॥ सा विद्या या विमुक्तये ॥

स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ, नांदेड

'ज्ञानतीर्थ', विष्णुपुरी, नांदेड – ४३१ ६०६ (महाराष्ट्र राज्य) भारत

SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED

'Dnyanteerth', Vishnupuri, Nanded - 431 606 (Maharashtra State) INDIA

Established on 17th September, 1994, Recognized By the UGC U/s 2(f) and 12(B), NAAC Re-accredited with'B++' grade

स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ, नांदेड

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Phone: (02462)215542 | E-mail: bos.srtmun@gmail.c

विद्यापीठ अनुदान आयोगाने शैक्षणिक वर्ष २०२०–२१ पासून मान्यता दिलेल्या बी. व्होक (व्होकेशनल कोर्सेसचे) पदवी अभ्यासक्रमाचे Syllabus शैक्षणिक वर्ष २०२१–२२ मध्ये द्वितीय वर्ष व शैक्षणिक वर्ष २०२२–२३ पासून तृतीय वर्षाचे अभ्यासक्रम लागू करणे बाबत.

प रि प त्र क

या परिपत्रकान्वये सर्व संबंधितांना कळविण्यात येते की, विद्यापीठ अनुदान आयोगाने शैक्षणिक वर्ष २०२०–२१ पासून मान्यता दिलेल्या बी. व्होक (व्होकेशन कोर्सेस) पदवी अभ्यासक्रमाचे Syllabus शैक्षणिक वर्ष २०२१–२२ पासून द्वितीय वर्ष आणि २०२२–२३ मध्ये तृतीय वर्षाचे Syllabus लागू करण्यास मा. विद्यापरिषदेच्या मान्यतेच्या अधीन राहून मा. कुलगुरू महोदयांनी मान्यता दिली आहे. त्या नुसार खालील अभ्यासक्रम लागू करण्यात येत आहेत.

1. B. Voc Software Development. II & III year
2. B. Voc. Bachelor of Medical Laboratory Technology. II & III year
3. Advance Diploma in Rediological Physics II year

सदरील परिपत्रक व अभ्यासक्रम प्रस्तुत विद्यापीठाच्या **www.srtmun.ac.in** या संकेतस्थळावर उपलब्ध आहेत. तरी सदरील बाब ही सर्व संबंधितांच्या निदर्शनास आणून द्यावी. ही विनंती.

स्वाक्षरित

सहा.कुलसचिव

शैक्षणिक (१–अभ्यासमंडळ) विभाग

जा.क्र.:शैक्षणिक–१/परिपत्रक/व्होकेशनल अभ्यासक्रम/N-२०२१–२२/३२९

दिनांक : १७.०२.२०२२

प्रत माहिती व पुढील कार्यवाहीस्तव :

१) मा. अधिष्ठाता, विज्ञान व तंत्रज्ञान विद्याशाखा, प्रस्तुत विद्यापीठ.
२) मा. संचालक, परीक्षा व मूल्यमापन मंडळ यांचे कार्यालय, प्रस्तुत विद्यापीठ.
३) प्राचार्य, सर्व संबंधित संलग्नित महाविद्यालये, प्रस्तुत विद्यापीठ.
४) साहाय्यक कुलसचिव, पदव्युत्तर विभाग, प्रस्तुत विद्यापीठ.
५) उपकुलसचिव, पात्रता विभाग, प्रस्तुत विद्यापीठ.
६) सिस्टम एक्सपर्ट, शैक्षणिक विभाग, प्रस्तुत विद्यापीठ. याना देवून कळविण्यात येते की, सदरील परिपत्रक विद्यापीठाच्या संकेतस्थळावर प्रसिध्द करण्यात यावे.

Swami Ramanand Teerth Marathwada University, Nanded

(NAAC Re-accredited with 'B++' Grade)

Syllabus, Regulation, Curriculumof PostM.Sc.DiplomainRadiologicalPhysics(DipRP)- 2 Years

(witheffect01.01.2021onwards)

Post-M.Sc. Dip.R.P.

1. Introduction

1.1 Preamble

Post-M.Sc. Diploma in Radiological Physics conducted by the S.R.T.M. University, Nanded is in accordance with the recommendations for the safe use of radiation in health care.Skills and knowledge are the driving forces of economic growth and social development for any country.Presently, the country facing serious issues and challenges in the COVID-19 pandemic. Some of these include the inadequate reach of basic healthcare services, shortage of medical skilled personnel, quality assurance, and inadequate outlay for health.Therefore, now India needs more 'skilled' workers thanthat is available in the present. In the higher education sphere, knowledge and skills are required for diverse forms ofemployment in the sectors of education, health care, manufacturing, and other services.

The Government of India, taking note of the requirement for skill development among students, launched NationalVocational Education Qualification Framework (NVEQF) which was later on assimilated into National SkillsQualifications Framework (NSQF). Various Sector Skill Councils (SSCs) are developing Qualification Packs(QPs), National Occupational Standards (NOSs), and assessment mechanisms in their respective domains, inalignment with the needs of the industry.

In view of this, our University initiated to start the advanced skill-based course in Radiological Physics which is the key diagnostic tool for many diseases and has an important role in monitoring treatment and predicting outcome.The advance program is highly relevant for all those who want to pursue a professionalcareer in health care.

1. 2 Title of the Program

The program shall be called Post M.Sc. Diploma in Radiological Physics, abbreviated as Dip RP.

2. Aims

The course has been designed to train the student to acquire the skill and competence to use radiation safely on patients in diagnosis and therapy. It is insisted that the course be conducted only in a teaching institution attached to a hospital having modern Radiotherapy and Diagnostic Imaging facilities and has to be taught by Medical Physics Faculty.

3. Objectives

This PG Diploma will enable the successful candidate to perform Medical Physics issues, a few of which are mentioned below:

1. Radiological safety of patients and staff.
2. Site Plan preparation and obtaining permission from AERB for setting up diagnostic radiology and radiotherapy installations.
3. Commissioning of radiotherapy installations.
4. Periodic Quality Assurance of radiotherapy and diagnostic radiology equipment.
5. Treatment Planning in radiotherapy.

