KERALA UNIVERSITY OF HEALTH SCIENCES

Thrissur 680596

SYLLABUS OF THE COURSE

BACHELOR OF SCIENCE IN RADIOTHERAPY TECHNOLOGY (B.Sc RTT)

Course Code:025

(w.e.f.2023 admission onwards)

2023

2. COURSE CONTENT

2.1 Title of the course

Bachelor of Science in Radiotherapy Technology-Abbreviated as BSc(RTT)

2.2. Objectives of the course

The aim of the course is to train the students of Bachelor of Science in Radiotherapy Technology.

At the completion of this course, the student will be the Radiotherapy Technologist graduate and

- Able to execute all routine Radiotherapeutic procedures as per prescription and direction of Radiation Oncologist.
- Able to operate the radiotherapy equipment independently and maintain the equipment under the supervision of a Medical Physicist
- Able to handle radiological safety issues as per the role of RTT including any emergency keeping in mind the radiation protection of staff, patients and public as per direction of RSO
- Skilled in fabricating immobilization devices for patient setup during Radiotherapy.
- Have knowledge to monitor the patient's general and psychological well-being during the entire course of treatment
- Train and supervise students of radiotherapy technologists.
- Promote, scientific knowledge by delivering lectures, demonstrations, discussions, and debates in conferences and workshops pertaining to radiotherapy technology.
- Work as a team to provide quality service to patients.

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2.3 Medium of instruction:

Medium of instruction and examinations shall be in English.

2.4 Course outline

Radiation oncology is an essential discipline of medicine in the management of cancer. Ionizing radiations are used extensively in this field for treatment. The extent of technological advances in the field of radiotherapy is tremendous and expertise is essential for the delivery of quality care. The Radiotherapy Technologist (RTT) is a member of the multidisciplinary team comprised primarily of the clinician (radiation oncologist), medical physicist and support staff as considered necessary in the local setting. They are the professionals with direct responsibility for

the daily administration of radiotherapy treatment to cancer patients. Sophisticated and high-cost radiation generating equipment like Linear Accelerators, Telecobalt therapy units, tomotherapy systems, brachytherapy units etc are required to deliver the treatment. Trained personnel to operate, maintain and ensure quality of treatment are required for optimal functioning of these facilities. Besides, industry engaged in the design, manufacture, and sale of radiation generating systems need these graduates as application specialists. There is a great demand for these professionals in all the developed and developing countries. Hence, career opportunities for radiotherapy technologists will continue to be bright and rewarding in the near and distant future. The BSc(RTT) syllabus cover additional topics and training as compared to the diploma program in specialized and complex radiotherapy processes to develop competency in the same. More clinical exposure towards imaging modalities such as CT, MRI, PET are given to develop competency in the delivery of image guided radiotherapy. Scientific basis of radiotherapy such as radiobiology, recent advances in the field of Radiotherapy, patient care in radiotherapy, introduction to research methodology, operational issues in RT, coordination with Radiation Oncologists and Medical Physicists in implementing new technologies for treatment will be covered in the degree program. After the completion of the course, the graduate is expected to register with the Atomic Energy Regulatory Board (AERB) or with other regulatory/standardizing body instituted by Ministry of Health and Family Welfare. The student is also expected to keep updated information on the live register and must re-register after every 5 years to ensure employability in the market.

2.5 Duration of the Course

The duration of the course shall be four academic years including one year of clinical training/internship. The students have to attend a minimum of 240 working day in an academic year. The number of hours is mentioned in the detailed syllabus.

2.6 Subjects

First Year

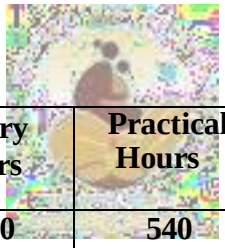
Paper	Subjects	Theory Hours	Practical Hours	Tutorials	Total Hours
Paper I	**Anatomy**	**100**	**35**	**35**	**170**
Paper II	**Physiology**	**100**	**35**	**35**	**170**
Paper III	**Pathology**	**100**	**35**	**35**	**170**
Paper III	**General and Nuclear Physics**	**100**	**35**	**35**	**170**
Paper IV	**Foundation Course:**				

	Introduction to Health care Delivery System in India	**60**			**60**
	Basic computers and information Science	**10**	**40**	**20**	**70**
	Communication and soft skills	**20**	**10**	**30**	**60**
	Medical Terminology and Recordkeeping(including anatomical terms)	**40**	**0**	**40**	**80**
	Medical Law and Ethics	**40**			**40**
	Introduction to Quality and Patient safety (including Basic emergency care and life support skills, Infection prevention and control, Biomedical waste management, Disaster management and Antibiotic resistance)	**40**	**60**	**30**	**130**
	Professionalism and values	**20**	**10**	**50**	**80**
	Biostatistics and introduction to research methodology	**40**	**20**		**60**
	Principals of Management	**40**	**0**	**20**	**60**
	Community orientation and clinical visit	**0**	**100**	**20**	**120**
	TOTAL HOURS				**1440**

Second Year:

Paper	Subjects	Theory Hours	Practical Hours	Tutorials	Total Hours
Paper V	Radiation Physics I	140	40	100	280
Paper VI	Radiotherapy I	140	410	200	750
Paper VII	Radiological, Nuclear Medicine, Other Imaging Modalities	140	210	60	410
	TOTAL	420	660	360	1440

Third year:



Paper	Subjects	Theory Hours	Practical Hours	Tutorials Hours	Total Hours
Paper VIII	Radiotherapy II	140	540	200	880
Paper IX	Radiation Physics II	140	140	100	380
Paper X	Radiological Safety and statutory aspects	70	50	60	180
	TOTAL	350	730		1440

Fourth Year: Internship

Internship of one year (Minimum 1440 hours) is compulsory. The interns will be given hands-on training in therapeutic procedures. The students will be posted to work in a hospital attached to the institution and to carryout project work simultaneously. No transfer to another hospital, which is not attached to the institution, will be allowed for the purpose. It is a training program for developing the candidate as a professional in the field. Hospital posting as well as project work must be substantiated with records duly signed by the head of department of the institution, where the candidate is posted. The students must work under the supervision of an experienced staff in the following areas:

	Postings	**Duration**
1	Teletherapy machines including Linac and Telecobalt	3months
2.	CT Simulator and Mould Room	2months
3	Brachytherapy	2months
3	Posting in Radiation Physics and Safety	2months
4	Posting in RT Ward, OP, Records,Reception	1 month
5	Posting in Diagnostic Radiology and other departments	2 months

2.7 Total number of hours: As given in clause 2.6

2.8 Branches if any with definition

The course shall comprise of both theoretical and practical studies in different branches of Radiotherapy Technology and its related subjects to make the graduate

i. Good communicator to effectively interact with not only the staff/other categories of professionals but also with the patients and their relatives
ii. Should have knowledge of the clinical aspects of cancer, its treatment and visible side-effects especially related to radiotherapy
iii. Should have knowledge of the various types of radiations, radiation generating equipment and their functioning
iv. Should have knowledge of radiation interactions, and dosimetry techniques
v. Should have knowledge of the various steps/processes involved in treatment planning
vi. Should be competent to operate the radiotherapy equipment
vii. Should be competent in patient handling, immobilization techniques and patient positioning/set-up for treatment/simulation
viii. Should be competent in handling and checking the treatment related data and data transfer among the various radiotherapy systems
ix. Should be competent in monitoring the radiation treatment delivery in terms of both equipment and patient parameters as per the treatment planning.
x. Should have knowledge about radiological safety issues in radiotherapy and also about the procedures/processes adopted in an emergency situation. He/she should be competent to perform his/her role effectively in an emergency
xi. Should be competent to handle data/record keeping and documentation, and patient management that includes providing treatment slots

