

BARATHIAR UNIVERSITY : COIMBATORE
M.Sc. Medical Physics
FOR THE CANDIDATES ADMITTED FROM THE ACADEMIC YEAR 2014-15

Semester	Course Title		Ins. Hrs/ week	Exam			Credit
				CIA	Univ. Exam.	Total	
Semester I	Paper – 1	Introductory Nuclear Physics	5	25	75	100	4
	Paper – 2	Solid State Physics	5	25	75	100	4
	Paper – 3	Fundamental Radiation Physics	5	25	75	100	4
	Paper – 4	Microelectronics and Biomedical Instrumentation	4	25	75	100	4
	Paper– 5	Anatomy and Physiology as Applied to Oncology and Imaging	5	25	75	100	4
	Practical	Electronics lab	6	80	120	200	8
Semester II	Paper – 6	Mathematical Physics	4	25	75	100	4
	Paper – 7	Radiation Detectors and Instrumentation	4	25	75	100	4
	Paper – 8	Physics of Radiation Therapy	6	25	75	100	4
	Paper – 9	Medical Imaging Technology	4	25	75	100	4
	Paper – 10	Radiation Dosimetry and Standardisation	6	25	75	100	4
	Practical	Medical Physics Lab I	6	80	120	200	8
Semester III	Paper – 11	Modern Radiotherapy Trends	6	25	75	100	4
	Paper – 12	Nuclear Medicine and Internal dosimetry	6	25	75	100	4
	Paper – 13	Radiation Biology	6	25	75	100	4
	Paper – 14	Radiation Hazards Evaluation and Control	6	25	75	100	4
	Practical	Medical Physics Lab II	6	80	120	200	8
Semester IV	Project	Project Work and Viva Voce (100+ 100+50)				250	10
Total						2250	90

SEMESTER – I PAPER 1
INTRODUCTORY NUCLEAR PHYSICS

UNIT – 1: Nucleus

Nuclei: General properties of nuclei – constituents of nuclei, nuclear size, nuclear radii, nuclear mass – nuclear units- atomic mass unit, eV- binding energy - systematics of binding energy - mass defect, mass excess, packing and binding fraction - discovery of radioactivity – radioactive decay- activity, half life, mean life, decay constant - radioactive series – radioactive equilibrium- secular, transient, non equilibrium.

UNIT – 2: Radioactive Decay Types

Alpha decay – energetics and spectrum- beta decay and its energies – origin of continuous beta spectrum- neutrino hypothesis – properties of neutrino- nuclear isomerism- gamma decay – nature of gamma rays- internal conversion – positron emission- electron capture- nuclear fission and its discovery - energy release in fission - nature of the fission fragments - energy distribution between the fission fragments - fissile and fertile materials - spontaneous fission - source of energy in stars - nuclear reactions and its types - conservation laws - Q values - cross section.

UNIT – 3: Particle accelerators

Introduction - classification and performance characteristics of accelerators - industrial, medical and research applications – resonant transformer – cascade generator - Van de Graff generator - cyclotron - betatron - synchrotron- linear accelerator - microtron – electron synchrotron – proton synchrotron – details of accelerator facilities in India.

UNIT – 4: Nuclear Models, Fission and Fusion Reactors

Shell model, Liquid drop model - fission - energetics of fission process, controlled fission reactions - chain reaction – basics of reactor - Gas cooled reactors - advanced gas cooled reactors - pressurized water reactor - boiling water reactor - heavy water reactor - breeder reactor. Fusion process - characteristics of fusion - solar fusion -controlled fusion reactors - critical conditions - four factor formula.

UNIT – 5: Nuclear Electronics and techniques

Preamplifiers – amplifiers - single channel analyzers - counting statistics - energy measurements. Introduction to spectroscopy - definition of energy spectra - measurement of an integral spectrum and differential spectrum - energy resolution of a detection system, multichannel analyzer - calibration of MCA - charged particle spectroscopy, energy straggling- Time of Flight Spectrometer – detector telescopes (E d E / h detectors)
– position sensitive detectors.

Reference books:

1. H.Enge : “Introduction to Nuclear Physics” (Addison Wesley)
2. Kenneth S. Krane : “ Introductory Nuclear Physics” (John Wiley)
3. Stefaan Tavernier : “ Experimental Techniques in Nuclear and Particle Physics”(Springer)
4. S.N.Goshal: “ Nuclear Physics” (S. Chand Ltd)
5. G.F.Knoll : “ Radiation detection and measurement” (John Wiley)
6. K. Muraleedhara Varier : “Nuclear Radiation Detection, Measurements and Analysis” (Narosa)
7. Joseph Magill and Jean Galy : " Radioactivity Radionuclides Radiation", (Springer-Verlag)
8. S.B.Patel : “An introduction to nuclear Physics” (New Age International Publishing)
9. Basdevant, Rich, Spiro: “Fundamentals in nuclear physics from nuclear structure to cosmology” (Springer publications)

PAPER 2 SOLID STATE PHYSICS

UNIT-1: Crystal Physics

Types of lattices - miller indices - simple crystal structures - crystal diffraction - Bragg's law - reciprocal lattice (sc, bcc, fcc) - Laue equations - structure factor - atomic form factor - types of crystal binding - cohesive energy of ionic crystals - Madelung constant - inert gas crystals - Vander Waal - Landon equation - metal crystals - hydrogen bonded crystals.

UNIT-2: Lattice dynamics

Monoatomic lattices - lattice with two atoms per primitive cell - first brillouin zone - group and phase velocities - quantization of lattice vibrations - phonon momentum - inelastic scattering by phonons - Debye's theory of lattice heat capacity - Einstein's model and Debye's model of specific heat - thermal expansion - thermal conductivity - Umklapp processes.

UNIT-3: Theory of metals and semiconductors

Free electrons gas in three dimensions - electronic heat capacity - Wiedmann-Franz law - Hall effect - band theory of metals and semiconductors - Bloch theorem - Kronig-Penny model - semiconductors - intrinsic carrier concentration - mobility - impurity conductivity - fermi surfaces and construction - experimental methods in fermi surface studies - de Haas Van Alphen effect.

UNIT-4: Magnetism

Elementary ideas of dia, para and ferro magnetism - quantum theory of paramagnetism - Rare earth ion - Hund's rule - quenching of orbital angular momentum - adiabatic demagnetization - quantum theory of ferromagnetism - Curie point - exchange integral - Heisenberg's interpretation of Weiss field - ferromagnetic domains - bloch Wall - spin waves - quantization - magnons - thermal excitation of magnons - Curie temperature and susceptibility of ferrimagnets - theory of antiferromagnetism - Neel temperature.