6. Teaching Medical Radiation Physics to undergraduate, post graduate medical and paramedical students.
7. Undertaking research work related to use of radiation for diagnosis and therapy.

4. Eligibility and Fees

A pass in Full time M.Sc. Physics conducted by any of the UGC approved Universities in India with 55%.

5. Components of Curriculum

There will be 8 theory papers and 2 practicals besides internal assessment.
One month will be allotted for Project Work.

6. Theory:

1. Radiation Physics, and Radiation Generators – 50 hours
2. Radiological Mathematics – 50 hours
3. Radiation dosimetry and Standardization - 50 hours
4. Radiation Detectors and Instrumentation–50 hours
5. Clinical and Radiation Biology- 50 hours
6. Medical Imaging -50 hours
7. Radiation Therapy -50 hours
8. Radiation Safety- 50 hours

7.Practical:

1. Radiation Detection and Measuring Instruments – 40 hours
2. Medical Imaging – 40 hours
3. Planning and Dosimetry in Radiotherapy – 40 hours
4. Quality Assessment of Radiotherapy equipment– 60 hours
5. Quality Control, Acceptance testing and Calibration of radiological equipment – 20 hours.

8. Project Work: 150 hours
9. Internship: one year
10.Duration of the Course:

Two years (including one-year mandatory internship in Life Care Hospital and research Center in Radio diagnosis, Radiotherapy and Nuclear Medicine).

11.Field Training and Project work:

Field training will be an integral part of the course. The candidates will be posted in Imageology, Nuclear Medicine, Radiation Physics and Radiation Oncology Divisions of the Institution during the course period under a faculty supervisor.
A field training report must be submitted to the supervisor at the end of every posting. Every candidate must do a project work also under an approved faculty supervisor in a topic having relevance to the application of radiation in medicine. The supervisor must certify to the adequacy of the field training and project work on the basis of the thesis reports submitted by

the candidate. The students should necessarily present at least one seminar on the basis of the project work. The record of the field training must be duly certified by the designated faculty member.
The final result will be declared only after satisfactory completion of field training, project work and internship.
Students will be eligible to do internship only after passing all the theory papers, practical's and viva.

12.Attendance

A candidate is required to put in at least 80% attendance in theory and 100% in practical subjects separately in the recognized institution approved for the same.

13. Examination

The classes will be more practical and clinically oriented. There will be weekly assessment of students.
Scheme of Examination and Distribution of Marks for **Post-M.Sc. DipRP**
Examination will be conducted at the end of first year. Internship will be allowed only after passing the theory papers, practicals and viva.
The duration of each theory paper will be 3 hours.
There will be two practical examinations each of four hours' duration.

SUBJECT	**Min Marks**	**Max marks**
Theory Papers		
Paper I: Radiation Physics and Radiation Generators	35	100
Paper II: Radiological mathematics	35	100
Paper III: Clinical and Radiation Biology	35	100
Paper IV: Medical imaging	35	100
Paper V: Radiation Dosimetry and Standardization	35	100
Paper VI: Radiation Detectors and Instrumentation	35	100
Paper VII: Radiation Therapy	35	100
Paper VIII: Radiation Safety	35	100
Practical Examination		
Paper I: Radiation Detection and Measuring Instruments, Medical Imaging, Quality Control, Acceptance testing and calibration of radiological equipment.	35	100
Paper II: Planning and Dosimetry in Radiotherapy; Quality Assessment of Radiotherapy equipment	35	100
Record Work	05	10
Project Work Record	35	100
Presentation and Viva	25	50
Grand Total	**415**	**1200**

There will be one external examiner, one internal examiner and one skilled assistant

for the Practical examination and viva voce.

COURSE CONTENT

14. SYLLABUS

The syllabus gives an outline of the topics to be covered during the course. However, the course being one of Applied Physics having relevance to many fields like medical imaging, radiotherapy, use of open radio nuclides etc. recent developments should be adequately taken care of in the teaching program. The syllabus described may show a certain overlap and the same is to give greater emphasis to the applied nature of the subjects and to ensure continuity.

PAPER I –RADIATION PHYSICS & RADIATION GENERATORS (50 hours)

Nuclear Physics

Radioactivity- General properties of alpha, beta and gamma rays- Laws ofradioactivity- 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 andReactors-Fusion.

Particle accelerators

Particle accelerators for industrial, medical and research applications- The resonant transformer-cascade generator- Van De Graff Generator-Pelletron-Cyclotron- Betatron- Synchro-Cyclotron- linear accelerators, wave guides and complete details about medical accelerators, Production and properties of micro waves – Magnetron, Klystron- Travelling and standing wave acceleration- Microtron- Electron Synchroton- Proton synchrotron. Details of accelerator facilities in India.

X-ray Generators

Discovery – Production and properties of X-rays – Characteristic 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.

Interaction of Radiation with Matter (oriented towards Radiology)

Interaction of electromagnetic radiation with matter– Exponential attenuation- Thomson scattering - Photoelectric and Compton process and energy absorption –Pair production – Attenuation and mass energy absorption coefficients- Relativeimportance of various processes.

Interaction of charged particles with matter: – Classical theory of inelastic collisionswith atomic electrons- Energy loss per ion pair by primary and secondaryionization- Dependence of collision energy losses on the physical and chemical stateof the absorber- Cerenkov radiation- Electron absorption process- Scattering,Excitation and Ionization- Radiative collision– Radiation energy loss(bremsstrahlung)– Range-energy relation-continuous slowing down approximation(CSDA) – straight ahead approximation and detour factors- transmission and depthdependence methods for determination of particle penetration- empirical relationsbetween range and energy- Back scattering.

Passage of heavy charged particles with matter –Energy loss by collision- Rangeenergy relation- Bragg curve- Specific ionization- Stopping Power- Bethe-Blochformula.Interaction of neutrons with matter – scattering –capture- Neutron induced nuclearreactions.