With the above aim the following subjects are included in the syllabus

1. Anatomy
2. Physiology and Pathology
3. General and Nuclear Physics.
4. General topics like Introduction to Healthcare Delivery System in India, Basic computers and information Communication and soft skills Science, Medical Terminology and Record keeping including anatomical terms, Medical Law and Ethics, Introduction to Quality and Patient safety(including Basic emergency care and life support skills, Infection prevention and control, Biomedical waste management, Disaster management and Antibiotic resistance),Professionalism and values, Biostatistics and introduction to research methodology
5. Radiotherapy I
6. Radiological/Nuclear Medicine/Other Imaging Techniques
7. Physics of Radiotherapy
8. Radiological Safety and statutory aspects
9. Modern Radiotherapy

2.9 Teaching and learning methods

Lecture, Tutorial, Problem based learning, small group teaching and learning, Continuous interactive learning, Clinical conferences, E-learning, Regular clinical posting to pick up practical skill and practice techniques. Students should present seminars in various subjects in to attain presentation skill.

2.10. Contents of each subject in each year

FIRST YEAR

Paper I
ANATOMY

The student must know basic anatomy of human body with reference to radiologically relevant Anatomy. The syllabus does not have as much in depth as that for MBBS course.

INTRODUCTION TO ANATOMY

Terms used in Anatomy; Regions of the body; Description of a typical animal cell: Cell mitosis; genes; sex cell -ova and spermatozoa. Fertilization of the ovum, Broad lines of embryonic development. Cell function and differentiation of tissues. General Histology: Epithelium; simple and complex epithelial glands; skin. Connective tissue; fibrous tissue; cartilage; bone; Haversian systems; blood; numbers and types of cells in blood, clotting of blood. Muscle tissue- involuntary, voluntary, and cardiac muscle. Nerve tissue.

MUSCULO SKELETAL SYSTEM

Classification of muscles, Anatomical relationships of muscles, origin and insertion of muscles, General description of bones, their main processes and attachments-including the skull with emphasis on the skull as a whole. Development of bones, Primary and secondary centers, diaphysis and epiphysis. Position and function of main joints. Some common diseases and injuries of bones and joints.

THORAX AND THORACIC CAVITY

Thoracic wall, pleura, lungs and its lobes and segments. Mediastinum and its contents, Heart and great vessels.

RESPIRATORY SYSTEM

Nasal cavity, Paranasal sinuses, Nasopharynx, Oropharynx, Larynx, Hypopharynx, Trachea, Bronchi, Bronchial tree, Thoracic cavity, Mediastinum, Pleura. Lungs- Position, relation, Structure, Broncho pulmonary segments.

DIGESTIVE SYSTEM

Oral cavity, teeth, salivary glands, tongue, tonsil, pharynx, esophagus, stomach, duodenum, small intestine, caecum, appendix, large intestine, rectum, anal canal, mesentery, omentum, peritoneum, peritoneal cavity.
Liver-Position, relations, structure, gall bladder, cystic duct, common bile duct, gall stones, Portal circulation.
Pancreas-Position, structure, pancreatic duct.
Spleen- Position, relation, blood supply.

GENITOURINARY SYSTEM

The kidneys, collecting system, Urinary bladder and urethra in male and female. Testis, seminal vesicles, spermatic cord, prostate, penis, ovaries, fallopian tubes, uterus, vagina, vulva and clitoris.

NERVOUSSYSTEM

Brain- its coverings, different parts of brain, cerebrum, cerebellum, midbrain, pons medulla oblongata, Corpus callosum, cranial nerves and ventricles of brain.

Spinal cord-its position and structure, coverings, spinal nerves and applied anatomy. Brief study of important peripheral nerves, sympathetic and para sympathetic system.

CARDIOVASCULARSYSTEM

Heart, Pericardium, cardiac chambers, aorta and its paired and unpaired branches. Major blood vessels of extremities and brain.

LYMPHATICSYSTEM

Structure of lymph node, different lymph node groups and its drainage areas, lymphatic vessels and thoracic duct.

ENDOCRINESYSTEM

Gross anatomy of endocrine glands- Pituitary, Thyroid, Parathyroid, Pancreas, Adrenals, Pineal, Ovary, testes.

MISCELLANEOUS

Gross and microscopic structure of skin and appendages.
Orbit and Orbital structures.
External, middle and internal ear, mastoid air cells.

REFERENCE BOOKS:

Atlas of Anatomy basic to Radiology – by I Meschan
Gray's anatomy for students-by Adam W, M Michell Richard L Drake etc
Anatomy and physiology for nurses including notes on their clinical application- Evelyn C.Pearce
Basic Anatomy and Physiology for Radiographers- M.R.E. Dean
Surface and Radiological Anatomy- A Halim.
Text book of Anatomy by Dr Sreedevi

Paper II

PHYSIOLOGY

PHYSIOLOGY

The student expected to know basic physiology of human body. The syllabus does not that as much in depth as that for MBBS students.

INTRODUCTION TO PHYSIOLOGY

RETICULO-ENDOTHELIAL SYSTEM:

Composition of blood, gross structure of RBC, WBC, platelets, its production and functions. Anemia, polycythemia, leukopenia, leukocytosis, thrombocytopenia, pancytopenia- definition, common causes and clinical significance. Physiology of coagulation, coagulation factors, thrombus formation.

LYMPH: Lymph formation and its, functions

RESPIRATORYSYSTEM:

General physiological functions of respiratory system, Mechanism of ventilation. Pulmonary circulation.

Respiratory and non-respiratory functions of lung. Diffusion of gases in lungs and factors influencing

ENDOCRINE SYSTEM:

Brief description of endocrine organs, its hormones, functions of hormones, diseases produced by excess or deficiency of the hormones. Thyroid hormone production giving importance to role of iodine in detail.

DIGESTIVE SYSTEM:

Physiology of deglutition, movement of food through esophagus, stomach, small and large intestines and defecation. Brief study of different digestive juices, its functions on digestion and absorption.

REPRODUCTIVE SYSTEM

Male reproductive system, Functions of gonads., secondary sexual characters in male and onset of puberty. Physiology of the sperm, normal characteristics and composition of semen. Cryptorchidism.

Female reproductive system, secondary sexual characters in female and onset of puberty. Physiology of formation of Ovum and menstrual cycle. Pregnancy, infertility and menopause.

CARDIOVASCULAR SYSTEM:

General functions of cardiovascular system. Systemic and pulmonary circulation. Cardiac cycle, atrial systole and diastole, ventricular systole and diastole. Pulse, blood pressure, shock. anaphylactic shock- detection and management.

NERVOUS SYSTEM

General introduction and structure. Functions of central nervous system-motor, sensory and special senses. CSF-Formation, properties, functions and absorption.

