SYLLABUS

M.Sc(RADIOTHERAPY TECHNOLOGY)

First Year

Sl. No.	Name of the Paper	Hours of Study		
		Theory	**Practical**	**Total**
1.	Human applied and Imaging Anatomy , Physiology, Pathology & Terminology	60	80	140
2.	Imaging Modalities, Equipment Operations, Safety and Maintenance related to Radiotherapy & Medical Physics	60	140	200
3.	Patient Care and Evaluation Include BLS	60	120	180
4.	Research Methodology and Biostatistics - Certified with 5 days programme.	No	University	Exam
5.	Adoption of New Radiotherapy Technology, Radiation Hazards, Evaluation and Control	60	100	160
	GRAND TOTAL OF HOURS	**240**	**440**	**680**

PAPER 1: HUMAN APPLIED & iMAGING ANATOMY, PHYSIOLOGY, PATHOLOGY AND TERMINOLOGY

Cell:

Cell morphology and diversity

Introduction to ultra-structure and function of cell organelles and cell inclusions.

Tissues:

Macroscopic and microscopic studies of epithelial tissue, general connective tissue, cartilaginous tissue, bone tissue, muscle tissue, nervous tissue and the integument, major functional advantages of each tissue type.

Skeletal Muscles:

Major skeletal muscles of the head, Neck, Thorax, Abdomen and upper and lower limbs.

General Osteology:

General morphology of bones

Structural classification of bones

Identification and naming of individual bones of the skeleton

Development and growth of skeletal tissue and bones.

General Astrology:

Structural and functional classification of joints

General morphology of synovial joint and associated structures

Movements made available by synovial joints

Detailed Osteology and Astrology- Naming and identification of osteological features of individual human bones

Naming, Identification and application of classifications to the major joints of the human body, Examples of variability in the human skeleton.

Cardiovascular System:

Macroscopic features, function and location of the adult and foetal heart and the location of major arteries and veins

Macroscopic features of blood vessels including arteries, veins and capillaries; morphological features of the cellular components of blood.

Lymphatic System:

Macroscopic features, Major function and location of the lymphatic vascular structures, Lymph nodes, Tonsils and other mucosa-associated lymphatic tissue, Spleen and thymus; Microscopic anatomy of lymph nodes.

Nervous System:

Macroscopic features and major functions of the brain and spinal cord
Morphological features and major functions of the contents of the peripheral nervous system and autonomic nervous system.

Respiratory System:

Macroscopic features and major functions of the nasal cavity
Paranasal sinuses
Pharynx, Larynx, Trachea, Bronchi, Lungs and Thoracic wall including the thoracoabdominal diaphragm
General microscopic anatomy of the epithelium of the respiratory tract and the lungs.

Digestive System:

Macroscopic features and major functions of the Mouth, Salivary glands, Pharynx, esophagus, stomach, small and large intestines, liver pancreas, biliary system and peritoneal cavity; general microscopic anatomy of the esophagus, stomach, small intestine, pancreas and liver.

Urinary System:

Macroscopic features, Major functions and location of the kidneys, Ureters, Urinary bladder and the urethra; Microscopic anatomy of the kidney.

Endocrine System:

Macroscopic features
Location and basic function of the hypothesis cerebri
Thyroid gland
Parathyroid glands
Suprarenal glands
Pineal gland and organs with a minor endocrine function
Microscopic anatomy of the hypothesis cerebri
Thyroid gland, Bulbourethral glands.

Male Reproductive System-

Macroscopic features, Major functions and location of the scrotum, Testes, Epididymis, Ductus deferens, Inguinal canal, Seminal vesicles, Prostate gland, Bulbourethral gland and penis; Microscopic anatomy of the testis.

Female Reproductive System-

Macroscopic features
Major functions and location of the ovaries
Uterine tubes, Uterus, Vagina and external genitalia; Microscopic anatomy of the ovary.