STANDARD BOOKS FOR STUDY AND REFERENCES

1. W.R.Hendee, "Medical Radiation Physics", Year Book – Medical Publishers Inc.London, 1981.
2. E.J.Hall Radiobiology for Radiologists J.B.Lippincott Company, Philadelphia 1987.
3. J.R.Greening "Fundamentals of Radiation Dosimetry", Medical Physics HandBook Series No.6 Adam Hilger Ltd., Bristol 1981.
4. Practical Applications of Radioactivity and Nuclear Radiations, G.C.Lowental and P.L.Airey, Cambridge Universiyt Press, U.K., 2001
5. H.E.Jones, J.R.Cunnigham, "The Physics of Radiology" Charles C.Thomas, NY, 1980.
6. W.J.Meredith and J.B.Massey "Fundamental Physics of Radiology" John Wright and sons, UK, 1989.
7. Christensen 'Physics of Diagnostic Radiology' Lea and Febiger – Philadelphia (1990).

PAPER II – RADIOLOGICAL MATHEMATICS (50 hours)

Probability, Statistics 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, Bivariate distribution, correlation and regression, Chi-Square distribution, t-distribution, F- distribution.

Counting and Medical Statistics

Statistics of nuclear counting – Application of Poisson's statistics – Goodness – fit tests – Lexie's divergence coefficients – Pearson's chi-square test and its extension – Random fluctuations. Evaluation of equipment performance- Signal-to-noise ratio Selection of operating voltage- Preset of rate meters and recorders- Efficiency and sensitivity of radiation detectors- statistical aspects of gamma ray and beta ray counting- special considerations in gas counting and counting with proportional counters- statistical accuracy in double isotope technique.
Sampling and sampling distributions-confidence intervals. Clinical study designs and clinical trials. Hypothesis testing and errors. Regression analysis.

Numerical methods

Why numerical methods, accuracy and errors on calculations-round-off error, evaluation of formulae. Iteration of solving x = g(x), Initial Approximation and Convergence criteria, Newton-Raphson method. Taylor series, approximating the derivation, numerical differentiation formulas. Introduction to numerical quadrature, Trapezoidal rule, Simpson's rule, Simpson's Three-Eighth rule, Boolerule, Weddle rule. Initial value problems, Picard's method, Taylor's method, Euler's method, modified Euler's method, Runge – Kutta method.
Monte Carlo: 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 samples, integration of simple I-D integrals including worked samples.

Computational Tools and Techniques

Computational packages: Overview of programming in C++, MATLAB/Mathematica and Statistical in data analysis and graphics.

STANDARD BOOKS FOR STUDY AND REFERENCES

1.A.Arfken: Mathematical Methods for Physicists (Academic Press).
2.S.S.Sastry, Introductory Methods of Numerical Analysis, Prentice Hall of India, New Delhi, 1979.
3.S.C.Gupta and V.K.Kapoor, Elements of Mathematical Statistics, Sultan Chand and Sons, New Delhi, 1983.
4.S.Ramani, N.V.Koteswara Rao and R.Nagarajan, A test book on Computer Programming, M.M.C School of Management, Bombay 1984.
5.Venkataraman, Numerical Methods in Science and Engineering, National Publishing Co, Madras, 1986.
6.L.A.Pipes, Applied Mathematics for Engineers and Physicists – McGraw Hill Book Co., 1980.
7.E.Butkov, Mathematical Physics – Addison Wesley Co., London 1973.
8.E.Kreyzsig, Advanced Engineering Mathematics – Wiley Eastern Ltd., 1980.
9.M.K.Venkataraman, Advanced Mathematics for Engineers and Scientists – National Publications Co., Madras, 1986.

PAPER III - RADIATION DOSIMETRY AND STANDARDISATION (50 hours)

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; The roentgen; 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)

Radiation Sources:

Radiation Sources - Natural and artificial radioactive sources – Large scale production of isotopes – Reactor produced isotopes – Cyclotron produced isotopes – Fission products – industrial uses – Telecobalt and Brachy Cesium sources - Gold seeds – Tantalum wire - ^{125}Iodine sources – Beta ray applicators – Thermal and fast neutron sources – Preparation of tracers and labeled compounds – Preparation of radiocolloids.

Dosimetry & Standardisation of X and Gamma Ray Beams

Standards- Primary and Secondary Standards, Traceability, Uncertainty in measurement. Charged Particle Equilibrium (CPE), Free Air Ion Chamber (FAIC), Design of parallel plate FAIC, Measurement of Air Kerma/ Exposure. Limitations of FAIC.

Bragg-Gray Theory, Mathematical expression describing Bragg-Gray principle and its derivation. Burlin and Spencer- Attix cavity theories. Transient Charged particle Equilibrium (TCPE), Concept of D_{gas}, Cavity ion chambers, Derivation of an expression for sensitivity of a cavity ion chamber. General definition of calibration factor- N_x,N_k, $N_{D,air}$, $N_{D,W}$. IAEA TRS 277: Various steps to arrive at the expression for D_W starting from N_x. TRS 398: $N_{D,W,Q}$: $N_{D,W}$: $K_{Q,Q0}$: K_Q, Derivation of an expression for K_Q,Q_0. Calorimetric standards- Intercomparison of standard.

Measurement of D_w for External beams from ^{60}Co teletherapy machines: Reference conditions for measurement, Type of ion chambers, Phantom, Water proof sleeve, Derivation of an expression for machine timing error, Procedure for evaluation of temperature and pressure correction: Thermometers and pressure gauges. Measurement of temperature and pressure. Saturation correction: derivation of expression for charge collection efficiency of an ion chamber based on Mie Solution. Parallel plate, cylindrical and spherical ion chambers, Ksat, Two voltage method for continuous and pulsed beams, Polarity correction. Measurement of Dw for high energy photon beams from Linear accelerators: Beam Quality and Index, quality correction coefficient, Cross calibration, Measurement of Dw for high energy electron beams from linear accelerators: Beam quality, index, correction coefficient, Cross calibration using intermediate beam quality, Quality Audit Programs in Reference and Non-reference conditions.