REFERENCE BOOKS;

The Human Body-Best and Taylor.
Basic anatomy and physiology for radiographers- M.R.E. Dean.
Human anatomy and Physiology-King and showers.
Text book of Physiology- Guyton and Hall
Essentials of Medical Physiology- K Sembulingam

Paper III
PATHOLOGY

Introduction to pathology

Disorders of Circulation-Thrombosis, Embolism, Infarction, Oedema Mechanism and changes in inflammation
Common Infection-Common acute bacterial infection Detailed study of tuberculosis, Leprosy, Syphilis
Common fungal infection with a short account of opportunistic fungal infection.
Brief account of all viral infections including AIDS, Common Diseases caused by protozoa and helminthes

Detailed study of tumors- Characteristics, Classification, Aetiology and pathogenesis of common benign and malignant tumors

Regenerative changes - Fatty change, Necrosis, Gangrene, Pathogenic calcification Genetic Diseases-Down's syndrome, Haemophilia
Immunology-Autoimmune diseases, Rheumatoid arthritis, SLE, Immune deficiency-AIDS Brief study of nutritional diseases
Study of biological effects of radiation

Diseases of individual organ systems (Basic Outline only is required):

Cardio Vascular System: IHD, RHD, Infective endocarditis, Hypertension, Valvular diseases

Lung: Pneumonias, TB, Asthma, Lung Tumors

GIT: Oral cavity, Ca oral cavity, Ca-Esophagus, Peptic ulcer, Ca stomach, malabsorption, Inflammatory Bowel diseases, dysentery, appendicitis, peritonitis

Gall Bladder-Stones, Cholecystitis

Pancreas: Pancreatitis, Stones, Diabetes mellitus, Ca Pancreas

Male Reproductive system: Hydrocele, Orchitis and Epididymitis, Benign prostate hypertrophy, Ca Prostate
Female reproductive system: Cervicitis, Ca Cervix, Ca Endometrium, Disorders of Menstruation Leiomyoma, Brief account of ovarian tumors, Disease of pregnancy-PHT-Ectopic

Breast: Fibro adenoma, Ca Breast

Blood- Anemia, Leukemia, Bleeding disorders,

Lympho reticular systems: Lymphadenitis, Lymphomas

Bones- Congenital Conditions, Osteomyelitis, Rickets, osteomalacia, Bone tumors, arthritis

Endocrine Systems-Thyroid, Pituitary. Adrenal, Parathyroid,

Brief account of eye and ear infection

Skin -Psoriasis, Eczema, Skin tumors -Basal, squamous, Malignant Melanoma

Kidney – Kidney Stones, Glomerulo nephritis, Pyelonephritis, Renal failure, Nephrotic syndrome, Tumors of kidney

Paper IV

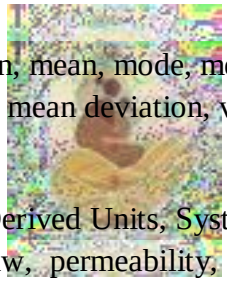
General and Nuclear Physics

GENERAL PHYSICS

Physics is a key component of all education programs for RTTs and should comprise a significant proportion of the overall syllabus. The physics modules will provide the scientific basis to understand the functioning of the radiotherapy equipment, dosimetry, and basis of radiation protection and safe practice.

Basic mathematics applicable to Physics

Algebra-Laws of indices, logarithm, exponential, logarithm series, Trigonometry- measurement of angles, trigonometric ratios, relations connecting complementary and supplementary angles, Calculus-functions and limits, differentiation, rules of differentiation, vectors-definition, product of vectors, scalar and vector products, Complex numbers- Definition, properties of complex numbers, Fourier transforms, Laplace transform.



Statistics-Basic ideas of statistical evaluation, mean, mode, median and standard deviation. Calculation of mean, median, mode, standard deviation, mean deviation, variance, coefficient of variation

General Physics

Units and dimensions: fundamental units, Derived Units, Systems of units

Magnetism: magnetic poles, coulombs law, permeability, magnetic field, flux and flux density, Magnetic induction, Webber and Tesla, Magnetic Properties, Intensity of magnetization, Types of magnetic materials - Ferro magnetic, para magnetic and diamagnetic, magnetic susceptibility, hysteresis.

Electrostatics- electric charges, coulombs law, dielectric constant, electric filed strength, conductors and insulators, electric potential and potential difference, volt.

Electric capacitance, Farad, Type of capacitors, capacitors in series and parallel, capacitors in DC circuits.

Current electricity, ampere, resistance, ohms law, electrical energy, joule and watts, power in resistor, kWh, power losses in cables

Electromagnetic Induction: Magnetic effects due to electric currents, solenoid, Eddy Current, Flemings left hand rule, electromagnetic relays, self and mutual induction, Faraday`s laws, lenz's law, henry, electric motors and generators.

Alternating currents: meaning of AC and its advantages over DC, AC generators, peak, RMS, effective and average values of currents and voltages, phase difference, LC Circuit, RC Circuit, LR Circuit, LCR circuit- LCR circuits series and parallel, AC Circuits- Single phase and three phase circuits, Three phase in X-ray applications, Star and Delta connections.

Transformers- Introduction, turns ratio, step up, step down and even ratio transformer, efficiency, transformer losses, constant voltage transformer, transformer rating, autotransformer, mains voltage compensation, transformers used in X ray circuits

Measuring instruments: Galvanometer, moving coil and moving iron type, voltmeter, ammeters, shunts, conversion of galvanometer to ammeters and voltmeters, multi meters, meters used in X-ray circuits, main Voltmeter, prereading KV Meter, mA meter and mAs meter.

Simple Harmonic Motion-Introduction, expressions for period, velocity and acceleration, phase, initial phase, forced oscillations, resonance.
Ultrasonics-Introduction, piezoelectric effect and its applications, Doppler Effect-Introduction-General expression for apparent frequency. Applications of Doppler Effect

Basic Electronics: Gas filled diode, Thyratron tubes, semiconductors-intrinsic and extrinsic semiconductors, N type and P type, PN junction, biasing of PN junction, PN junction diode, Zenor diode, transistors, rectifiers, half wave and full wave, introduction to digital electronics, gate circuits, AND, OR, NAND, NOR, NOT gates.

Basic Modern physics: LASER, super conductivity, super conducting magnets, fluorescence, phosphoresce and scintillation, band theory and band structure, applications in radiography and radiotherapy.
Atomic structure, elements and compounds, atoms and molecules, protons, neutrons, nucleons, electrons, electron shells, binding energy, atomic number, mass number and atomic weight, Avogadro number, atomic mass unit, mass defect, mass energy equivalence, distribution of orbital electrons, atomic energy levels, nuclear forces, periodic table, ionization and excitation, characteristic and continuous spectrum.
Atom Model-Thomson's atom model, Rutherford and Bohr atom model, Vector atom model, Pauli's exclusion principle, Larmour precession, DE-Broglie's theory phase and group velocities, uncertainty principle.

Electromagnetic radiations- wave length, frequency, energy and their relations, inverse square law, quantum nature, particle nature, electromagnetic spectrum, properties of EM waves

Basic Nuclear Physics- Introduction, general properties of nucleus, binding energy, nuclear forces, nuclear stability, Alpha decay Beta and Gamma decay with examples., Neutrino, other sub atomic particles. Nuclear reactions-common nuclear reactions, proton bombardment, Fission, Fusion, Nuclear reactors, production of short lived and long lived isotopes, nuclear isomerism. Radio activity, radioactive disintegrations, radioactive emission, alpha, beta and gamma emission, electron capture, internal conversion, Auger electrons, exponential law of radioactive decay, decay equation, half-life, decay constant, natural radioactive materials, radioactive equilibrium. Artificial radio activity, nuclear reactions, neutron bombardment, proton bombardment, nuclear fission and fusion, nuclear reactor and cyclotrons.