UNIT-5: Super conductivity

Experimental facts-occurrence - effect of magnetic fields - Meissner effect - entropy and heat capacity - energy gap - microwave and infrared properties - type I and II superconductors - theoretical explanation - thermodynamics of super conducting transition - London equation - coherence length - BCS Theory - single particle tunneling - josephson tunneling - DC and AC Josephson effects - high temperature super conductors - SQUIDS.

Reference books:

1. C. Kittel : "Introduction to Solid State Physics" (7th Edition, Wiley, New York.)
2. M. Ali Omar: "Elementary Solid State Physics-Principles and Applications" (Addison-Wesley, London)
3. H.P. Myers: "Introductory Solid State Physics" (2nd Edition, Viva Book, Delhi)
4. S.O. Pillai: "Solid State Physics" (New Age International, New Delhi)
5. N.W. Aschroft and N.D. Mermin: "Solid State Physics", (Rhinehart and Winton, New York)
6. J.S. Blakemore, "Solid State Physics" (2nd Edition, W.B. Saunder, Philadelphia)
7. A.J. Dekker: "Solid State Physics" (Macmillan India, New Delhi)
8. H.M. Rosenberg: "The Solid State" (3rd Edition, Oxford University Press, Oxford).
9. S.O. Pillai, "Problems and Solutions in Solid State Physics" (New Age International, New Delhi)
10. S.L. Altmann: " Band Theory of Metals" (Pergamon, Oxford)
11. M.A. Wahab: "Solid State Physics, Structure and Properties of Materials" (Narosa, New Delhi)
12. J.M. Ziman: "Principles of the Theory of Solids" (Cambridge University Press, London)

PAPER - 3
FUNDAMENTAL RADIATION PHYSICS

UNIT- 1: Non Ionizing Radiation

Different sources of non ionizing radiation - radio frequency, microwaves, infrared, visible and ultra violet radiation production, physical properties and their interaction with tissues - electrical impedance and biological impedance - principle and theory of tomography applications

Lasers: Theory and mechanism- interaction of laser radiation with tissues - photothermal - photochemical - photoablation - electromechanical effect - lasers in dermatology, oncology and cell biology.

UNIT-2: Ionizing Radiation and X-ray Generators

Radiation Sources: Natural and artificial radioactive sources – large scale production of isotopes – reactor produced isotopes – cyclotron produced isotopes – fission products

X-rays discovery and production: Discovery - production - properties of X-rays - characteristics and continuous spectra - design of hot cathode X-ray tube - basic requirements of medical diagnostic, therapeutic and industrial radiographic tubes - rotating anode tubes - hooded anode tubes - industrial X-ray tubes - X-ray tubes for crystallography - rating of tubes - safety devices in X-ray tubes - rayproof and shockproof tubes - insulation and cooling of X-ray tubes - mobile and dental units - faults in X-ray tubes - limitations on loading.

Electric Accessories for X-ray tubes: Filament and high voltage transformers - high voltage circuits - half-wave and full-wave rectifiers - condenser discharge apparatus - three phase apparatus - voltage doubling circuits - current and voltage stabilizers - automatic exposure control - automatic brightness control- measuring instruments - measurement of kV and mA - timers - control panels - complete X-ray circuit - image intensifiers and closed circuit TV systems - modern Trends

UNIT-3: Interaction of photons with matter

Interaction of photons with matter: Ionization – photon beam exponential attenuation – Rayleigh scattering – Thomson scattering - Photoelectric effect – Compton effect - energy absorption – Pair production – attenuation, energy transfer and mass energy absorption coefficients – relative importance of various types of interactions.

UNIT-4: Interaction of charged particles with matter:

Classical theory of inelastic collisions with atomic electrons – energy loss per ion pair by primary and secondary ionization – dependence of collision energy losses on the physical and chemical state of the absorber – 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 heavy charged particles- Energy loss by collision – range energy relation – Bragg curve – specific ionization – stopping power – Bethe Bloch formula

UNIT-5: Interaction of Neutrons with matter

Neutron Sources – properties – energy classifications – elastic and inelastic scattering coefficients and cross sections – energy transfer and logarithmic energy decrement- nuclear reactions – dependence on E and Z – (n,p), (n,2n), (n,f) and other reactions – neutron activation, radio isotope production .

Reference books:

1. Markolf H. Neimz: " Laser-Tissue Interactions" (Springer Verlag, 1996)
2. E.B.Podgarsak : "Radiation Physics for Medical Physicists" (Springer Verlag,1996)
3. H.E.Johns and Cunningham: " The Physics of radiology" (Charles C Thomas Publishers)
4. E.B.Podgarsak : " Radiation Oncology Physics : Handbook for Teachers and Students" (IAEA, Vienna)
5. F.H. Attix: "Introduction to Radiological Physics and Radiation Dosimetry" (Viley – VCH, Verlag, 2004)
6. Curry,T.S. Dowdey and J.E. Murry,R.C : "Christensen's introduction to the Physics of diagnostic radiology " (Philadelphia,Lea& Febiger)
7. Chesney,D.N. & Chesney,M.O: " X-ray equipment for student radiographers"

PAPER- 4

MICROELETRONICS AND BIOMEDICAL INSTRUMENTATION

UNIT- 1: Basic Electronics:

Zener diode - characteristics - voltage regulator circuits - bipolar junction transistors - CB and CE Configuration characteristics. FET, MOSFET-principle of operation – characteristics - JFET Amplifier. Op-Amp-circuit symbol-ideal Op-Amp characteristics- CMRR-applications: adder, subtractor, analog integrator, analog differentiator, voltage-to-current converter, current-to-voltage converter and logarithmic amplifier.

UNIT- 2: Digital Electronics:

Logic gates - Boolean algebra - Boolean laws – De-Morgan's theorem - implementation of logic circuits from truth table – sum-of-products method – products-of-sum method - combinational circuits: multiplexer and de-multiplexer circuits - BCD to decimal decoders - Seven segment decoders - decimal to BCD encoder - arithmetic building blocks: half-adder and full-adder - digital comparator.
Flip Flops: RS, Clocked RS, D-Flip Flop, edge-triggered D flip flop – J K flip flop- sequential logic circuits: registers - shift registers – applications. Counters: ripple counters - up, down and up-down ripple counters - asynchronous and synchronous counters. A/D and D/A converters.

UNIT- 3: Microprocessor:

8085A- architecture and pin configuration - basic 8085 instructions – assembly language programming.

UNIT- 4: Physiological Assist Devices:

Cardiac pacemakers – natural and artificial pacemakers-pacemaker batteries-defibrillator-A.C./D.C synchronized defibrillator – stimulators – bladder stimulators – heart lung machine various types of oxygenators- kidney machine – hemo dialysing units – peritoneal dialysis.