Standardisation of brachytherapy sources- Apparent activity- Reference Air Kerma Rate- Air Kerma Strength- Standards for HDR ^{192}Ir and ^{60}Co sources- Standardisation of ^{125}I and beta sources- IAEA TECDOC 1274- room scatter correction. Calibration of protection level instruments and monitors.

Neutron Standards and Dosimetry:

Neutron classification, neutron sources, Neutron standards- primary standards, secondary standards, Neutron yield and fluence rate measurements, Manganese

sulphate 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.

Standardisation of Radionuclides

Methods of measurements of radioactivity – Defined solid angle and 4л counting – Beta-Gamma coincidence counting – Standardization of beta emitters and e-capture nuclides with proportional, G.M and scintillation counters- standardization of gamma emitters with scintillation spectrometers, – Ionisation chamber methods – Gas counting – Extrapolation chamber – Routine sample measurements with radioisotopes – re-entrant ionization chamber methods, Liquid counters – Window- less counting of liquid samples – Measurement of neutron flux – Activation and absorption methods – Methods using (n, γ) and (n, p) reactions – Determination of the yield of neutron sources- space integration methods – Solid State detectors.

Radiation Chemistry and Chemical Dosimetry:

Definitions of free radicals and G-value- 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 polymerisation, effects of radiation on polymers and their applications in dosimetry- Formation of free radicals in solids and their applications in dosimetry- Description of irradiators from dosimetric view point-Dosimetry principles- Definition of optical density, molar absorption coefficient, Beer – Lambert law, spectrophotometry- Dose calculations- Laboratory techniques- Reagents and procedures- Requirements for an ideal chemical dosimeter- Fricke Dosimeter- FBX dosimeter- Free radical Dosimeter- Cerric Sulphate dosimeter- Other high and low level dosimeters- Applications of chemical dosimeters in Radiotherapy and industrial irradiators.

STANDARD BOOKS FOR STUDY AND REFERENCES

1.Practical Applications of Radioactivity and Nuclear Radiations, G.C.Lowental and P.L.Airey, Cambridge University Press, U.K., 2001

2.J.R Greening, Medical Physics, North Holland publishing Co, New York, 1981.

3.H.E.Jones, J.R.Cunnigham, "The Physics of Radiology" Charles C.Thomas, NY, 1980.

4.W.J.Meredith and J.B.Massey "Fundamental Physics of Radiology" John Wright and sons, UK, 1989.

5.W.R.Hendee, "Medical Radiation Physics", Year Book – Medical Publishers Inc. London, 1981.

6.E.J.Hall Radiobiology for Radiologists J.B.Lippincott Company, Philadelphia 1987.

7.J.R.Greening "Fundamentals of Radiation Dosimetry", Medical Physics Hand Book Series No.6 Adam Hilger Ltd., Bristol 1981.

PAPER IV – RADIATION DETECTORS AND INSTRUMENTATION (50 hours)

Medical Electronics

Semiconductor diodes-JFET-MOSFET-IC. OPAM and their characteristics- Differential Amplifier- OPAM systems- Applications-Addition, subtraction, Integration and Differentiation-

Active Amplifiers-Pulse Amplifiers- Decoders and Encoders- Microprocessors and associated Peripherals-Power supplies- Regulated power supplies using ICs- DC-DC converter and RF power supplies- Switching mode power supplies- AC regulators

Principles of Radiation Detection

Principles of radiation detection and measurement: Gas filled detectors- ionization chambers-Theory and design- Construction of condenser type chambers and thimble chambers- Gas multiplication- proportional counters, GM counters- Characteristics of organic and inorganic counters- Dead Time and Recovery Time- Scintillation detectors- semiconductor detectors- Chemical systems- Radiographic and Radiochromic films- Thermo luminescent dosimeters (TLD)- Optically stimulated Luminescence Dosimeter (OSLD), Radiophotoluminescent dosimeters- Neutron Detectors- Nuclear Track emulsions for fast neutrons- Solid State Nuclear Track (SSNTD) detectors- Calorimeters – New Developments.

Radiation Measuring & Monitoring 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- Farmer Dosimeters- Radiation Field Analyser (RFA)- Radio isotope calibrator- multipurpose dosimeter- Water phantom dosimetry systems - Brachytherapy dosimeters- Thermo luminescent dosimeter readers for medical applications- Calibration and maintenance of dosimeters.

Instruments for personnel monitoring- TLD badge readers- PM film densitometers- Glass dosimeter 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 ray and gamma radiations-Neutron monitors-tissue equivalent survey meters-flux meters, dose equivalent monitors- Pocket neutron monitors- Teledose systems.

Instruments for counting and spectroscopy- Portable counting systems for alpha and beta radiation – gamma ray spectrometers- Multichannel Analyser- Liquid scintillation counting systems, RIA counters- Whole body counters- Air Monitors for radioactive particulates and gases. Details of commercially available instruments and systems.

STANDARD BOOKS FOR STUDY AND REFERENCES

1.W.E. Burcham & M. Jobes – Nuclear and Particle Physics – Longman (1995)

2.G.F.Knoll, Radiation detection and measurements

3.W.J.Meredith and J.B.Massey “Fundamental Physics of Radiology” John Wright and sons, UK, 1989.

4.J.R.Greening “Fundamentals of Radiation Dosimetry”, Medical Physics Hand Book Series No.6 Adam Hilger Ltd., Bristol 1981.

5.Practical Applications of Radioactivity and Nuclear Radiations, G.C.Lowental and P.L.Airey, Cambridge University Press, U.K., 2001

PAPER V- CLINICAL AND RADIATION BIOLOGY (50 hours)

Cell Biology:

Cell Physiology and Biochemistry- Structure 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.