Paper V

Foundation Course

Introduction to National Healthcare System

The course provides the students a basic insight into the main features of Indian health care delivery system and how it compares with the other systems of the world. Topics to be covered under the subject areas follows:

1. Introduction to health care delivery system
    a. Health care delivery system in India at primary, secondary and tertiary care
    b. Community participation in health care delivery system
    c. Health system in developed countries.
    d. Private Sector
    e. National Health Mission
    f. National Health Policy
    g. Issues in Health Care Delivery System in India
2. National Health Programme-Background objectives, action plan, targets, operations, achievements and constraints in various National Heath Programme.
3. Introduction to AYUSH system of medicine
    a. Introduction to Ayurveda.
    b. Yoga and Naturopathy
    c. Unani
    d. Siddha
    e. Homeopathy
    f. Need for integration of various system of medicine
4. Health scenario of India-past, present and future
5. Demography& Vital Statistics-
    a. Demography–its concept
    b. Vital events of life& its impact on demography
    c. Significance and recording of vital statistics
    d. Census& its impact on health policy
6. Epidemiology
    a. Principles of Epidemiology
    b. Natural History of disease
    c. Methods of Epidemiological studies

    Epidemiology of communicable &non-communicable diseases, disease transmission, host Defense immunizing agents, cold chain, immunization, disease monitoring and surveillance

Medical terminologies and record keeping

This course introduces the elements of medical terminology. Emphasis is placed on building familiarity with medical words through knowledge of roots, prefixes, and suffixes. Topics include: origin, word building, abbreviations and symbols, terminology related to the human anatomy, reading medical orders and reports, and terminology specific to the student′s field of study.

Spelling is critical and will be counted when grading tests. Topics to be covered under the subject areas follows:

1. Derivation of medical terms.
2. Define word roots, prefixes, and suffixes.
3. Conventions for combined morphemes and the formation of plurals.
4. Basic medical terms.
5. Form medical terms utilizing roots, suffixes, prefixes, and combining roots.
6. Interpret basic medical abbreviations/symbols.
7. Utilize diagnostic, surgical, and procedural terms and abbreviations related to the integumentary system, musculoskeletal system, respiratory system, cardiovascular system, nervous system, and endocrine system.
8. Interpret medical orders/reports.
9. Data entry and management on electronic health record system.

Basic computers and information science

The students will be able to appreciate the role of computer technology. The course has focus on computer organization, computer operating system and software, and MS windows, Word processing, Excel data worksheet and PowerPoint presentation. Topics to be covered under the subject areas follows:

1. Introduction to computer: Introduction, characteristics of computer, block diagram of computer, generations of computer, computer languages.
2. Input output devices: Input devices (keyboard, point and draw devices, data scanning devices, digitizer, electronic card reader, voice recognition devices, vision-input devices), output devices (monitors, pointers, plotters, screen image projector, voice response systems).
3. Processor and memory: The Central Processing Unit(CPU), main memory.
4. Storage Devices: Sequential and direct access devices, magnetic tape, magnetic disk, optical disk, mass storage devices.
5. Introduction of windows: History, features, desktop, taskbar, icons on the desktop, operation with folder, creating shortcuts, operation with windows (opening, closing, moving, resizing, minimizing and maximizing, etc.).
6. Introduction to MS-Word: introduction, components of a word window, creating, opening and inserting files, editing a document file, page setting and formatting the text, saving the document, spell checking, printing the document file, creating and editing of table, mail merge.
7. Introduction to Excel: introduction, about work sheet, entering in formation, saving work books and formatting, printing the work sheet, creating graphs.
8. Introduction to power-point: introduction, creating and manipulating presentation, views, formatting and enhancing text, slide with graphs.
9. Introduction of Operating System: introduction, operating system concepts, types of

Operating system.

10. Computer networks: introduction, types of network (LAN, MAN, WAN, Internet, Intranet), network topologies (star, ring, bus, mesh, tree, hybrid), components of network.
11. Internet and its Applications: definition, brief history, basic services (E-Mail, File Transfer Protocol, telnet, the World Wide Web (WWW)), www browsers, use of the internet.
12. Application of Computers in clinical settings.

Practical on fundamentals of computers-

1. Learning to use office: word, Power Point, Excel or similar office tool
2. To install different software.
3. Data entry efficiency

Medical law and ethics

Legal and ethical considerations are firmly believed to be an integral part of medical practice in planning patient care. Advances in medical sciences, growing sophistication of the modern society's legal frame work, increasing awareness of human rights and changing moral principles of
The community at large, now result in frequent occurrences of health care professionals being
Caught in dilemmas over aspects arising from daily practice. Medical ethics has developed into a well based discipline which acts as a "bridge" between theoretical bioethics and the bedside. The goal is "to improve the quality of patient care by identifying, analyzing, and attempting to resolve the ethical problems that arise in practice". Doctors are bound by, not just moral obligations, but also by laws and official regulations that form the legal framework to regulate medical practice. Hence, it is now a universal consensus that legal and ethical considerations are inherent and inseparable parts of good medical practice across the whole spectrum. Few of the important and relevant topics that need to focus on are as follows:
Medical ethics -Definition-Goal-Scope
Introduction to Code of conduct
Basic principles of medical ethics–Confidentiality
Malpractice and Negligence-Rational and irrational drug therapy
Autonomy and informed consent –Right of patients
Care of the terminally ill-Euthanasia
Organ transplantation
Medico legal aspects of medical records – Medico legal case and type- Records and document related to MLC - ownership of medical records - Confidentiality Privilege communication - Release of medical information - Unauthorized disclosure – retention of medical records –other various aspects.
Professional Indemnity insurance policy
Development of standardized protocol to avoid near miss or sentinel events
Obtaining an informed consent.

Communication and soft skills

Major topics to be covered under Communication course

1. Basic Language Skills: Grammar and Usage.
2. Business Communication Skills. With focus on speaking - Conversations, discussions, dialogues, short presentations, pronunciation.
3. Teaching the different methods of writing like letters, E-mails, report, case study, collecting the patient data etc. Basic compositions, journals, with a focus on paragraph form and organization.
4. Basic concepts &principles of good communication
5. Special characteristics of health communication
6. Types &process of communication
7. Barriers of communication & how to overcome

Introduction to Quality and patient safety

1. Quality assurance and management - The objective of the course is to help students understand the basic concepts of quality in health Care and develop skills to implement sustainable equality assurance program in the health system.
    a. Concepts of Quality of Care
    b. Quality Improvement Approaches
    c. Standards and Norms
    d. Quality Improvement Tools
    e. Introduction to NABH guidelines

2. Basics of emergency care and life support skills - Basic life support (BLS) is the foundation for saving lives following cardiac arrest. Fundamental aspects of BLS include immediate recognition of sudden cardiac arrest (SCA) and activation of the emergency response system, early cardiopulmonary resuscitation(CPR), and rapid defibrillation with an automated external defibrillator (AED). Initial recognition and response to heart attack and stroke are also considered part of BLS. The student is also expected to learn about basic emergency care including first aid and triage. Topics to be covered under the subject areas follows:
    a. Vital signs and primary assessment
    b. Basic emergency care–first aid and triage
    c. Ventilations including use of bag-valve-masks(BVMs)
    d. Choking, rescue breathing methods
    e. One-and Two-rescuer CPR
    f. Using an AED (Automated external defibrillator).