UNIT-5: Bioelectric signal recording and clinical equipments:

Bioelectric potentials – resting and action potentials – surface, needle and micro electrodes - flame photometer – Spectrofluorophotometer – pH meters – audiometer – endoscopes

Reference Books:

1. Santanue Chattopadhyay : "A text book of Electronics" (New Central Book Agency, Kolkata, 2006)
2. A.P. Malvino and D.P. Leach : "Digital Principles and Applications" (Tata McGraw-Hill Publishing Co, New Delhi, 1996)
3. A.B. Bhattacharya : "Electronic Principles and Applications" (New Central Book Agency, Kolkata, 2007)
4. A.P. Mathur : "Introduction to Microprocessors" (Tata McGraw-Hill Publishing Co, New Delhi, 2005)

PAPER-5

ANATOMY AND PHYSIOLOGY AS APPLIED TO ONCOLOGY AND IMAGING

UNIT- 1: Structure & function of organs, systems & their common diseases:

Skin, Lymphatic system, Bone and muscle, Nervous, Endocrine, Cardiovascular, Respiratory, Digestive (Gastro-Intestinal), Urinary, Reproductive, Eye and ear.

UNIT- 2: Basic, Radiographic anatomy and tumor pathology

Anatomy of human body, nomenclature & surface anatomy, radiographic Anatomy (including cross sectional anatomy – Identify the different organs/structures on plain x- rays, CT scans and other available imaging modalities. Normal anatomy & deviation for abnormalities. Tumor pathology and carcinogenesis, common pathological features of cancers and interpretation of clinico-pathological data.

UNIT- 3: Clinical aspects of Radiation Oncology

Radiation therapy, surgery, chemotherapy, hormone therapy, immunotherapy & radionuclide therapy, benign and malignant disease, methods of spread of malignant disease, staging and grading systems, treatment intent – curative & palliative, cancer prevention and public education and early detection & screening- patient management on treatment – side effects related to radiation and dose – acute & late – monitoring and common management of side effects – information and communication.

UNIT- 4: Site specific signs, symptoms, diagnosis and management:

Head and Neck, Breast, Gynecological, Gastro-Intestinal tract, Genito-Urinary, Lung & Thorax, Lymphomas & Leukemias & other cancers including AIDS related cancers.

UNIT-5: Professional aspects and role of medical physicists:

General patient care - principles of professional practice – medical terminology – research & professional writing – patient privacy – ethical & cultural issues. legal aspects – confidentiality, informed consent, health and safety.

Reference Books

1. Meschan. Normal Radiation Anatomy
2. Hollinshead W.H. Text Book of Anatomy

PRACTICALS

ELECTRONICS LAB

1. Zener regulated power supply and percentage of regulation.
2. Transistor characteristics- CB configuration.
3. Transistor characteristics- CE configuration.
4. Single stage R-C coupled transistor amplifier.
5. FET characteristics.
6. Single stage FET amplifier- CS configuration.
7. OP-Amp applications- Adder, Subtractor, Differentiator and Integrator.
8. Logic gates OR, AND, NOT, NOR and NAND Gates.
9. NAND gate as a universal gate.
10. Half adder and Full adder.
11. A/D and D/A converters.
12. Microprocessor programming.
13. Programs using C
14. Programs using MATLAB.
15. Programs using MATHEMATICA.
16. Programs using STATISTICA.
17. Photosensitive diodes
18. Hall effect

SEMESTER – II

PAPER

6

MATHEMATICAL PHYSICS

UNIT-1: Probability, Statistic and Errors

Probability – addition and multiplication laws of probability, conditional probability, population, variates, collection, tabulation and graphical representation of data-basic ideas of statistical distributions frequency distributions, averages or measures of central tendency, arithmetic mean, properties of arithmetic mean, median, mode, geometric mean, harmonic mean, dispersion, standard deviation, root mean square deviation, standard error and variance, moments, skewness and kurtosis-application to radiation detection – uncertainty calculations, error propagation, time distribution between background and sample, minimum detectable limit- binomial distribution, poisson distribution, Gaussian distribution, exponential distribution – additive property of normal variates, confidence limits, Bivarite distribution, correlation and regression, Chi-Square distribution, t- distribution

UNIT- 2: Solutions of equations and Interpolation

Bisection method – false position method – Newton Raphson method – basic Gauss elimination method – forward & backward differences Gregory Newton forward and backward interpolation formula for equal intervals – divided differences – properties of divided differences – Newton’s divided difference formula – Lagrange’s interpolation formula for unequal intervals.

UNIT- 3: Monte Carlo Method

History of Monte Carlo simulation, Monte Carlo Method Vs deterministic Method, random variables, discrete random variables, continuous random variables, probability density function, discrete probability density function, continuous probability distributions, cumulative distribution function, accuracy and precision, law of large number, central limit theorem, random numbers and their generation, tests for randomness, inversion random sampling technique including worked examples, a simple integrals an example of Monte Carlo, sample calculation of neutron transport in tissue, general purpose Monte Carlo codes.

UNIT- 4: Numerical integration and Differentiation

Trapezoidal rule, Simpson’s rule, Simpson’s Three-eight rule, Boole rule, Weddle rule Taylor series method for first order differential equations – basic Euler’s method – Improved Euler’s method – modified Euler’s method – Runge – Kutta IV order method – RK method for simultaneous first order differential equations – RK method for second order differential equations.

UNIT- 5: Computer programming in C

Constants – variables – data types – operators and expression – input – output statements – control statements functions – arrays – one, two, multidimensional array declarations and initializations – simple applications.

Reference books:

1. Hoffman: “ Numerical Methods for Engineers and scientists” – 2nd Edition
Revised and Expanded, Marcel Dekker Inc

2. A.C. Bajpai, I.M. calus and J.A. Fairley: “ Numerical Methods for Engineers and scientists – A students course book” (John Wiley &sons)
3. Band W: “ Introduction to mathematical physics”
4. Croxton “ Elementary Statistics”
5. Dahlberg G : “ Statistical Method of Medical & Biology students”
6. S.G. Kochan: “Programming in C”, (CBS Publishers & Distributors, Delhi)
7. James Wood: “Computational methods in Reactor shielding”, 1982.

PAPER-7

RADIATION DETECTORS AND INSTRUMENTATION

UNIT - 1: Introduction to Radiation Measurements and Gas filled detectors

Radiation Measurements: Statistical nature of radiation emission - errors, accuracy and precision of measurements - types of errors

Gas filled detectors: Principle of gas filled detectors- relationship between high voltage and charge collected - ionization chambers - construction of condenser type chamber, thimble chambers- Gas multiplication- Proportional Counters, Geiger muller Counters - dead time and recovery time – quenching - characteristics of organic and inorganic counters.