Special Senses:

Macroscopic features and major functions of the contents of the orbital cavity, the eyeball, Lacrimal apparatus, and external, Middle and internal ear; Microscopic anatomy of the photosensitive retina.

Upper Limb:

Relevant osteology
Detailed plain radiographic anatomy of skeletally mature and immature individuals
Regional and surface anatomy of the shoulder, axilla, and upper limb with an emphasis on blood and lymphatic vessels
MRI and axial sectional anatomy of the glen humeral joint.

Lower Limb:

Relevant osteology
Detailed plain radiographic anatomy of skeletally mature and immature individuals
Regional and surface anatomy of the hip, thigh, crus and pes, with an emphasis on blood and lymphatic vessels
MRI of the knee joints; angiography of the lower limb.

Head and Neck:

Relevant osteology of the skull and cervical vertebrae, Surface anatomy, Lymphatic,
Major blood vessels and nerves of the head and neck

Regional anatomy of the brain and its meanings-

Axial, Coronal and Sagittal sectional anatomy of the head and axial sectional anatomy of the neck
Plain radiographic anatomy
Computerized tomography
MRI and angiography of the head and neck.

Cross sectional anatomy of body:

Radiographic anatomy of different radiographs in various projections
Surface anatomy and applied anatomy pertaining to Radiology.

General Physiology:

Structure of cell membrane.
Transport across cell membrane and Homeostasis
Blood- A B O System & mismatch-transfusion
WBC plasma protein Erythrocytes
Hemoglobin. Normal values of Blood (composition & function)

Nerve Neuron AHC- Structure, Classification & Properties

R.M.P., Action potential
Propagation of nerve impulse
Degeneration & regeneration
Reaction of degeneration.

Muscle- Structure -properties -classification -excitation/contraction coupling, Motor, EMG - factors affecting muscle transmission, neuromuscular transmission.

C.N.S. & P.N.S. - Receptor Physiology:

Classification & properties

Synapse structure

Properties, & transmission

Reflexes-structure, properties, & transmission

Sensory & Motor Tracts -effect of transaction (Complete & Incomplete) at various levels Physiology of Touch , Pain, Temperature & Perception

Physiology of Muscle Tone (muscle spindle), Stretch, Vestibular Apparatus mainly organ Anatomy, Function of Basal ganglia, Thalamus, Hypo-Thalamus, Pre-Frontal lobe, P.A.S., Sensory / motor cortex, Sensory / motor cortex, Limbic System, Learning , memory & condition reflex, Physiology of Voluntary movement.

Excretory System

Kidneys-(short note) -structure & function, urine formation

Maturation - neural control- neurogenic bladder, Temperature Regulation, Circulation of the skin-body fluid-electrolyte balance, Endocrine, Secretion -regulation & function of Pituitary-thyroid-parathyroid Pancreas

Reproductive System-

Functions of Estrogen

Progesterone & Testosterone

Puberty & Menopause Special senses

Eye-Errors of refraction-accommodation-reflexes-dark & light Adaptation photosensitivity Ear, skin.

Respiratory System-

Introduction

General organization

Mechanics of respiration

Pulmonary Volumes & capacities

Anatomical &Physiological Dead space- ventilation/perfusion ratio

Alveolar ventilation

Transport of respiratory gases

Nervous & Chemical control of respiration

Pulmonary function tests-Direct & indirect method of measurement

Physiological changes with altitude & acclimatization

Cardiovascular System-

Structure & properties of cardiac muscle

Cardiac cycle

Heart rate regulation-factors affecting Heart Rate

Blood pressure-

Definition -regulation-factors affecting

Cardiac output-

Regulation & function affecting
Peripheral resistance
Venous return
Regional circulation-coronary-muscular
Cerebral, Normal ECG

Introductory Pathology:

Cellular adaptation and cell death

Inflammation and repair; infection; circulatory disorders; immune defense

Genetics of disease

Neoplasia

Cell injury and adaptation-

Atrophy, Hypertrophy, Metaphase, Hyperplasia

Classification of tumors, Premalignant lesion

Types of inflammation & system manifestations of inflammation

Disorders of vascular flow & shock (Brief introduction)

Oedema, Hyperemia or congestion, Thrombosis, Embolism, Infarction shock, Ischemia, Over hydration, Dehydration

The Response to infection

Categories of infectious agents, Host barriers to infection

How disease is caused

Inflammatory response to infectious agents

Hematopoietic and Lymphoid System-

Hemorrhage, Various type of Anemia, Leucopenia, Leukocytosis, Bleeding disorders coagulation mechanism.

Fundamentals of Medical Terminology – I:

Word Roots, Prefix, Suffix, Abbreviations & Symbols

Introduction to Anatomy & Physiology
Organs & Systems
Gastro intestinal, Respiratory, Circulatory, Renal, Reproductive, Nervous, Common Diseases & Procedures, Gastro intestinal, Cholecystitis, Cholelithiasis, Appendicitis, Intestinal Obstruction, Peritonitis Gastro copy- Endoscopy, Laparotomy, laparoscopy, Common Diseases & Procedures, Respiratory, Tuberculosis, Bronchial Asthma, Respiratory Failure, Pulmonary Emboli son, Pneumonia, Bronchoscopy, Pulmonary Function test, Cardio-Pulmonary, Resuscitation.

Fundamentals of Medical Terminology-II:

Circulatory ,Hypertension ,Coronary Artery Disease ,Arrhythmias, Cardiac Arrest ,Shock, Deep Vein thrombosis (DVT) , ECG,2D Echo Cardiogram, Coronary Angiography, Cardiac Catheterization, Stress test, Pacemaker, Renal, Nephrotic Syndrome ,Urinary Tract Infection Renal /Bladder Stones Intravenous Pyelography, Cystoscopy, Urinalysis, Haemodialysis, Peritoneal Dialysis ,Reproductive, Female - breast cancer /Self Examination, Menstrual Disorders, Dysmenorrheal, Premenstrual Syndrome (PMS), Menorrhagia Ovarian, Cyst,

Fibroids, Malignancy, Infertility Mammography, Ultra Sound, Laparoscopy, IV F, Tubectomy, D& C, Male - Prostate Enlargement, Hydrocele, Impotence, T transurethral Research of Prostate, Nervous Stroke (Cerebro Vascular Accident),Brain Tumor, Brain Injuries, Spinal Cord Injuries, Lumbar Puncture, Myelography, CT Scan, MRI, EEG, EMG, Oncology, Investigations, Tumor markers, RECIST Criteria for response evolution

PAPER 2: IMAGING MODALITIES, EQUIPMENT OPERATION, SAFETY AND MAINTENANCE RELATED TO RADIOTHERAPY& MEDICAL PHYSICS

Patient imaging holds crucial importance in radiotherapy. An RTT has to be well versed with various imaging modalities that are used in radiotherapy.

1. Positioning Terminology in Radiology
2. Ultrasonography
3. Radiography and fluoroscopy
4. CT
5. MRI
6. PET/SPECT
7. MV and kV CBCT
8. Optical Imaging
9. Angiography

The students will serve a rotation in the radiology wing of the hospital to acquire the skill needed to use the imaging equipment in radiotherapy.

In addition to refreshing the knowledge of various radiotherapy equipment their functioning and operations, the students will focus on safety and maintenance aspects of the advanced equipment namely a dual energy linac with on- and off-line imaging, HDR brachytherapy system and the sophisticated immobilization and stereotactic RT accessories.