Professionalism and values

The module on professionalism will deliver the concept of what it means to be a professional and how a specialized profession is different from a usual vocation. It also explains how relevant is professionalism in terms of health care system and how it affects the overall patient environment.
Professional Values-Integrity, Objectivity,
Professional competence and due care, Confidentiality
Personal values-ethical or moral values
Attitude and behavior- professional behavior, treating people equally
Code of conduct, professional accountability and responsibility, misconduct
Differences between professions and importance of team efforts
Cultural issues in the health care environment

Research Methodology and Biostatistics

The objective of this module is to help the students understand the basic principles of research and methods applied to draw inferences from the research findings.

1. Introduction to research methods
2. Identifying research problem
3. Ethical issues in research
4. Research design
5. Basic Concepts of Biostatistics
6. Types of Data
7. Research tools and Data collection methods
8. Sampling methods
9. Developing a research proposal

Principals of Management

The course is intended to provide a knowledge about the basic principles of Management.

1. Introduction to management
2. Strategic Management
3. Foundations of Planning
4. Planning Tools and Techniques
5. Decision Making, conflict and stress management
6. Managing Change and Innovation
7. Understanding Groups and Teams
8. Leadership
9. Time Management
10. Cost and efficiency

Community orientation and clinical visit

The objective of this particular section of the foundation course is to sensitize potential learners

with essential knowledge; this will lay a sound foundation for their learning across the under-graduate program and across their career. Innovative teaching methods should be used to ensure the attention of a student and make them more receptive such as group activities, interactive for a, role plays, and clinical bed-side demonstrations.

The community orientation and clinical visit will include visit to the entire chain of health care delivery System-Sub center, PHC, CHC, SDH, DH and Medical college, private hospitals, dispensaries and clinics.

The student will also be briefed regarding governance at village level including interaction and group discussion with village panchayat and frontline health workers.

Clinical visit to the irrespective professional department within the hospital.

Managing an emergency including moving a patient

At the end of this topic, focus should be to teach the students to perform them aneuvers in simulation lab and to test their skills with focus on airways management and chest compressions.

At the end of the foundation course, each student should be able to perform and execute/operate on the above mentioned modalities.

Biomedical waste management and environment safety-The aim of this section will be to help prevent harm to workers, property, the environment and the general public. Topics to be covered under the subject areas follows:

Definition of Biomedical Waste

Waste minimization

BMW–Segregation, collection, transportation, treatment and disposal (including color coding)

Liquid BMW, Radioactive waste, Metals/Chemicals/Drug waste

BMW Management& methods of disinfection

Modern technology for handling BMW

Use of Personal protective equipment(PPE)

Monitoring &controlling of cross infection (Protective devices)

Infection prevention and control - The objective of this section will be to provide a broad understanding of the core subject areas of infection prevention and control and to equip AHPs with the fundamental skills required to reduce the incidence of hospital acquired infections and improve health outcomes. Concepts taught should include–

Evidence-based infection control principles and practices [such as sterilization, disinfection, effective hand hygiene and use of Personal protective equipment(PPE)],

Prevention & control of common health care associated infections,

Components of an effective infection control program, and Guidelines (NABH and JCI) for Hospital Infection Control

Antibiotic Resistance-

History of Antibiotics

How Resistance Happens and Spreads

a. Types of Resistance-Intrinsic, Acquired, Passive
b. Trends in Drug Resistance
c. Actions to Fight Resistance
d. Bacterial persistence
e. Antibiotic sensitivity
f. Consequences of antibiotic resistance
g. Antimicrobial Stewardship-Barriers and opportunities, Tools and models in hospitals

Disaster preparedness and management-The objective of this section will be to provide knowledge on the principles of on-site disaster management. Concepts to be taught should include-

a. Fundamentals of emergency management,
b. Psychological impact management,
c. Resource management,
d. Preparedness and risk reduction,
e. Key response functions (including public health, logistics and governance, recovery, rehabilitation and reconstruction), information management, incident command and institutional mechanisms.

SECOND YEAR

Paper VI

RADIATION PHYSICS-I

In this paper the students will learn to understand the principles of x ray production, radiation quantities, their measuring units, Interactions of radiation with matter, and various types of survey meters/dosimeters and basic physics of diagnostic Radiology

Cathode Rays: Conduction of electricity through gases, Production, and properties of cathode rays-Thermionic emission-variation of anode current with voltage- Voltage and filament temperature-Thermionic gas diode.

Spectra: Emission spectra-continuous, Line and band spectra-Spontaneous and stimulated emission-Laser. Type of Laser, He-Ne Laser, Absorption Spectra, Luminance, Fluorescence and Phosphorescence with examples and use.

Physics of X-ray production- Production and properties of X-rays, Continuous and characteristic x-rays, X-ray spectra, intensity and quality of X-rays and factors controlling them, Intensity distribution around the focal spot, Quality and quantity analysis, dependence on KV, mA, exposure time, distance, filtration, charactoristic component– its removal and special applications
Various types of X-ray tubes, Comparison of diagnostic and therapy X-ray tubes, CT x ray tubes,

Mammography tubes. Filters and filtration, inherent and added filtration, heavy metal filter, Effect of filtration on low and high energy beams
Collimators, grids, grid characteristics, Types of grids, evaluation of grid performance

Electrical and electronic X ray circuits- High Tension Transformer, Filament Transformer, Auto transformer, KV, mA, mAs and exposure time measuring systems, comparison of different X-ray systems like self-rectified, half wave rectified, full wave rectified, multi pulse and constant voltage systems.

Dissipation of Heat in X-ray production, X- ray tube and housing rating charts and their evaluation, Heel effect, Measures to protect X- ray units from over-heating, preventive measures. High energy systems–MV generators.

Calibration techniques for exposure factors, use of spinning top, KVp meter, mA(S)meter, KVP cassettes etc Timers: Synchronous, Electronic, ionization, Photo, MAS timers. - Pulse counting Rating factors controlling rating-Use of rating charts,

Interaction of ionizing radiation with matter (Qualitative aspects only): Absorption and Transfer of Energy-Attenuation-Attenuation coefficients- HVL and TVL-Narrow and Broad beams-Attenuation processes.
Photoelectric effect- Thomson scattering- Rayleigh scattering- Compton scattering- pair production, Photonuclear reaction - Total attenuation coefficient, - importance of these interactions in medical applications and radiotherapy.

Interaction of charged particles: LET, range, stopping power, interactions of electrons, interactions of heavy Particles, interaction of proton, Bragg Peak, Interaction of neutron

Units and Measurement of ionizing radiation: Radiation quantities- Energy, Intensity, Exposure, Roentgen, Electronic equilibrium, Exposure rate constant, - Free Air ionization chamber, Kerma, Energy absorbed, Absorbed dose, Rad, Gray. Equivalent Dose, Effective Dose
Basic principle of Radiation Detectors (Qualitative aspects only): Description and working of radiation measuring systems, Ion chambers, Thimble chamber, GM detectors, proportional chambers, scintillation detectors, TLD, chemical detectors, photographic detectors, Neutron Detectors etc.