UNIT-2: Principles of Radiation Detection using scintillation and other detectors:

Scintillation detectors: Different types - the relationship between pulse height and energy and type of incident particle - photomultiplier tube - assembly of a scintillation counter and role of light pipes - dead time of scintillation counters - sources of background in a scintillation counter - resolving time – resolving power

Radiographic and Radio chromic films – Semi conductor detectors- different types- damage due to radiation- chemical systems- Thermoluminescent dosimeters (TLD) – detection process- glow curve and dose response - common TLD materials and their characteristics – fading - residual TL and annealing for reuse. Optically stimulated luminescence dosimeters (OSLD). Radio photoluminescent dosimeters. Neutron detectors – nuclear track emulsions for fast neutrons – solid state nuclear track detectors (SSNTD) – Calorimeters – new developments.

UNIT- 3: Dosimetry Instruments:

Dosimeters based on condenser chambers – Pocket chambers – dosimeters based on current measurement – different types of electrometers – MOSFET, Vibrating condenser and Varactor bridge types – secondary standard therapy level dosimeters – Farmers dosimeters – Radiation field analyzer (RFA) – radioisotope calibrator – multipurpose dosimeters – water phantom dosimetry systems – brachytherapy dosimeters – Thermo luminescent dosimeter readers for medical applications – calibration and maintenance of dosimeters.

UNIT-4: Protection instruments

Instruments for personnel monitoring : TLD badge readers – PM film densitometers – glass dosimeters readers - digital pocket dosimeters using solid state devices and GM counters – Teletector – industrial gamma radiography survey meter – gamma area (Zone) alarm monitors - contamination monitors for alpha, beta and gamma radiation – hand and foot monitors - laundry and portal monitors - scintillation monitors for X and gamma radiations – neutron monitors, tissue equivalent survey meters – flux meter and dose equivalent monitors – pocket neutron monitors -teledose systems.

UNIT-5: Nuclear medicine instruments

Instruments for counting and spectrometry – portable counting systems for alpha and beta radiation – gamma ray spectrometers – multichannel analyzer – liquid scintillation counting system – RIA counters – whole body counters – air monitors for radioactive particulates and gases-details of commercially available instruments and systems.

Reference Books:

1. Price W.J: "Nucleus Radiation detection"
2. S.S.Kapoor and V. Ramamurthy: "Nuclear Radiation Detectors"
3. Nicholas Tsoufanidis "Measurement and Detection of Radiation"
4. Mcknlly, A.F: "Thermoluminescence Dosimetry" Bristol, Adam Hilger
5. W.J.Meredith and J.B.Massey: "Fundamental Physics of Radiology" John Wright and sons, UK, 1989.
6. J.R.Greening : "Fundamentals of Radiation Dosimetry", Medical Physics Hand Book Series No.6 Adam Hilger Ltd., Bristol 1981.

PAPER-8

PHYSICS OF RADIATION THERAPY

UNIT-1: Therapy beam generators

Kilo voltage therapy X-ray Units: Grenz ray therapy - contact therapy, superficial therapy, orthovoltage, deep therapy - spectral distribution of kV x-rays and effect of filtration - thoraues filter - output calibration procedure.

Telecobalt units: Construction and working - source design - beam shutter mechanisms - mercury shutter pneumatic pressure system - rotating wheel shutter system - beam collimation - penumbra and it's types - trimmers and breast cones - isocentric gantry **Medical electron linear accelerators:** Construction and working - klystron and magnetron - traveling and standing wave acceleration - pulse modulators and auxiliary systems - bending magnet systems - treatment beam production - X-rays - electron beam - beam collimation - asymmetric collimator – multi leaf collimator - dose monitoring and beam stabilization - electron contamination- relative merits and demerits of kV x-rays, gamma rays, MV x-rays and electron beams.

UNIT-2: Dosimetry parameters

Central axis dosimetry parameters: percentage depth doses (PDD), tissue air ratio (TAR), back scatter factor/Peak scatter factor (BSF/PSF) - tissue phantom ratio (TPR) - tissue maximum ratio (TMR)- collimator scatter factor, phantom scatter factor and total scatter factors - relationship between TAR and PDD and its applications - relationship between TMR and PDD and its applications – scatter air ratio(SAR) – scatter maximum ratio(SMR)- off axis ratio field factors- surface dose and buildup region.

Isodose curves - isodose surface - measurement of isodose curves- RFA- tissue equivalent phantoms- parameters of isodose curves – factors influencing isodose curves- contour irregularity, beam obliquity and tissue inhomogeneity- correction methods for contour irregularity, beam obliquity and tissue inhomogeneity – isodose curves for single, parallel opposed and multiple fields.

UNIT-3: Conventional to Conformal Teletherapy and dose calculations

Treatment planning dimensionality (2D, 2.5D, and 3D treatment plans) - treatment planning with asymmetric collimators - wedge filters – wedge systems- universal, motorized and dynamic wedges – treatment planning with wedges-shielding blocks - field shaping, custom blocking - tissue compensation – design of compensators, 2D compensators, 3D compensators-special considerations in treatment planning - skin dose, field matching, integral dose, DVHs – differential, integral.

Treatment time and Monitor unit calculations: SSD and SAD/isocentric technique – Co-60 calculations- accelerator calculations- irregular fields- Clarkson technique for mantle and inverted Y fields - Arc/Rotation therapy.

UNIT- 4: Physics of Brachytherapy

Brachytherapy: Introduction- requirement for brachytherapy sources – description of radium and radium substitutes - ¹³⁷Cs, ⁶⁰Co, ¹⁹²Ir, ¹²⁵I and other commonly used brachytherapy sources - definition and classification of Brachytherapy techniques – surface mould, intracavitary, interstitial and intraluminal techniques-Classification of Brachytherapy based on dose rate- low dose rate (LDR), high dose rate (HDR) and pulsed dose rate (PDR)-classification of brachytherapy based on source loading-manual pre loading systems, manual after loading systems, remote after loading systems - advantages and disadvantages of

manual and remote afterloading techniques- source trains (fixed and programmable) - stepping source - different types of applicators (gynecological, esophageal, nasopharyngeal, bronchial) and templates-temporary and permanent implants- Partial breast irradiation using balloon catheter - use of classical implant systems (Manchester, Quimby, Paris) for interstitial implants – AAPM TG-43/43U1 dosimetry protocol. Intra-operative Brachytherapy -Integrated Brachytherapy unit - electronic brachytherapy – micro brachytherapy-ocular brachytherapy using photon and beta sources- Intravascular brachytherapy – classification – sources – dosimetry procedures - AAPM TG 60 protocol.