Medical Physics

RADIATION DOSIMETRY STANDARDIZATION AND SAFETY

Radiation Quantities and Units

1. Basic Radiation Physics

Atomic Structure, Nucleus, Atomic No., Mass No., Electron orbit and energy levels, Isotopes and isobars, Radioactivity, Radioactive decay, Half life, Particle radiation, Electromagnetic Radiation, Production of X-rays, Continuous X ray spectrum, Bremsstrahlung radiation , Characteristic X – rays, Filters, Quality of X – rays, Effect of voltage and current on the intensity of X – rays, Properties of X – rays.

2. Interaction of Radiation with Matter

Photoelectric effect, Compton Effect, Pair production, Ionisation of matter, Energy absorbed from X- rays, X – rays Scattering, X - rays transmission through the medium, Linear and mass attenuation coefficient, HVT and TVT, Interaction of

charged particle and neutrons with matter.

3. 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 – Kerma - Exposure – Air Kerma rate constant(AKR) – Charge 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) – Radioactivity, Equivalent Dose, Weighting Factors, Effective Dose, Natural Background Radiation, Occupational Exposure Limits, Dose Limits to public.

4. Radiation Hazard evaluation and Control

Philosophy of radiation protection, Effect of Time, Distance and Shielding, Calculation of workload, Calculation of Weekly dose to the radiation worker and general public, good work practices in diagnostic radiology and / or radiotherapy practices (including teletherapy and Brachytherapy) Planning consideration for radiology and / or radiotherapy installation including work load, use factor & occupancy factors, effect of different shielding material.

5. Biological effects of radiation

The Cell, Effect of ionising radiation on Cell, Chromosomal aberration and its application for the biological dosimetry, Somatic effects and hereditary effects, stochastic and deterministic effects, Acute exposure and chronic exposure L D 50/60.

6. Detection and measurement of radiation & measuring instruments

Ionisation of gases, Fluorescence and Phosphorescence, Effect on Photographic, emulsion, Ionisation chambers, Proportional Counters, G.M. Counters, Scintillation Detectors, Liquid scintillator, Pocket Dosimeters, TL Dosimeters and their use in personnel monitoring badges Advantages and disadvantages of various detectors, appropriateness of different types of detectors for different types of radiation measurement.

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 Caesium sources – Gold seeds – Tantalum wire – ^{125}I sources – Beta ray applicators – Thermal and fast neutron sources – Preparation of tracers and labeled compounds – Preparation of radio colloids.

Dosimetry & Standardisation of X and Gamma Rays 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 TRS277: various steps to arrive at the expression for D_w starting from Nx. TRS398: $N_{D,\ W,\ Q}$: $N_{D,\ W}$: $K_{Q,Q0}$, K_Q Derivation of an expression for $K_{Q,Q0}$ Calorimetric standards – Intercomparison of standard.

Measurement of Dw for External beams from Cobalt-60 teletherapy machines: Reference conditions for measurement, Type of ion chambers, Phantom, Waterproof sleeve, Derivation of an expression for Machine timing error, procedure for evaluation of Temperature and pressure correction. Thermometers and barometer. Measurement of temperature and pressure. Saturation correction: derivation of expression for charge collection efficiency of an ion chamber based on Mie theory. 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, beam quality index, beam quality correction co-efficient, Cross calibration using intermediate beam quality. Quality Audit programmes in Reference and Non-Reference conditions.

Standardization of brachytherapy sources – Apparent activity – Reference Air Kerma Rate – Air Kerma strength 0 Standards for HDR Ir-192 and Co-60 sources – standardization of I-125 and beta sources – IAEA TECDOC 1274 – room scatter correction. Calibration of pπrotection 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.

Standardization of Radionuclides

Methods of measurement of radioactivity – Defined solid angle and 4π 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 of alpha, beta and gamma emitter – Re-entrant ionization chamber methods – methods using (n,γ) and (n,p) reactions – Determinaiton of yield of neutron sources – Space integration methods – Solid state detectors.

Radiation Chemistry and Chemical Dosimetry

Definition 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 polymerisaiton, 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 – Definitions of optical density, molar absorption co-efficient, Beer-Lambert’s 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.