Principles of Image Radiologic formation: Physical principles, latent image and its processing, automatic and manual processing techniques, flat panel detectors and film less imaging, Solid state detectors and image receptors, amorphous silicon flat panel detectors, Intensifying and fluorescent screens, Characteristics of radiographic images, contrast, sharpness, definition, distortion, and factors affecting them. methods to improve the quality of images, Exposure factors in imaging,

Modern systems of imaging:
Digital subtraction Angiography- Introduction and principle.
Computed Tomography: Introduction Principles and operations, Different generations of CT units, spiral CT machines, Special features of X-ray generators and detectors. In CT, Types of CT scanners, CT simulators.

Magnetic Resonance Imaging physics: Basic Physics of MRI, relaxation and tissue contrast-T1 and T2 relaxation.

Paper VII

RADIOTHERAPY-1

The topic covered in in this paper is to understand the radiobiological principles of radiotherapy and underlying the choice of treatment and the relative place of radiotherapy with surgery, chemotherapy, and hormone therapy in treatment of malignant diseases.

Radiobiology**:**
Cell cycle,

Effect of radiation on tissues–DNA Damage and repair Oncogenes and Tumour suppressor genes

Acute and late effects of radiotherapy on skin, Mucosa, GI tract, Genito-urinary system, respiratory system, CNS.
Effect of radiation on the body including effects of total and hemi body radiation.
Oxygen effect, Oxygen Enhancement Ratio

Radio sensitizers and Radio protectors: Examples and principles of action, Principles of radiation dosage, Effect of fractionation
5Rs of Radiobiology, Radio sensitivity and radio-resistance
Biologically Equivalent dose and EQD2.Second malignancies,

Radiation Oncology:

The student should have knowledge of various diseases, which may require radiotherapy. A general knowledge of the disease process, including knowledge of normal cell structure and lifecycle, carcinogenesis etc is necessary basis for an understanding of the abnormality.

For the disease listed below basic knowledge on anatomy including lymphatic drainage of the organ/site involved, pathology, etio-pathogenesis, basic epidemiology, patterns of spread, treatment options for various stages and role of radiotherapy should be known. Common diseases to study are:
Brain tumors,
Head and Neck Cancers, Lung Cancers,
Breast Cancer, Esophageal Cancer, Rectal Cancer, Cervical Cancer, Endometrial Cancer,
Vulva and Vagina, Soft Tissue Sarcomas, Testis, Penis, Prostate,
Kidney, Ureter and Bladder, Pancreas, Liver Stomach, Lymphomas.
Pediatric tumors: Retinoblastoma, Wilms Tumor, Rhabdomyo sarcoma, Patterns of spread of cancer
Basic tests done for cancer patient's workup including biopsy and staging work up.
TNM, FIGO, and Ann Arbor Staging systems,
Palliative radiotherapy, Radiotherapy in pregnancy

Paper VIII

Radiological, Nuclear Medicine, Other Imaging Techniques

An RTT should understand the role of various types of imaging in radio therapy planning. Also he/she should be well versed with various types of imaging modalities.

Surface anatomy
Plain and cross-sectional radiographic anatomy Plain film/conventional radiographs
Practical safety measures in diagnostic radiography principles of x-ray diagnosis.
Radiographic films, single coated, double coated films. Various stages of film processing
X-Ray developer, fixer, replenisher Fog in X-ray films.
Automatic X-ray film processing. Intensifying screens, fluoroscopic screens, Grids, Moving grid, radiographic cones. Networking in Radiology
PACS and online imaging;
Contrast media: Type of contrast agents, Strength, and quantities and methods of introduction with the radiographic technique, Precautions and contraindications, use of contrast media in children and during pregnancy.
Digital radiography, Digital Angiography, Digital subtraction angiography Fluoroscopy/Image intensifier, Digitally Reconstructed Radiographs(DRR): Digitally reconstructed radiograph; Reconstructive image parameters
Mammography: Introduction, clinical Principles and Techniques

Computed Tomography(CT): Introduction, clinical Principles and Techniques, Computed tomography equipment and methodology

Magnetic Resonance Imaging(MRI): Magnetic Resonance Imaging Equipment, positioning, comparison of MR to conventional radiology, physical principles, biomedical effects of MR, clinical application.

Ultrasound: Introduction, clinical applications of Ultrasound and techniques

Nuclear medicine: Introduction, Radioisotopes used for Imaging, measurement of sample activity, Detection of radioactivity in the body, whole body counting, scanners, Gamma cameras. Radiopharmaceuticals- Properties and uses, various radiopharmaceutical used for imaging Thyroid uptake, Plasma volume, elusion.
Positron emission tomography-principles, clinical studies, PETCT.

Safety checks of radiographic equipment: Safety checks of radiographic equipment and accessories such as led aprons and gloves and collimator accuracy, symptoms of mal functions in radiographic equipment

Application of imaging modalities in radiotherapy planning

Image fusion at the treatment machine console, Bony matching, soft tissue matching for estimating the preliminary data for applying shifts.

THIRD YEAR

Paper IX
RADIOTHERAPY II

Hospital procedure: Hospital staffing and organization; records relating to patients and departmental statistics, professional attitude of the technologist to patients and other members to the staff; medico-legal aspects, accidents in RT departments, appointments organization; minimizing waiting time, out –patient and follow-up clinics; stock-taking and stock keeping.

Care of the patient: First contact with patients in the department, management of chair and stretcher patients and aids for this , management of the unconscious patient, elementary hygiene, personal cleanliness, hygiene in relation to patients(for example clean linen and receptacles, nursing care, temperature pulse and respiration, essential care of the patient who has a tracheotomy, essential care of the patients who has a colostomy, bedpans and urinals, simple application of a sterile dressing. First aid, Infection (Bacteria, spread of infections, auto-infection etc.).

General welfare of the patient during and after the treatment including the care of any inter- current disease (diabetes, hypertension, tuberculosis, arthritis).

The observation and reporting of any change in the signs and symptoms of patients receiving treatment.

Care under specific circumstances: Catheter care, Stoma care Wound care, Unconscious patient, Bone metastases, Physically disabled, Mentally disturbed, Blind, deaf patients, Diabetics Nutrition, Diet and fluid intake.

Ethics in radiotherapy, Legal aspects: Confidentiality, Informed consent, Data protection

Patient privacy, Skin care, Universal precautions, Laboratory investigations

The care of local and systemic reaction. Local reaction should include those in the, ear, nose, throat and eye and those arising from treatments given to the pelvis.

Information and communication and Documentation of side effects

Organization of radiotherapy, department practice, appointment organization in the planning room, treatment area. Management of waiting patients.

Drugs in the department: Storage: Classification; labelling and checking, regulations regarding dangerous and other drugs, unit of measurement, special drugs, anti-depressive, anti-hypertensive etc.

Basic Tumor localization principles and procedures: Use of imaging techniques for tumor localization. Mould room and motion management techniques: Methods of patient immobilization. Breath hold, motion reduction, tracking and gating techniques.

Different types of immobilization devices, Historical evolution of the mould materials and techniques to make moulds, Thermoplastic moulds, Positioning aids-Breast boards, Lung boards, Belly boards, Head-and-neck fixation devices, Vacuum packs, Stereotactic systems

Simulation. Conventional simulators and CT simulators, Virtual simulation

Clinical Principles of beam modifying devices. Use of wedges, shields and tissue compensators-Use of beam directional devices,

Beam directed radio therapy principles and practice. Steps involved in beam directed radio therapy. Setup of single, multiple fields

2D planning, X-ray based treatment planning of common malignancies given in Radiotherapy- I Bony land marks for field placement.