UNIT-5: Electron and Particle beam therapy physics

Electron beams: Energy specification - depth dose characteristics (D_s , D_x , R_{100} , R_{90} , R_p , etc.) of electron beam – beam flatness and symmetry – penumbra – isodose plots – monitor unit calculations – output factor formalisms - Planning and dose calculation effects of patient and beam geometry: air gap, beam obliquity, irregular patient surface, internal heterogeneities: bone, fat, lung, air- treatment planning techniques - energy and field size selection, Bolus- Collimation: Inserts, skin, internal - field abutment techniques- photon electron mixed beams.

Particulate beam therapy: relative merits of electrons, neutron, x-ray and gamma ray beams – neutron capture therapy: history, principle, radiobiology, dosimetry, advantages and difficulties – heavy ion therapy.

Reference books

1. Faiz M.Khan:"The Physics of Radiation Therapy"
2. H.E. Johns and Cunningham: "The Physics of Radiology"
3. Faiz M.Khan, Roger A. Potish: "Treatment Planning in radiation Oncology"
4. C.K.Bomford, I.H.kunkler: "Walter and Miller's Textbook of Radiotherapy"
5. W.R.Hendee, "Medical Radiation Physics", Year Book – Medical Publishers Inc London, 1981.
6. R.F.Mould, "Radiotherapy Treatment Planning Medical Physics Hand book series No.7, Adam Hilger Ltd, Bristol, 1981.
7. S.C.Klevenhagen "Physics of Electron Beam Therapy" Medical Physics Hand Book Series No.6 Adam Hilger Ltd, Bristol, 1981.
8. S.H. Levitt, J.A. Purdy, C.A. Perez and S.Vijayakumar (Editors). Technical Basis of Radiation Therapy practical Clinical Applications – 4th Revised Edition, Springer Berlin Heidelberg New York.
9. D. Baltas, L. Sakelliou and N. Zamboglou:" The Physics of Modern Brachytherapy for Oncology" (CRC Press, Taylor and Francis Group, 6000 Brooken Sound Parkway NW Suite 300, Boca Raton – FL 33487-2742)
10. T.J.Godden: "Physical aspects of Brachytherapy"

PAPER-9

MEDICAL IMAGING TECHNOLOGY

Unit1: Principles of X-ray Diagnosis & Conventional Imaging

Physical Principle of diagnostic radiology: Interactions of X-rays with human body- differential transmission of x-ray beam - spatial image formation - visualization of spatial image - limitations of projection imaging technique viz. superimposition of overlying structures and scatter - application of contrast media and projections at different angles to overcome superimposition of overlying structures.

Prime factors (kVp, mAs and SID/SFD): influence of prime factors on image quality, selection criteria of prime factors for different types of imaging, different type of projection and slices selected for imaging-inherent and added filters, purpose of added filters, beryllium filters, filters used for shaping X-ray spectrum (K-edge filters: holmium, gadolinium, molybdenum)

Scatter reduction : factors influencing scatter radiation, objectives of scatter reduction, contrast reduction factor, scatter reduction methods- beam restrictors (diaphragms, cones/cylinders & collimators), grids (grid function, different types of stationary grids, grid performance evaluation parameters, moving grids, artifacts caused by grids, grid selection criteria), air gap technique.

Radiographic Film and Screens: components of radiographic film, physical principle of image formation on film, double and single emulsion film, sensitometric parameters of film (density, speed, latitude etc.) QA of film developer- function of intensifying screens, screen function evaluation parameters, emission spectra and screen film matching, conventional screens Vs rare earth screens.

Different Radiography Techniques: Xero-radiography, mammography, fluoroscopy, digital subtraction techniques, orthopan tomography (OPG)

UNIT-2: Computed Tomography

Conventional X-ray tomography (Basic principle), data accumulation, original EMI scanner, scanning motions or generations- first, second, third and fourth generations, principle of helical CT scan and scan parameters (kV, mAS and pitch)-other scan configurations-X-ray tubes, collimators, detectors-scintillation crystal and Xenon gas ionization chamber, image reconstruction, algorithms for image reconstruction-back projection, iterative method and analytical methods, comparison of mathematical models, CT numbers, image display, image quality, resolution-spatial and contrast resolution, patient exposure, artifacts-motion artifacts, streak artifacts, beam hardening artifacts and ring artifacts, 3D imaging –surface reconstruction and volumetric reconstruction.

UNIT-3: Magnetic Resonance Imaging

Magnetic resonance image – proton density, relaxation time T1 & T2 images – image characteristics – MRI system components – magnets, magnetic fields, gradients, magnetic field shielding, radio frequency systems, computer functions – imaging process – image artifacts – MRI safety.

UNIT4: Ultrasound

Basics of ultrasound, propagation of sound, interaction of ultrasound with matter-ultrasound transducer, piezoelectric material, transducer design, transducer array- beam

properties- near field-far field-side lobes-spatial resolution- image data acquisition- data acquisition systems, ADC-receiver, echo display modes, scan converter-image data acquisition, pulse echo acquisition- ultrasound image display, amplitude mode, motion mode, brightness mode- Doppler ultrasound-ultrasound image quality- image artifacts-bioeffects of ultrasound

Unit 5: Quality assurance in Diagnostic Radiology

Quality assurance of X-ray radiography, fluoroscopy, digital X-rays-CT-MRI and Mammography.

Reference

books:

1. Curry,T.S. Dowdey and J.E. Murry,R.C : "Christensen's introduction to the Physics of diagnostic radiology " (Philadelphia,Lea& Febiger)
2. Bushberg,S.T; Seibert,J.A; Leidholt,E.M & Boone,J.M. "The essential Physics of Medical imaging" (Baltimore, Williams & Wilkins)
3. David J. Dowsett; Patrick A. Kenny; Eugene Johnston R. "The Physics of Diagnostic imaging"
4. Johns,H.E.& Cunningham,J.R: " The Physics of Radiology"
5. Hendee,W.R. & Ritenour,R.(1993) : “ Medical Imaging Physics”
6. Dendy,P.P. & Heaton,B: “ Physics for diagnostic radiology”
7. E.Seeram, “X-ray imaging equipment, An introduction”
8. Hashemi,R.H. Bradley, W.G;& Lisanti C.J. “MRI the basics”
9. RF Farr and PJ Allisy-Roberts “Physics for Medical Imaging”
10. Sprawls,P; “Magnetic resonance imaging principles, methods and techniques”
11. Chesney,D.N. & Chesney,M.O. “X-ray equipment for student radiographers”
12. Chesney,D.N. & Chesney,M.O. “Radiographic imaging”

PAPER-10

RADIATION DOSIMETRY AND STANDARDIZATION

Unit1: Radiation Quantities and Units

Radiation quantities and units - radiometry - 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 - radiation and tissue weighting factors, equivalent dose, effective dose, committed equivalent dose, committed effective dose - concepts of collective dose - KERMA-CEMA - 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 $H_p(d)$ - individual dose equivalent superficial $H_s(d)$.