Books for References

1. Joseph Magill and Jean Galy, Radioactivity Radionuclides Radiation, European commission Joint research centre, Institute for Transuranium Elements, P.O.Box 2340, 76125 Karlsruhe, Germany

2. IAEA TRS 374, Calibration of dosimeters used in Radiation Therapy

3. F.H. Attix. Introduction to Radiological Physics and Radiation dosimetry, Viley-VCH, Verlog, 2004

4. Field, clinical use of Radioisotopes.

RADIATION DETECTORS AND INSTRUMENTATION

Medical Electronics

Semiconductor diodes – JFET – MOSFET – Integrated Circuits – Operational amplifiers (OPAM) and their characteristics – Differential Amplifier – Operational amplifier systems OPAM applications – Addition, Subtraction, Integration and Differentiation – Active amplifiers – Pulse Amplifiers – Decoders and Encoders – Microprocessors and associated peripherals – Power supplies – Regulated power supplies using ICs – AC-DC converter and RF power supplies – Switching mode power supplies – AC regulators.

Principles of Radiation Detection

Principles of Radiation Detection and measurement – Basic Principles of radiation detection – Gas filled detectors – ionization chambers – Theory and design – construction of condenser type chambers and thimble chambers – Gas multiplication – proportional and GM counters – Characteristics of organic and inorganic counters – Dead time and recovery time – scintillation detectors – Semiconductor detectors – Chemical systems – Radiographic and Radiochromic **films-Thermolumenescent Dosimeters (TLD)– Optically** stimulated Luminescence dosimeters (OSLD) – Radiophotoluminescent dosimeters – Neutron Detectors – Nuclear track emulsions for fast neutrons – Solid State Nuclear track (SSNTD) detectors – Calorimeters – New Developments.

Radiation measuring & Monitoring Instruments

30 hours Dosimeters based on condenser chambers – pocket chambers – Dosimeters based on current measurement – Different type of electrometers – MOSFET, Vibrating condenser and varactor bridge types – Secondary standard therepy level dosimeters – Farmer Dosimeters – Radiation field analyzer (RFA)- Radioisotope calibrator – Multipurpose dosimeter – Water phantom dosimetry systems – Brachytherapy dosimeters – Thermoluminescent 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 dosimeter 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 equiv alent survey meters – Flux meter and dose equivalent monitors – pocket neutron monitors – Teledose system.Instruments for counting and spectrometry – Portable counting systems for alpha and beta radiation – Gamma ray spectrometers – Multichannel Analyser – Liquid scintillation counting system – RIA counters – whole body counters – Air Monitors for radioactive particulates and gases. Details of commercially available instruments and systems.

Books for References

1. Price W.J. Nucleus Radiation detection
2. Stepanor B.J. Theory of Luminescence
3. Glenn F Knoll. Radiation detection and Measurement
4. Albert Paul Malvino. Electronics principles
5. Robert L. Boylestad. Electronics devices and circuit theory
6. Paul – Horowitz. Art of Electronics
7. Greiner R.A. Semiconductor devices and Application
8. **Crawford R.H. MOSFET in circuit design**

PAPER 3: PATIENT CARE AND EVALUATION INCLUDING BLS

Patients of all ages and performance status come for radiotherapy. An RTT has to be skilled to handle these patients physically and psychologically. This also requires managing the attendants of the patients.

- *Procedures for patient transfer such as table to table, table to wheelchair, wheelchair to bed, bed to stretcher, the three-man lift, and draw sheet lift*

- *Procedures for turning patients who have severe trauma, Unconsciousness, Disorientation, or Amputated limbs*
- *Radiographic procedures*

Management of infectious patients:

Psychological considerations for the management of infectious patients

The vital signs used to assess patient condition

Measurements of temperature, pulse, blood pressure, and respiration

Clinical measurement and recording of temperature, pulse, blood pressure and respiration.