Mantle field planning. Radiotherapy in pregnancy Radiotherapy in pediatric cancers
Oncological Emergencies, role of radiotherapy
Practical experience with care of radiotherapy machines. Care of machine Handling emergencies in Teletherapy
Electron beam therapy clinical applications: Moving beam therapy, Total and Hemi Body Irradiation, Total Skin Electron therapy

Brachytherapy: Principle of brachytherapy, interstitial-intra cavitary-surface mould, intra luminal, Image Guided Brachytherapy/Integrated Brachytherapy, Clinical Applications of brachytherapy, the principles of pre-loaded and after loaded techniques, Dose-rate effects in Brachytherapy, HDR, LDR, PDR,

Imaging protocols: development and implementation, Cone Beam CT: kV-CBCT, MVCBCT, Non-action levels(NAL), On-line/off-line corrections, Matching/co-registration procedures, Geometric uncertainties,

Treatment Planning: Target volume, Organs at risk, Tumor dose, Mean, maximum, minimum, Number of fractions, Normal tissue tolerance Dose, prescription, Patients treatment charts, ICRU guide lines for target volume delineation and concept of GTV/CTV/PTV and ITV.

3D CRT, IMRT/VMAT, Helical Tomotherapy, Total Body Radiation, Intraoperative radiotherapy

Conformal treatment planning of common malignancies given in Radiotherapy Part1I
Adaptive radiotherapy
Radio Immunotherapy
Special techniques in Radiation Therapy, (SRT) – Stereo tactic Radio surgery (SRS) –Methods – BRW and CRW frames – angiographic localizer box – preparation of target sheets – Quality Assurance – Isocentric check–Treatment execution–care to be taken –check list

Recent developments in radiotherapy and treatment techniques: Proton therapy and carbon ion therapy, artificial intelligence in Radiotherapy

Practical

Preparation of mould for head & neck case.
Preparation of Mould for Pelvis case.
Study of mould room equipment in Radiotherapy.
Preparation of customize shielding block.
Preparation of patient set-up in SAD technique.
Conduct image fusion at the treatment machine console
Do bony matching
Do soft tissue matching for estimating the preliminary data for applying s shifts
Prepare documentation

PAPER X
RADIATION PHYSICS II

In this paper, the students learn physics of various machines used for therapy Basic Treatment planning techniques used by physicists and about the accessories used along with radiotherapy equipment such as on-board imaging, dosimetry accessories, use of computers in RT and various types of networking used in RT:

Clinical radiation generators: introduction. Kilo Voltage Machines, Vandegraff generators, Betatron, Cyclotron, Synchrotron, microtron, Neutron Generators.

Teletherapy Machines: Introduction, machines using radionuclides, production, and properties of telecobalt sources, telecobalt units, source housing, shutter mechanisms, beam collimation, penumbra, source transport mechanism, advantages, and disadvantages of telecobalt machines.
Linear accelerators: Introduction, linear accelerator systems, Construction, production of electron and X-ray beam, magnetron, clystron, treatment head, penumbra, target, scattering foil, beam flattening filter, beam collimation, gantry, Electron cones, FFF. Laser systems.

Radiotherapy with Protons, Neutrons, and heavy charged particles

Dose distribution and scatter analysis (Qualitative Only): Phantoms, Inverse Square Law, depth dose parameters, percentage depth dose, tissue air ratio, backscatter factor, tissue maximum dose tissue phantom ratio, scatter air ratio, variations with field size, depth, quality of beams, penumbra, equivalent square Fields, SSD and SAD techniques.

Beam Modifying Devices -Wedge filters, wedge factors. Bolus, beam shaping blocks, tissue Compensators, correction for contour irregularities and tissue inhomogeneity

Total body irradiation MLC -beam direction devices – front and back pointer Irregular fields, Radiation field analyser.
Introduction to treatment planning (Basics Only): 2D and 3D planning, isodose charts, isodose curves, combination of radiation field, parallel opposed fields, edge effect, multiple fields. computerized treatment planning system
ICRU volumes-GTV,CTV,PTV,OAR
Dose volume histograms - treatment simulation –Virtual simulation - treatment verification – Electronic portal imaging devices-contour irregularities-correction for field shaping–geometric separation of adjacent fields.
EPID and other on-board imaging systems, Record and Verify Systems, Oncology Information Systems, Image/Patient data archiving, storage and transfer.

CT Simulator
Electron Beam therapy (Qualitative Description only), Introduction, electron beam characteristics, treatment planning, field shaping, electron arc therapy, total skin irradiation.

Brachytherapy Physics: Brachytherapy-Introduction, Brachytherapy sources production and properties, types of sources needles, tubes and wires, source specifications, Classification of Brachytherapy techniques-surface mould, intra cavitary, interstitial and intraluminal, Intraoperative, Endovascular techniques, remote after loading. Qualitative description of implant dosimetry systems-Patterson parker system, Quimby system, memorial system, Paris system, dose spec2if5ication for cancer of cervix- Manchester system, ICRU system. Brachytherapy Machines, Qualitative description of Low dose rate(LDR),Medium Dose rate(MDR)high dose rate (HDR) and pulsed doserate(PDR) brachytherapy. HDR units, prostate implants

Special Procedures and Techniques in Radiotherapy(Qualitative Description only):3DConformal radiotherapy-introduction, imaging data, 3D CRT techniques

IMRT-Introduction, IMRT systems-fixed gantry angle, tomotherapy, IMRT with rotating cone beams. Stereotactic radio therapy and radio surgery- Introduction, SRS techniques, x knife, gamma knife. IGRT-Introduction, IGRT technologies, management of respiratory motion.
Proton therapy- Introduction, basic physics, Bragg peak, Proton beam delivery systems
Nuclear Medicine: Introduction Biological, Physical and effective half-lives-specific activity-
Radioisotopes used for Therapy

Practicals:

Study of Record and Verify system in External Radiotherapy.
Study of operational safety mechanism of Medical Linear
Accelerator. Congruence between light field and radiation field
Online verification of patient set-up(Head&Neck)by On Board Imager(OBI) Online verification of patient set-up(Pelvic)by OBI
Daily Quality Assurance in Cobalt unit/Remote Afterloader Brachytherapy Unit
Study of difference between SSD&SAD technique.
Demonstration of Parallel opposed technique with dose to one critical organ measurement
Four field technique with dose to one critical organ measurement

Paper XI

RADIOLOGICAL PROTECTION AND STATUTORY ASPECTS

The radiation therapy needs to be carried out carefully as per the regulatory requirements of the country. This paper consists of syllabus pertaining to safety requirements for RTT course as per Atomic Energy Regulatory Board, Govt of India.

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.
Interaction of Radiation with Matter: Photoelectric effect, Compton Effect, Pair production, Ionization 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

Radiation Quantities and Units: Radioactivity, Flux, Fluence, Kerma, Exposure, Absorbed Dose, Equivalent Dose, Weighting Factors, Effective Dose, Natural Background Radiation, Occupational Exposure Limits, Dose limits to Public.

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 tele therapy and Brachytherapy), Planning consideration for radiology and/or radiotherapy installation including work load, use factor & occupancy factors, effect of different shielding material.

Biological effects of radiation: The Cell, Effect of ionizing 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,LD50/60.