Unit 2: Dosimetry & Standardization of X and Gamma Rays Beams

Dosimetry Standards: Primary and Secondary standards, traceability, uncertainties in measurements.

Two stage energy transfer process- Electronic equilibrium: Charged Particle Equilibrium (CPE), Transient Charged Particle Equilibrium (TCPE). Brag Gray, Burlin and Spencer Attix cavity theories. Free Air Ionization chamber (FAIC) – design measurement of exposure and limitations. Cavity ion chambers- Dose in free space (D_{gas}), Dose in Medium (D_{med}), expression for sensitivity, - general definition of calibration factors – N_x , N_k , N_D , air, N_D , w. Different types of Ion chambers- Cylindrical, parallel plate, spherical. Temperature pressure correction: Thermometers, pressure gauges. Saturation correction: Charge collection efficiency based on Mie theory. Polarity correction: Two voltage method for continuous and pulsed beam. Beam quality, beam quality index, expression for beam quality correction coefficient.

IAEA TRS277: Reference conditions, various steps to arrive at the expression for D_w starting from N_x . TRS398: Reference conditions, Various steps involved in D_w calculations. TRS 381, AAPM TG 51 and other dosimetric protocols. Calorimetric standards – inter comparison of standards.

Unit 3: Neutron Standards & Dosimetry

Neutron standards – primary standards, secondary standards - neutron yield and fluence rate measurements - manganese sulfate bath system - precision long counter - activation method- neutron spectrometry - threshold detectors- scintillation detectors - multispheres - neutron dosimetry - neutron survey meters- calibration - neutron field around medical accelerators.

Unit 4: Standardization of Radionuclide

Methods of Measurement of radioactivity – defined solid angle and 4 π counting – Beta gamma coincidence counting – standardization of beta emitters and electron capture nuclides with proportional, GM and scintillation counters – standardization of gamma emitters with scintillation spectrometers – ionization chamber methods – extrapolation chamber – routine sample measurements – liquid counter – windowless counting of liquid samples – scintillation counting methods for alpha, beta and gamma emitter – reentrant ionization chamber methods – methods using (n, f) and (n, p) reactions – determination of yields of neutron sources – space integration methods – solids state detectors.

Unit 5: Radiation Chemistry and Chemical Dosimetry

Definitions of free radicals and G-Values-Kinetics of radiation chemical transformations – LET and dose-rate effects – radiation chemistry of water and aqueous solutions, peroxy radicals, pH effects – radiation chemistry of gases and reactions of dosimetry interest – radiation polymerization- effects of radiation on polymers and their applications in dosimetry – description of irradiators from dosimetric view point – dosimetry principles – definitions of optical density- molar absorption coefficient- Beer – Lamberts law- spectrophotometry – dose calculations – laboratory techniques – reagents and procedures -requirements for an ideal chemical dosimeter – Fricke dosimeter – FBX dosimeter – Free radical dosimeter – Ceric sulphate dosimeter – other high and low level dosimeters – applications of chemical dosimeters in radiotherapy and industrial irradiators.

Reference books

1. IAEA TRS 374, Calibration of Dosimeters used in Radiation Therapy.
2. F.H. Attix: "Introduction to Radiological Physics and Radiation Dosimetry" (Viley – VCH, Verlag, 2004)
3. W.R.Hendee: "Medical Radiation Physics" (Year Book Medical Publishers Inc., London, 1981)
4. S.C.Klevenhagen: "Physics of Electron Beam Therapy" (Medical Physics Hand Book Series No.6, Adam Hilger Ltd., Bristol, 1981)
5. G.C.Bentel : "Radiation Therapy Planning" (Macmillan Publishing Co.,New York, 1992)
6. Govinda Rajan, "Advanced Medical Radiation Dosimetry" (Prentice hall of India Pvt.Ltd., New Delhi, 1992)
7. IAEA TRS 277, "Absorbed dose determination in Photon and Electron beams".

PRACTICALS

MEDICAL PHYSICS LAB - I

Suggested New Practical:

1. Statistics of Radioactive Counting
2. Characteristics of GM counter Plateau analysis and determination of operating voltage.
3. Detection efficiency of GM counters for both Gamma and emitting Sources.
4. Determination of Linear and Mass attenuation coefficients for Al, Cu and Pb.
5. Demonstration of Inverse Square law
6. Calibration of Gamma ray spectrometer and identification of unknown sources
7. Determination of operating voltage of Gamma ray spectrometer
8. Spectral analysis of Cs source using Gamma ray spectrometer
9. Attenuation of X/Gamma rays through different materials and HVL analysis.
10. Manual monitor unit calculations of simple and complex treatment plans
11. Manual Treatment Planning of Single and Parallel Opposed fields
12. Manual Treatment Planning of Three and Four fields
13. Manual Treatment Planning- Isodose Shift method
14. Manual Treatment Planning- Heterogeneity Correction Method

Demonstration

1. Quality assurance of diagnostic X-ray Machine
2. Radiation protection survey of Diagnostic radiology installations

SEMESTER - III

PAPER

11

MODERN RADIOTHERAPY TRENDS

UNIT-1: Simulation principles and Tumor volume definition

Patient positioning/immobilization - 2D and 3D simulation techniques- conventional simulator, CT simulator- use of contrast, markers - patient data acquisition

Tumor volume definition: Gross tumor volume (GTV) - Clinical target volume (CTV) - Internal target volume (ITV) - Internal margin- Planning target volume (PTV) – Organ at Risk (OAR) – Treated volume - Irradiated volume - Maximum target dose - Median target dose - Modal target dose - hot spot - ICRU 50, ICRU 62 and ICRU 83. Contouring using images from CR, CT, MRI, US, PET, fusion techniques. Dose specification and normalization - Virtual simulation- Digitally Reconstructed Radiograph (DRR)

Unit-2: Computers in Treatment Planning

Scope of computers in radiation treatment planning – review of algorithms used for treatment planning computations – pencil beam, double pencil beam, Clarkson method, convolution superposition, lung interface algorithm, fast Fourier transform, Inverse planning algorithm, Monte Carlo based algorithms. Treatment planning calculations for photon beam, electron beam, and Brachytherapy – factors to be incorporated in computational algorithms-plan optimization – direct aperture optimization – beamlet optimization –simulated annealing – dose volume histograms – indices used for plan comparisons – hardware and software requirements – beam & source library generation-networking, DICOM and PACS- acceptances, commissioning and quality assurance of radiotherapy treatment planning systems using IAEA TRS 430 and other protocols.