Symptoms of cardiac arrest, anaphylactic shock, convulsion, seizure, hemorrhage, apnea, emesis, aspiration, fractures and diabetic coma/insulin reaction

Acute care procedures for cardiac arrest, Anaphylactic shock, Convulsion, Seizure,

Hemorrhage, Apnea, Emesis, Aspiration, Fractures, and diabetic coma/insulin reaction Use of medical equipment and supplies in treating medical emergencies.

The teaching/training in patient care/ handling continues with the view to take on more responsibility for the same. Communication with other care givers including the ones from out-side the radiation oncology system for better and efficient management of patient care.

PAPER 4: RESEARCH METHODOLOGY AND BIOSTATISTICS CERTIFIED WITH 5 DAY PROGRAMME

Health care – an overview:

Functions of Hospital administration

Modern techniques in Hospital management

Challenges and strategies of Hospital management

Administrative Functions:

Planning, Organizing, Staffing, Leading and Controlling Organizational Structure, Motivation and leadership.

Designing health care organization.

Hospital Management:

Medical record, House-keeping services.

Laboratory performance.

Management of biomedical waste.

Total patient care – indoor and outdoor.

Nursing and ambulance resources.

Evaluation of hospital services. Quality assurance.

Record reviews and medical audit.

Research Methodology:

Introduction to Health systems

Identifying research problem

Ethical issues in research

Developing a research proposal

Research design

Research tools and Data collection methods

Sampling methods

Bias and confounding

Introduction to program evaluation

Data management

Analyzing information for drawing inferences

Report writing

Group presentations

Biostatistics:

1. Concepts of Biostatistics

   Sample and population. Statistical definitions. Random sampling. Testing of hypothesis.

   Statistical tools for collection, presentation and analysis of data relating to causes and one incidence of diseases.

   Measurement of central tendency.

   Measures of variation. Frequency distribution.

   Concept of Probability: Laws of Probability. Probability Distribution: Binomial, Normal and Chi-square distribution

   Commonly used procedures and test of significance and estimation

   Correlation and regression

   Test of significance namely Z test, T test, Chi square test, F test

   Analysis of variance.

2. Types of Data
3. Research tools and Data collection methods
4. Sampling methods
5. Developing a research proposal

PAPER 5: ADOPTION OF NEW RADIOTHERAPY TECHNOLOGY, RADIATION HAZARDS,

Concept of Time , Distance and Shielding, Calculation of workload, Calculation of Weekly dose to the radiation worker and general public, good work practices in radiotherapy/ diagnostic radiology, planning consideration for radiotherapy installation including work load, use factor & occupancy factors, effect of different shielding material. Biological effect of radiation, role of RTT in predicting and managing acute and late radiation toxicities.

Any sophisticated RT equipment commissioned for treatment is operated by an RTT. Before using the equipment for treatment, the operation and safety aspects of the new technology have to be thoroughly understood by the operating RTT.

Take lead in learning the various steps required to adopt the technology: Training/learning from the application specialist and equipment manual about all the functional/safety features of the equipment. Organize/manage the users's training classes/demonstrations with the trainers.

1. Basic Radiation Therapy Physics

Historical developments in Radiotherapy, Physical components of Telecobalt Unit / Linear Accelerator Unit / Remote After Loading Brachtherapy Unit/ Gamma knife Unit / Simulator and their descriptions, Various types of sources used in Radiotherapy and their properties, Physics od Photons, electros, protons and neutrons in radiatherapy, physical parameters of dosimetry such as percentage Depth Dose, Tissue-Air Ratio, Tissue Maximum Ratio physics of Bolus and Phantom materials, Compensators, Wedges, Shielding Blocks, Patient Immobilization devices, post film, processing and development, Special techniques in Radiotherapy such asd SRS, SRT,IMRT, IGRT and Tomotherapy.