Anatomy, Physiology and Pathology

Anatomy and physiology as applied to radiodiagnosis and radiotherapy –Structure and function of organs and systems and their common diseases: Skin, Lymphatic system, Bone and muscle, Nervous, Endocrine, Cardiovascular, Respiratory, Digestive (Gastro-Intestinal), Urinary, Reproductive, Eye and ear.

Anatomy of human body, nomenclature and Surface Anatomy, Radiographic anatomy (including cross sectional anatomy)- identify the different organs/structure on plain x-rays, CT scans and other available imaging modalities. Normal anatomy and deviation for abnormalities. Tumour pathology and carcinogenesis, common pathological features of cancers and interpretation of clinic-pathological data.

Interaction of Radiation with Cells

Action of radiation on living cells ––Radiolytic products of water and their interaction with biomolecule- Nucleic acid, 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.

Survival curve parameters- Model for radiation action- Target theory- Multihit, multitarget-repair misrepair hypothesis- Dual action hypothesis- Modification of radiation damage- LET,RBE, dose rate, dose fractionation- Oxygen and other chemical sensitisers- Anoxic, hypoxic, base analogs, folic acid and energy metabolism inhibitors-Hyperthermic sensitization- Radio-protective agents.

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 – Effect of radiation on skin and blood forming organs, digestive tract– 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-effect relationship- first generation effects- Effects due to mutation of recessive characteristics- Genetic burden- Prevalence of hereditary diseases and defects-Spontaneous mutation rate- Doubling dose and genetic risk estimate.

Clinical Aspects of Medical Imaging and Radiation Oncology:

Radiation Therapy, Surgery, Chemotherapy, Hormone therapy, Immunotherapy and Radionuclide therapy. Benign and malignant disease, Methods of spread of malignant disease,

Staging and Grading Systems, Treatment intent- curative and palliative, Cancer prevention and public education and early detection and screening.
Site specific signs, symptoms, diagnosis and management: Head and Neck, Breast, Gynaecological, Gastro-intestinal tract, Genito-urinary, Lung and Thorax, Lymphomas and Leukemias and other cancers including AIDS related cancers.
Patient management on treatment- side effects related to radiation and dose- Acute and late- monitoring and common management of side effects- Information and communication.
Professional aspects and role of Medical Physicist: General patient care- Principles of professional practice- Medical terminology- Research and professional writing- Patient privacy- Ethical and cultural issues. Legal aspects- Confidentiality, Informed consent, Health and Safety.

Biological Basis of Radiotherapy

Physical and biological factors affecting cell survival tumor re-growth, normal tissue response, repair distribution in the cell cycle, Non- conventional fractionationscheme and their effect of reoxygenation, repair, redistribution in the cell cycle- High LET radiation therapy.

Time Dose Fractionation

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.

STANDARD BOOKS FOR STUDY AND REFERENCES

1.C.H.Best and N.B.Taylor "A Text in Applied Physiology" The Williams and Wilkins Company, Baltimore 1986.
2.C.K.Warrick, "Anatomy and Physiology for Radiographers" Oxford University Press 1988.
3.AitertsB.Bray, Lewis J., Raft M., Roberts K, Watson J.D, Molecular Biology of Cell, Garland Publishing Inc. London 1983.
4.Van Holde K.E, Physical Biochemistry, Prentice Hall, New Jersey, USA 1971.
5.Contour C.R and Schimmer P.R, Biophysical Chem. Vol.I – II W.H.Freeman and Co.San Francisco, USA, 1980.
6.S.P.Yaremonenko, "Radiobiology of Humans and Animals", MIR Publishers, Moscow, 1988.

PAPER VI - MEDICAL IMAGING (50hours)

Principles of X-ray Diagnosis and Conventional Imaging

Physical principle of Diagnostic Radiology: Interaction 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.

Radiography techniques: Prime factors (kVp, mAs, and SFD/SID) - 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, objectives of radio-diagnosis, patient dose vs. image quality.

Filters: inherent and added filters, purpose of added filters, beryllium filter, filters used for shaping x-ray spectrum (K-edge filters: holmium, gadolinium, molybdenum)

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

Intensifying screens: Function of intensifying screens, screen function evaluating parameters, emission spectra and screen film matching, conventional screens vs. rare earth screens.

Radiographic Film: Components of radiographic film, physical principle of image formation on film, double and single emulsion film, sensitometeric parameters of film (density, speed, latitude etc.), QA of film developer.

Image quality: Image quality parameters; sources of un-sharpness, reduction of un- sharpness, factors influencing radiographic contrast, resolution, factors influencing resolution, evaluation of resolution, Point spread function (PSF), Line spread function(LSF), Edge spread function (ESF), Modulation transfer function(MTF), focal spot size evaluation.

QA of conventional diagnostic X-ray equipment: Purpose of QA, QA protocols, QA test methods for performance evaluation of x-ray diagnostic equipment.

Digital X-Ray Imaging and Computed Tomography

Xero radiography, mammography, Interventional radiology, Digital Radiography (CR and DR systems), Digital Subtraction techniques, Conventional tomography (principle only), orthopan tomography (OPG), Computed Tomography (CT), QA of CT equipment.

Nuclear Medicine and Internal Dosimetry:

Physics of Nuclear Medicine:

Introduction to Nuclear Medicine, Unsealed sources, Production of radionuclides used in Nuclear Medicine, reactor produced and accelerator based radionuclides- Photonuclear activation, Equations for radionuclide production, Radionuclide Generators and their operation principles. Various usages of Radiopharmaceuticals.

In vivo non imaging procedures, thyroid uptake, Renogram, Life span of RBC, Blood Volume studies, etc. General concepts of Radionuclide Imaging and historical developments.

Radionuclide Imaging: Other techniques and Instruments: Rectilinear scanner and its operational principle, Basic principles and design of the Anger Camera/Scintillation camera; System components, Detector System and Electronics, Different types of collimators, Design and performance Characteristics of the converging, Diverging and Pin-hole collimator, Image display and recording systems, Digital Image Processing Systems, Scanning camera, Limitations of the detector system and electronics.