UNIT-3: Intensity modulated radiation therapy (IMRT) and Image Guided radiotherapy (IGRT)

Review of conventional and 3D conformal radiotherapy techniques- IMRT Principles – MLC based IMRT – step and shoot and sliding window techniques – Compensator based IMRT – planning process – inverse treatment planning – immobilization for IMRT – dose verification phantoms, dosimeters, protocols and procedures – machine and patient specific QA- Intensity modulated arc therapy (IMAT e.g. Rapid Arc).

Concept, imaging modality, kV cone beam CT (kVCT), MV cone beam CT (MVCT), image registration, plan adaption, QA protocol and procedures – special phantom, 4DCT.

Tomotherapy – principle – commissioning – imaging – planning and dosimetry – delivery – plan adaptation – QA protocol and procedures.

UNIT-4: Stereotactic Radiosurgery /Radiotherapy (SRS/SRT)

Cone and mMLC based X-knife – Gamma Knife – immobilization devices for SRS/SRT – dosimetry and planning procedures – evaluation of SRS/SRT treatment plans – QA protocols and procedures for X and Gamma knife units – patient specific QA- physical,

planning, clinical aspects and quality assurance of stereotactic body radiotherapy (SBRT) and Cyber knife based therapy.

UNIT-5: Special techniques in Radiation therapy

Total body irradiation (TBI) – large field dosimetry – total skin electron therapy (TSET) – electron arc treatment and dosimetry – intraoperative radiotherapy.

References books:

1. S.Webb: " The physics of three dimensional radiation therapy"
2. S.webb: "The Physics of Conformal radiotherapy"
3. S.Webb: "Intensity Modulated radiation therapy"
4. S.K.Jani: "CT simulation for radiotherapy"
5. S.H. Levit,J.A.Purdy,C.A. Perez and S.Vijayakumar: " Technical Basis of Radiation therapy Practical Applications "
6. J.Van Dyk: " The Modern Technology of Radiation Oncology"
7. S.C.Klevenhagen: "Physics and dosimetry of therapy electron beams"
8. Thomas Bortfeld, Rupert Schmidt- Ullrich, Wilfried De Neve, David E Wazer. "Image Guided IMRT" (Springer Berlin Heidelberg, 2006)

PAPER-12

NUCLEAR MEDICINE AND INTERNAL DOSIMETRY

Unit 1: Physics of Nuclear Medicine

Introduction to nuclear medicine- unsealed Sources- production of radionuclide used in nuclear medicine- reactor based radionuclide, accelerators based radionuclide, photonuclear activation, equations for radionuclide production, radionuclide generators and their operation principles- various usages of radiopharmaceuticals.

Unit 2: In-vivo and In-vitro techniques

Thyroid uptake measurements- reno gram- life span of RBC, blood volume studies, life Span of RBC etc-general concept of radionuclide- imaging and historical developments- In-vitro techniques- RIA/IRMA techniques and its principles.

Unit 3: Emission Tomography techniques

Radionuclide imaging: other techniques and instruments- the rectilinear scanner and its operational principles- basic principles and design of the Anger Camera / scintillation camera- system components, detector system and electronics- different types of collimators- design and performance characteristic of the parallel hole, converging, diverging and pin hole collimator- image display and recording systems- digital image processing systems- scanning camera- limitation of the detector system and electronics.

Different imaging techniques: basic principles- two dimensional imaging techniques- Three dimensional imaging techniques – basic principles and problems- focal plane tomography- emission computed tomography- single photon emission computed tomography- positron emission tomography- various image reconstruction techniques during image formation such as back projection and Fourier based techniques- iterative reconstruction method and their drawbacks- attenuation correction, scatter correction, resolution correction, other requirements or sources of error- image quality parameters: spatial resolution, factor affecting spatial resolution, methods of evaluation of spatial resolution, contrast, noise- NEMA protocols followed for quality assurance / quality control of imaging instruments.

Unit 4: Applied PET imaging

Principles of PET, PET instrumentations- annihilation coincidence detection- PET detector scanner design- data acquisition for PET- data corrections and quantitative aspect of PET- working of medical cyclotron- radioisotopes produced and their characteristic- treatment of thyrotoxicosis- thyroid cancer with I-131, use of P-32 and Y-90 for palliative treatment- radiation synovectomy and the isotopes used.

Unit 5: Internal Radiation Dosimetry

Different compartmental model- single compartmental model- two compartmental model with back transference- two compartmental model without back transference- classical methods of dose evaluation: beta particle dosimetry- equilibrium dose rate equation, beta dose calculation specific gamma ray constant- gamma ray dosimetry-

geometrical factor calculation- dosimetry of low energy electromagnetic radiation- MIRD technique for dose calculations- basic producer and some practical problems- cumulative activity, equilibrium dose constant, absorbed fraction, specific absorbed fraction, dose reciprocity theorem, mean dose per unit cumulative activity and problems related to the dose calculations- limitation of MIRD technique.

Reference Books:

1. G.S.Pant : "Advances in diagnostic Medical Physics".
2. W.H.Blahd: "Nuclear medicine" (McGraw Hill Co., New Delhi 1980)
3. W.N.Wagner: "Principles of Nuclear Medicine" (W.B.Saunders Co., London 1970)
4. J.Herbert and D.A.Rocha: " Text Book of Nuclear Medicine" Vol. 2 and 6, (Lea and Febiger Co., Philadelphia, 1984)
5. S.Webb: "The Physics of Medical Imaging" Medical Science Series, (Adam Hilgers Publications, Bristol, 1984)

PAPER-13
RADIATION BIOLOGY

Unit 1: Cell Biology

Cell Physiology and biochemistry – structures of the cell _ types of cells and tissue, their structures and functions - organic constituents of cells – carbohydrates, fats, proteins and nucleic acids – enzymes and their functions – functions of mitochondria, ribosomes, golgi bodies and lysosomes – cell metabolism – DNA as concepts of gene and gene action – mitotic and meiotic cell division – semi conservative DNA synthesis, genetic variation crossing over, mutation, chromosome segregation – heredity and its mechanisms.