2. QA in Radiotherapy

Accessories and tools used for QA tests in Radiotherapy such as Front pointer, Back pointer, Laser Alignmernt etc, Optical and radiation field congruence, Beam shaping blocks, Beam shaping jaws, Delineator / Diaphragm movements, Isocentre alignment, patient support system, Beam on and off mechanisms, Technician's role in QA tests on telecobalt / linear Accelerator / Brachytherapy/ Gamma knife/ Simulator/CT Simulator machines.

3. Radiation Emergency Preparedness

Safety and security of radiation sources, case histories of emergency situations and preparedness, equipments and tools including role of Gamma Zone Monitor, Regulatory requirements and prevention of emergency, Preventive maintenance and Safety Culture, Role of technicians in handling radiation emergencies.

4. Regulatory requirements

National Regulatory Body, Responsibilities, organization, Safety Standards, Codes and Guides, Responsibilities of licensees, registrants and employers of enforcements of Regulatory requirements.

5. Demonstration:

- **Time, Distance and Shielding, measurement of HVT & TVT**
- **Familiarisation of radiation survey meters and their functional performance cheeks**
- **Radiological Protection Survey of Radiotherapy, Simulator and CT Simulator Installations**
- **QA on X – ray. Simulator and Radiotherapy Equipment(s)**
- **Procedures followed for calibration of measuring and monitoring instruments**

SECOND YEAR

Sl. No.	Name of the Paper	Hours of Study		
		Theory	Practical	Total
1.	Clinical Biology, Radiation Toxicities, Stereotactic Radiotherapy, Radio Surgery, SBRT Radiotherapy	90	100	190
2.	Management of Motion, Patient Care and Data in Radiotherapy	100	100	200
3.	Recent Advances in Radiotherapy and Special Radiotherapy Procedures	100	100	200
	GRAND TOTAL OF HOURS	290	300	590

PAPER 1: CLINICAL RADIOBIOLOGY ANDRADIATION TOXICITIES, STEREOTACTIC RADIOTHERAPY, RADIO SURGERY, SBRT RADIOTHERAPY

Concepts of Clinical Radiobiology are needed to appreciate the basis of radiotherapy and fractionation in radiotherapy:

1. Cell Survival
2. 5 Rs of Radiotherapy
3. History of radiation effect modeling
4. LQ model and BED concepts
5. TC/NTCP and therapeutic ratio
6. Radiobiology of hyper and hypo-dose fractionation
7. Early and late reacting tissues
8. Managing radiation toxicities

Stereotactic Radiotherapy (SRT)/Radiosurgery (SRS)/SBRT Radiotherapy

1. Technical, Physical and Biological aspects
2. Patient set-up and immobilization
3. Safety aspects
4. Patient scheduling and management

PAPER 2: MANAGEMENT OF MOTION, PATIENT CARE AND DATA IN RADIOTHERAPY

Managing the motions (intra-fraction/inter-fraction) is crucial for successful outcome of radiotherapy. From immobilization till treatment delivery all steps need constant and consistent monitoring to reduce the errors/uncertainties. Various methods of motion management such as breath control, motion restriction, gating and tracking need to be taught and clearly understood by the student.

Managing patient demographic, diagnostic and RT data including 3D imaging data, integrity of data transfer among various workstations in RT, scheduling patient appointment based on the treatment technique, easy data retrieval for research.

PAPER 3: RECENT ADVANCES IN RADIOTHERAPY AND SPECIAL RADIOTHERAPY PROCEDURES

Recent Advances in Radiotherapy:

1. Unflat photon beams
2. Proton and heavy ion therapy
3. 4-D and biologically guided radiotherapy
4. Newer isotopes for brachytherapy
5. Optical/EM probes for motion management

Special Radiotherapy Procedures

1. Total body irradiation
2. Intraoperative EBRT
3. Intra/preoperative brachytherapy
4. Electronic brachytherapy

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