Different Imaging Techniques: Basic Principles, 2D and 3D imaging techniques- basic principles and problem, Focal Plane tomography, emission computed tomography; Single

Photon Emission Computed Tomography (SPECT), Positron Emission Tomography (PET) Various image reconstruction techniques during Image formation like Back projection, 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 for QA/QC of Imaging Instruments.

In-vitro Technique: RIA /IRMA principles and techniques

Physics of PET and Cyclotron- Principles of PET, PET Instrumentation, Annihilation Coincidence Detection, PET Detector and scanner design, data acquisition for PET, Data Correction, and quantitative aspect of PET, Working of Medical Cyclotron, Radioisotopes produced and their characteristics.
Treatment of thyrotoxicosis, thyroid cancer with Iodine, use of 32Phosphorus and 90Y
- for palliative treatment, Radiation Synovectomy and the isotopes used. Concept of Delay tank and various Waste Disposal Methods in Nuclear Medicine.
Planning and Shielding calculations during the installation of SPECT,PET/CT and Medical Cyclotron in the Nuclear Medicine Department..

Internal Dosimetry

Internal Radiation Dosimetry: Different compartmental model; Single Compartmental Model, Two compartmental model with and 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 procedure 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 calculation. Limitation of MIRD Technique.

Magnetic Resonance Imaging (MRI):

Magnetic Resonance Image- Proton density, relaxation time T1 and 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.

Ultrasound Imaging:

Interaction of sound waves with body tissues, production of ultrasound- Transducers- acoustic coupling- image formation- modes of image display- Colour Doppler.

STANDARD BOOKS FOR STUDY AND REFERENCES

1.J.P.Woodcock, Ultrasonic, Med. Physics Handbook Series I Adam Hilger, Bristol, 1981.
2.J.R Greening, Medical Physics, North Holland publishing Co, New York, 1981.
3.H.E.Jones, J.R.Cunnigham, "The Physics of Radiology" Charles C.Thomas, NY, 1980.
4.W.J.Meredith and J.B.Massey "Fundamental Physics of Radiology" John Wright and sons, UK, 1989.

5.Christensen 'Physics of Diagnostic Radiology' Lea and Febiger – Philadelphia (1990).
6.W.R.Hendee, "Medical Radiation Physics", YearBook – Medical Publishers Inc. London, 1981.
7.E.J.Hall Radiobiology for Radiologists J.B.Lippincott Company, Philadelphia 1987.
8.Hussey M, Basic Physics and Technology of Medical Diagnostic Ultrasound, McMillan, London, 1985.
9.W.H.Blahd, "Nuclear Medicine", McGraw Hill Co., New Delhi, 1980.
10.H.N.Wagner, "Principles of Nuclear Medicine", W.B.Saunders Co, London, 1970.
11.Herbert (John) &D.A.Rocha, Text Book of Nuclear Medicine, Vol 2 & 6, Lea and Febiger, Philadelphia, 1984.
12.S.Webb, The Physics of Medical Imaging, Medical Science Series, Adam Hilger, Bristol, 1984.

PAPER VII – RADIATION THERAPY(50 hours)

Beam Therapy

Description of low kV therapy x-ray units- spectral distribution of kV x-rays and effect of filtration-Thoraeus filter – output calibration procedure.

Construction and working of telecobalt units, source design- beam collimation and penumbra-trimmers and breast cones. Design and working of Medical electron linear accelerators- beam collimation- asymmetric collimator- multileaf collimator- dose monitoring- electron contamination. Output calibration of cobalt 60 gamma rays, high energy x-rays and electron beams using IAEA TRS398, AAPM TG 51 and other dosimetry protocols. Relative merits and demerits of kV x-rays, gamma rays, MV x-rays and electron beams.

Radiotherapy simulator and its applications. CT and virtual simulation.

Central axis dosimetry parameters- Tissue Air Ration (TAR) Back scatter/Peak scatter factor (BSF/PSF)- Percentage depth dose (PDD), Tissue Phantom Ratio (TPR), Tissue Maximum Ratio (TMR)- Collimator, Phantom and total scatter factors. Relation between TAR and PDD and its application- Relation between TMR and PDD and its applications. SAR, SMR, Off axis ratio and Field factor. Build-up region and surface dose. Tissue equivalent phantoms. Radiation Field Analyser (RFA). Description and measurement of isodose curves/charts. Dosimetry data resources.

Beam modifying and shaping devices- wedge filters- universal, motorized and dynamic wedges- shielding blocks and compensators. Treatment planning in teletherapy- target volume definition and dose prescription criteria-ICRU-50 & 62- SSD and SAD set ups- two and three dimensional localization techniques- contouring- simulation of treatment techniques- field arrangements- single, parallel opposed and multiple fields- corrections for tissue inhomogeneity, contour shapes and beam obliquity- integral dose. Arc/ rotation therapy and Clarkson technique for irregular fields- mantle and inverted Y fields. Conventional and conformal radiotherapy. Treatment time and Monitor unit calculations.

Clinical electron beams- energy specification- electron energy selection for patient treatment- depth dose characteristics (Ds, Dx, R_{100}, R_{50}, $R_p$etc)- beam flatness and symmetry-penumbra- isodose plots- monitor unit calculations- output factor formalisms- effect of air gap on beam dosimetry- effective SSD.

Particulate beam therapy- Relative merits of electron, neutron, x-ray and gamma ray beams- Neutron capture therapy- Heavy ion therapy.

QA in radiation therapy- precision and accuracy in clinical dosimetry- quality assurance protocols for telecobalt, medical linear accelerator and radiotherapy simulators- IEC requirements- acceptance, commissioning and quality control of telecobalt, medical linear accelerator and radiotherapy simulators. Portal and in- vivo dosimetry. Electronic portal imaging devices.