Unit 2: Interaction of Radiation with Cells

Action of radiation on living cells – radiolytic products of water and their interaction with biomolecule – nucleic acids, proteins, enzymes, fats – influence of oxygen, temperature – cellular effects of radiation – mitotic delay, chromosome aberrations, mutations and recombinations – giant cell formation, cell death recovery from radiation damage – potentially lethal damage and sublethal damage recovery - pathways for repair of radiation damage- Law of Bergonie and Tribondeau.

Repair misrepair hypothesis – dual action hypothesis – modification of radiation damage – LET,RBE, dose rate, dose fractionation – oxygen and other chemical sensitizers – anoxic, hypoxic, base analogs, folic acid, and energy metabolism inhibitors – hyperthermic sensitization – radio-protective agents.

Unit 3: Biological Basis of Radiotherapy

Physical and biological factors affecting cell survival, tumor regrowth and normal tissue response – non-conventional fractionation scheme and their effect of reoxygenation, repair, redistribution in the cell cycle – High LET radiation therapy.

Unit 4: Radiobiological models

Cell population kinetic models- survival curve parameters – model for radiation action – target theory – multihit, multitarget –time dose fractionation – basis for dose fractionation in beam therapy – concepts for nominal standard dose (NSD)- Roentgen equivalent therapy (RET) – time dose fractionation (TDF) factors and cumulative radiation effects (CRE) – gap correction, linear and linear Quadratic models- TCP and NTCP evaluation.

Unit 5: Biological Effects of Radiation

Somatic effects of radiation – physical factors influencing somatic effects – dependence on dose, dose rate, type and energy of radiation, temperature, anoxia - acute radiation sickness – LD 50 dose – effects of radiation on skin and blood forming organs- digestive track – sterility and cataract formation – effects of chronic exposure to radiation – induction of leukemia – radiation carcinogenesis – risk of carcinogenesis – animal and human data – shortening of life span – in-utero exposure – genetic effects of radiation – factors affecting frequency of radiation induced mutations – dose-effects relationship – first generation effects – effects due to mutation of recessive characteristics – genetic burden – prevalence of hereditary diseases and defects – spontaneous mutation rate – concept of doubling dose and genetic risk estimate.

Reference Books

1. E.J.Hall, Radiobiology for Radiologists, J.B.Lippincott Co., Philadelphia, 1987.
2. S.P.Yarmonenko, Radiology of Humans and animals, MIR,Publishers, Moscow, 1990.

PAPER-14

RADIATION HAZARDS EVALUATION AND CONTROL

Unit 1: Radiation protection standards

Radiation dose to individuals from natural radioactivity in the environment and manmade sources-basic concepts of radiation protection standards – historical background – International Commission on Radiological protection and its recommendations – The system of radiological protection – justification of practice, optimisation of protection and individual dose limits – potential exposures, dose and constraints – system of protection for intervention – categories of exposures – occupational, Public and medical exposures – permissible levels for neutron flux – factors governing internal exposure – radionuclide concentrations in air and water – ALI, DAC and contamination levels.

Unit 2: Principles of Monitoring and Protection

Evaluation of external radiation hazards – effects of distance, time and shielding – shielding calculations – personnel and area monitoring – internal radiation hazards – radio toxicity of different radionuclide and classification of laboratories – control of contamination – bioassay and air monitoring – chemical protection – radiation accidents – disaster monitoring.

Unit 3: Safety in the Medical Uses of Radiation

Planning and shielding calculations of medical radiation installation – general considerations – design of diagnostic, deep therapy, telegamma, accelerators and installations, brachytherapy facilities, SPECT, PET/CT and medical cyclotron in the nuclear medicine department and medical radioisotope laboratories-evaluation of radiation hazards in medical diagnostic therapeutic installations – radiation monitoring procedures – protective measures to reduce radiation exposure to staff and patients – radiation hazards in brachytherapy department and teletherapy departments and radioisotope laboratories – particle accelerators protective equipment – handling of patients – radiation safety during sources transfer operations special safety features in accelerators, reactors.

Unit 4: Radioactive Waste Disposable and Transport of Radioisotopes

Radioactive waste – sources of radioactive waste – classification of waste – treatment techniques for solid, liquid and gaseous effluents – concept of delay tank and various Waste disposal Methods used in nuclear medicine. permissible limits for disposal of waste – sampling techniques for air, water and solids – geological, hydrological and meteorological parameters – ecological considerations- disposal of radioactive wastes – general methods of disposal- transportation of radioactive substances – historical background – general packing requirements – transports documents – labeling and marking of packages – regulations applicable for different modes of transport – transports by post –transport emergencies – special requirements for transport of large radioactive sources and fissile materials – exemptions from regulations – shipments approval – shipment exclusive use – transports under special arrangement – consignors and carriers responsibilities.

Unit 5: Radiation safety Legislation and Radiation Emergencies and their Medical Management (Seminar)

Atomic Energy Act-1962, RPR-2004 and applicable safety codes- radiation accidents and emergencies in the use of radiation sources and equipment industry and medicine - radiographic cameras and teletherapy units – loading and unloading of sources – loss of radiation sources and their tracing – typical accidents cases, radiation injuries, their treatment and medical management – case his histories.

Reference

Books:

1. Herman Cember: “ Introduction to Health Physics”
2. Atomic Energy Act 1962
3. AERB Radiation Protection Rules 2004
4. ICRP 1990 Recommendations
5. ICRP 2007 Recommendations
6. IAEA Basis Safety Standards 115, 1997
7. Shapiro J. Radiation Protection
8. Mckenzie: “ Radiation protection in Radiotherapy”

Practical Medical Physics Lab-II

Experiments

1. Study of Voltage-Current Characteristics of an Ion Chamber
2. Cross Calibration of Ion Chambers
3. Measurement and Verification of PDD, TAR and TMR values
4. Absolute Calibration of Photon beams - using TRS 398
5. Absolute Calibration of Electron beams - using TRS 398
6. Wedge and Tray factor determination
7. Quality Assurance of a Linear Accelerator
8. Autoradiography test for Brachytherapy source in Remote Afterloader unit
9. Source strength verification Brachytherapy source
10. Quality Assurance of Brachytherapy unit
11. Pretreatment IMRT Quality Assurance
12. Radiation Protection survey of Teletherapy and Brachytherapy installations

Demonstrations

1. Determination of output of a Telecobalt unit - Using TRS 398
2. Quality Assurance of a Telecobalt unit
3. Evaluation of Profile parameters using Radiation Field Analyzer
4. Preparation and standardization of unsealed sources
5. Study and calibration of thyroid uptake measurement unit
6. Teletherapy treatment planning using TPS
7. Brachytherapy treatment planning using TPS