mechanics

Quantum Mechanics I (M.Sc.):

Linear Algebra: Vector Spaces and Operators, State vectors and linear operators in Hilbert space, Dual space, Dirac notation, Matrix representations, Schrodinger and Heisenberg pictures, Conservation laws and the degeneracy associated with symmetry, Continuous symmetries – space and time translations, Rotations, Discrete symmetries – parity and time reversal, Two-state systems, Angular momentum algebra, Orbital and spin angular momentum operators, Clebsch-Gordon coefficients, spin-orbit interaction and applications, central potential, solutions of Schrodinger equation in a central potential, Hydrogen-like atom, 3-dimensional harmonic oscillator, Time independent perturbation theory for non-degenerate and degenerate energy levels: applications, time-dependent perturbation theory, Fermi-golden rule, adiabatic approximation, Geometric Phase and the Aharonov-Bohm effect.

Reading Material:

1. Modern Quantum Mechanics: J. J. Sakurai and J. J. Napolitano, Pearson
2. Introduction to Quantum Mechanics: David J Griffiths, Pearson
3. Principles of Quantum Mechanics by R. Shankar

4. Quantum Mechanics by Bransden and Joachain

MP5001	Lab

MP6000	Radiological Mathematics

MP6010	Lasers and Photonics in Medicine

MP6020	Computational modeling of biological systems (PHY)