Brachytherapy:

Definition and classification of brachytherapy techniques- surface mould, interstitial, intracavitary and intraluminal techniques. Requirement for brachytherapy sources- Description of Radium and radium substitutes, ^{60}Co, ^{82}Ta , ^{137}Cs, ^{192}Ir, ^{125}I and other commonly used brachytherapy sources. Dose rate considerations and classification of brachytherapy techniques- Low Dose Rate (LDR), High Dose Rate (HDR) and Pulsed Dose Rate (PDR). Paterson Parker and Manchester Dosage systems. ICRU 38 and 58 protocols. Specification and calibration of brachytherapy sources-RAKR and AKS-IAEA TECDOC 1274 and ICRU 72 recommendations. Point and line source dosimetry formalisms- Sievert Integral- AAPM TG-43/43UI and other dosimetry formalisms.

Afterloading techniques- advantages and disadvantages of manual and remote afterloading techniques. AAPM and IEC requirements for remote afterloadingbrachytherapy equipment. Acceptance, commissioning and quality assurance of RAL brachytherapy equipment. ISO requirements and QA of brachytherapy sources, Integrated brachytherapy unit.

Brachytherapy treatment planning - CT/MR based brachytherapy planning- forward and inverse planning- DICOM image import/export from OT- Record and verification.

Brachytherapy of Prostate cancer. Occular brachytherapy using photon and beta sources.

Intravascular brachytherapy- classification- sources- dosimetry procedures- AAPM TG 60 protocol. Electronic brachytherapy (Axxent, Mammosite, etc)

Computers in Treatment Planning:

Scope of computers in treatment planning- Review of algorithm used for treatment planning computation – 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, interstitial 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 and source library generation. Networking, DICOM and PACS. Acceptance, commissioning and quality assurance of radiotherapy treatment planning systems using IAEA TRS 430 and other protocols.

Special and Advanced Techniques of Radiotherapy

Special techniques in radiation therapy- Total Body Irradiation (TBI)- large field dosimetry- total skin electron therapy (TSET)- electron arc treatment and dosimetry- intraoperative radiotherapy.

Stereotactic radiosurgery/radiotherapy (SRS/SRT) Cone and mMLC based - X-Knife- Gamma knife- Immobilisation 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 QA of stereotactic body radiotherapy (SBRT) and Cyber Knife based therapy.

Intensity Modulated Radiation Therapy (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 (VMAT, Rapid Arc), Image Guided Radiotherapy (IGRT)- concept, Imaging modality, kV cone beam CT (kVCT), MV cone beam CT (MVCT), image registration, plan adaptation, QA protocol and procedures- special phantom, 4DCT, Tomotherapy- principle- commissioning- imaging- planning and dosimetry- delivery- plan adaptation- QA protocol and procedures.

STANDARD BOOKS FOR STUDY AND REFERENCES

1.J.R Greening, Medical Physics, North Holland publishing Co, New York, 1981.

2.H.E.Jones, J.R.Cunnigham, "The Physics of Radiology" Charles C.Thomas, NY, 1980.

3.W.J.Meredith and J.B.Massey "Fundamental Physics of Radiology" John Wright and sons, UK, 1989.

4.Christensen 'Physics of Diagnostic Radiology' Lea and Febiger – Philadelphia (1990).

5.W.R.Hendee, "Medical Radiation Physics", YearBook – Medical Publishers Inc. London, 1981.

6.E.J.Hall Radiobiology for Radiologists J.B.Lippincott Company, Philadelphia 1987.

7.F M Khan – The Physics of Radiation Therapy, 1984. Williams and Wilkins, Baltimore.

8.H.Handee, Radiation Therapy Physics (2nd edition)

9.U.B.Thripathi Quality assurance of Radiation therapy equipment and practice – lecture note, DipRP, BARC

10.Comprehensive QA for radiation oncology- Report of AAPM radiation therapy committee task group

11.J.R.Greening "Fundamentals of Radiation Dosimetry", Medical Physics Hand Book Series No.6 Adam Hilger Ltd., Bristol 1981.

12.R.F.Mould, "Radiotherapy Treatment Planning Medical Physics Hand book series No.7, Adam Hilger Ltd, Bristol, 1981.

13.S.C.Klevenhagen "Physics of Electron Beam Therapy" Medical Physics Hand Book Series No.6 Adam Hilger Ltd, Bristol, 1981.

14.F.A.Attix "Radiation Dosimetry" Vol I-III, Academic press New York, 1985.

15.Treatment Planning in Radiation Oncology, FaizM.Khan Roger A.Potish

16.NCRP, ICRP, ICRU, IAEA, AERB Publications.

17.TRS-398 IAEA Technical Series

18.TG 51 AAPM Task Group

PAPERVIII – RADIATION SAFETY (50 hours)

Radiation Protection standards

Radiation dose to individuals from natural radioactivity in the environment and man-made 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- Radiation and Tissue weighting factors, equivalent dose, effective dose, committed equivalent and effective dose, Concepts of collective dose- Potential exposures, dose and dose 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.

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 radio nuclides and the classifications of laboratories –– Control of contamination – Bioassay and air monitoring – Chemical protection – Radiation accidents – Disaster monitoring.

Safety in the Medical Uses of Radiation

Planning of medical radiation installations- General considerations- Design of diagnostic, deep therapy, telegamma, accelerator installations, brachytherapy facilities and Nuclear Medicine.

Evaluation of radiation hazards in medical diagnostic and therapy installations- Radiation monitoring procedures- Protective measures to reduce the radiation exposure to staff and the patients- Radiation Hazards in brachytherapy and teletherapy departments, radio isotope laboratories and particle accelerator facilities- Protective equipment- Handling of patients- Waste disposal facilities- Radiation safety during source transfer operations- Special safety features in accelerators, reactors.

Radioactive Waste Disposal

Radioactive wastes – Sources of radioactive waste – Classification of waste – Treatment techniques –for solid, liquid and gaseous effluents – permissible limits for disposal of waste- Sampling technique for water, air and solid- Geological, hydrological and meteorological parameters- Ecological considerations.

Disposal of radioactive wastes- General methods of disposal- Management of radioactive waste in medical, industrial, agricultural and research establishments.

Transport of Radioisotopes

Transportation of Radioactive materials:– Historical background – General packing requirements – Transport documents – Labeling and marking of packages – Regulations applicable for different modes of transport- Transport by Post- Transport emergencies- Special requirements for transport of large radioactive sources and fissile materials – Exemptions from regulations- Shipment approval- Shipment under exclusive use- Transport under special arrangement- Consignor's and Carrier's responsibilities.

Legislation:

Physical protection of sources- Safety and security of Sources during storage, use, transport and disposal- Security provisions: administrative and technical- security threat and graded approach in security provision.

National legislation- Regulatory framework- Atomic energy act, radiation protection rules- applicable safety codes, standards, Guides and Manuals- Regulatory Control- Licensing, Inspection and Enforcement- Responsibilities of Employers, Licensees, Radiological Safety Officers and Radiation Workers- National Inventories of radiation sources- Import, Export procedures.

Radiation Emergencies and their Medical Management

Radiation accidents and emergencies in the use of radiation sources and equipment in Industry and Medicine- Radiographic cameras and Teletherapy units- Loading and unloading of sources- Loss of radiation sources and their tracing- Typical Accident cases. Radiation injuries, their treatment and medical management- Case histories. -

STANDARD BOOKS FOR STUDY AND REFERENCES

1.Practical Applications of Radioactivity and Nuclear Radiations, G.C.Lowental and P.L.Airey, Cambridge Universiyt Press, U.K., 2001

2.S.P.Yaremonenko, "Radiobiology of Humans and Animals", MIR Publishers, Moscow, 1988.

3.R.F. Mold "Radiation Protection in Hospitals" Adam Hilger Ltd. Bristol, 1985.

4.A.Martin and S.A.Harbisor, An Introduction to Radiation Protection, John Willey & Sons, Inc. New York, 1981.

5.NCRP, ICRP, ICRU, IAEA, AERB Publications.

15. PRACTICALS: -

1.GM counter – Construction and calibration

2.Determination of plateau and resolving time of a G.M. Counter and its application in estimating the shelf-ratio and activity of a beta source.

3.Production and attenuation of Bremsstrahlung

4.Range of beta particles by Feather Analysis

5.Backscattering of beta particles and its applications.

6.Measurement of radioactivity using an isotope calibrator

7.Scintillation spectrometer – Calibration and determination of unknown energy

8.Absorption and back scattering of Gamma rays –Determination of HVT

9.Voltage current characteristics of an ion chamber

10. Statistics of counting

11.GM counter – Inverse square law properties, half-life of a short lived isotope, effect of time, distance and shielding on radiation intensity.

12.Isotope calibrator

13.Measurement of contamination level and methods of decontamination.

14.Study of voltage and current characteristics of an ionisation chamber

15.Calibration of survey instruments and pocket dosimeters

16.QA of Films, Intensifying screen, Film-screen combination, Processing chemicals, Dark room, Safe light, Light proofing, Automatic Processor

17.Quality Assurance of a diagnostic X-ray unit.
18.Patient dose measurements in diagnostic radiology
19.Study and calibration of Thyroid uptake measurement unit.
20.Calibration and acceptance testing of a cobalt therapy unit
21.Measurement of central axis percent depth dose of photon and electron beams.
22.Dose out put measurement of electron beams used in radiotherapy treatment.
23.Calibration of a survey meter using a standard source
24.Use of optical densitometer for field profile determination
25.Calibration of a therapy level dosimeter
26.Preparation and standardization of unsealed sources
27.Treatment Planning and dosimetry for single field photon irradiation, multiple fields, use of TAR and TPR, Long SSD techniques, Rotational treatment, Critical organs, entrance and exit doses, tissue inhomogeneities, Orthogonal Films for planning.
28.Use of computerized treatment planning system
29.Management of emergencies in a cobalt therapy unit and brachytherapy unit
30.Tracing a missing source
31.Preparation of a surface applicator and its dosimetry
32.Dosimetry of irregular fields
33.AKS/RAKR measurement of HDR Brachytherapy sources using well type and cylindrical ionisation chambers.
34.In-phantom dosimetry of a brachytherapy source.
35.Dosimetry of a linear arrangement of brachytherapy sources, dosimetry for a cylindrical mould
36.Dosimetry for single plane and double plane implants
37.Q.A testing of brachytherapy systems
38.Integrity check and calibration of low activity brachytherapy sources.
39.Q.A testing of C.T units
40.Routine testing of a Linac system
41.Room planning of a radiotherapy installation
42.Survey of radioisotope laboratory and study of surface and air contamination.
43.Radiation protection survey of a teletherapy installation
44.Radiation protection survey in diagnostic radiology

16. Scheme of Classes and Examination:

Course Content: Theory:

1.Radiation Physics, and Radiation Generators – 50 hours
2.Radiological Mathematics – 50 hours
3.Clinical and Radiation Biology- 50 hours
4.Medical Imaging -50 hours
5.Radiation dosimetry and Standardisation - 50 hours
6.Radiation Detectors and Instrumentation–50 hours

7.Radiation Therapy -50 hours
8.Radiation Safety- 50 hours

Practical:

1.Radiation Detection and Measuring Instruments – 40 hours
2.Medical Imaging – 40 hours
3.Planning and Dosimetry in Radiotherapy – 40 hours
4.Quality Assessment of Radiotherapy equipment– 60 hours
5.Quality Control, Acceptance testing and calibration of radiological equipment– 20 hours.
The classes are so proposed as to ensure a minimum of 600 hours of theory and practical classes. The classes per day shall work out as 4 hours for theory and 3 hours for practical. Working days per week – 6.

Examination:
The classes will be more practical and clinically oriented. There will be weekly assessment of students.

Criteria for Pass
Minimum marks for a pass: Theory 35 % minimum per paper and an aggregate of
35% - separately for theory and practical.