Detection and measurement of radiation & measuring instruments: Ionization of gases, Fluorescence and phosphorescence, Effect on photographic emulsion, Ionization 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.

Basic Radiation Therapy Physics: Historical developments in Radiotherapy, Physical components of Telecobalt Unit / Linear Accelerator Unit / Remote After Loading Brachytherapy Unit / Gamma Knife Unit / Simulator and their descriptions, Various types of sources used in Radiotherapy and their properties, Physics of Photons, electrons, protons and neutrons in radiotherapy, 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, Port

film, processing and development, Special techniques in Radiotherapy such as SRS, SRT, IMRT, IGRT and Tomotherapy.

QA in Radiotherapy: Accessories and tools used for QA tests in Radiotherapy such as Front pointer, Backpointer, Laser Alignment etc. Optical and radiation field congruence, Beamshaping 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.

Radiation Emergency Preparedness: Safety and security of radiation sources, case histories of emergency situations and preparedness, equipment 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.

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

International agencies of Radiation Protection: ICRP, WHO, IAEA and their role, ICRP Recommendations (Brief)

Demonstration:

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

FOURTHYEAR:

Posting in Radiotherapy, Radiation Physics, Radiodiagnosis, and other departments as per section2.6

2.11 Project Work

In fourth year, the students will be posted for internship in attached hospital of the institution and to carry out project work simultaneously. Hospital posting as well as project work must be substantiated with bona fide records duly signed by the designated faculty members concerned. Submission of a Project work is a compulsory requirement. Each student can choose a topic for the project, in any one of the subjects related to Radiotherapy. The supervising Teacher should have minimum 3years fulltime teaching experience in the concerned subject. The student under the guidance of the supervising staff, should carry out the work on the topic selected and prepare a project report including results and references of not less than 1000 words which will be handed over to the supervisor or trainer. The report can include objective, scope of the project and an in-depth report. It

is to be approved by the HOD and submitted to university. The general/specific guidelines of the University(KUHS) are to be followed for the format and style of the project/thesis/dissertation synopsis/protocol submission

2.12 No: of hours per subject: As given in clause 2.6

2.13 Practical training: As given in clause 2.6

2.14. Records: Records should be maintained for each exercise done in the practical laboratory for every subject and duly signed by the supervising teacher should be submitted at the time of university practical examination.

2.15 Dissertation: Not applicable

2.16 Prescribed/recommended text books for each subject

Text Books

Christensen's Physics of Diagnostic Radiology by Thomas Curry
Radiographic Imaging- Chesney& Chesney,
Care of patient in diagnostic Radiography -Chesney&Chesney.
Clarks Positioning in Radiography Imaging by Stewart Whitley etal
Recent advances in Radiology and Medical Imaging" Lodge &Steiner
Interventional Radiology-Principles and Techniques by J Ring and Mclean
Radiation Protection in Hospitals. Richard F .Mould
Perez &Brady's Principles and Practice of Radiation Oncology
The Physics of Radiation Therapy Faiz M. Khan and John P.Gibbons
Practical Radiotherapy Planning by Dr. JaneDobbs ,Professor Ann Barrett et al
Radiobiology for the Radiologist by Eric J. Hall,
Clinical Radiation Oncology Leonard L.Gunderson and, Joel E.Tepper
Treatment planning& dose calculation in radiation oncology Gunilla Carleson Bentel
Fundamental Physics of Radiology W. J. MeredithJ. B. Massey
Electronic Devices and circuits. Salivahanan &N. S.Kumar,3rd Ed.,Tata Mc-Graw Hill
A text book in Electrical Technology-BLTheraja-SChand &Co.
Introductory nuclear Physics by K enneth S.Krane (WileyIndiaPvt .Ltd.,
Concepts of Modern Physics, Arthur Beiser, McGraw-Hill
Electricity and Magnetism, DC Tayal, Himalaya Publishing House.
University Physics. FW Sears, MW Zemansky and HD Young13/e, Addison-Wesley
Law and ethics in medical practice: An Overview.2003;8. Available from
www.fmshk.org/article/746.pdf.
Standards of practice for ACT Allied Health Professionals2005

Other materials to study

AERB safety Codes for Diagnostic Radiology, Radiotherapy, Nuclear Medicine
Atomic Energy Act and Radiation Protection Rules, Govt of India

2.17. Logbook: A log book has to be maintained by all students and this has to be reviewed by the HOD of the department periodically. Periodic assessment has also to be done in the department by the teachers. Logbook is to be submitted at the time of practical examination for perusal by examiners

a) Model of Log Book

LOG BOOK OF B.Sc.(RTT)

1. Name…….

2. Roll No.

3. Address

4. Details Of Posting: To Be Signed By The Supervising Teacher

   - Radiotherapy
   - Radiation physics
   - Nuclear Medicine
   - Imageology/Radiology
   - Others

5. Participation Conferences–CME Programmes.

6. Details of Leave Availed.

7. Details of Participation in Academic Programmes.

8. Seminars/Symposia Presented

9. Journal Clubs

10. Special Duties (If Any)

11. Miscellaneous

12. Daily Activities Record (Blank Pages)

    (Four Page for Each MonthX48MonthPages)

Signature of Student:

Signature of Supervising Teacher:

Signature of Head of Division/Co-coordinator of the course:

3. EXAMINATIONS

3.1 Eligibility to appear for exams

No candidates shall be admitted to any year of B.Sc (RTT) examination unless he/she has a minimum of 80% attendance with the provision for one time condonation up to 5% on medical grounds (condonable limit 75%). Condonation for shortage of attendance shall be vested with a committee constituted by the Principal/Head of Institution, with the Principal/ Head of Institution as the Chairman and five members (senior teachers) in the committee, and remittance of required fee to the University. A candidate who has not attained 80%attendance and the shortage is beyond the condonable limit he/she shall not be eligible to continue the course with the same batch of students. He/ She may obtain special sanction (Condonation of Break of Study) from the institution and the university to continue with the junior batch of students. Those who obtain 50% of aggregate in each paper towards internal assessment will be eligible for appearing the university examinations.

3.2 Schedule of Regular/Supplementary exams

Every year there shall be an examination to examine the students. Each examination may be held twice a year. The first examination in a year shall be the annual examination and the second examination shall be supplementary examination.
The examinations shall be of written and practical /viva voce) carrying maximum marks for each part of a subject

First year	
Paper-I	**Anatomy**
Paper-II	**Physiology**
Paper III	**Pathology**
Paper IV	**General and Nuclear Physics**
Paper V	**Foundation Course**

No University examination and only internal examination for Paper V
No Practical examination for Paper I,II,III,IV,V

Second year	
Paper VI	**Radiation Physics I**
Paper VII	**Radiotherapy I**
Paper VIII	**Radiological, Nuclear Medicine, Other Imaging Techniques**
No Practical and only viva voce examination for Paper VI,VII,VIII	
Third year	
Paper IX	**Radiotherapy II**
Paper X	**Radiation Physics II**
Paper XI	**Radiological Protection and statutory aspects**
Practical examination for Paper IX and X will be one day for each paper. Only viva voce examination for Paper XI	
Fourth year	
Project	Should be submitted for evaluation in the fourth year B.Sc.(RTT)and shall Be valued by the university examiners in the final year.

3.3 Scheme of examination showing maximum marks and minimum marks

FIRST YEAR EXAMINATION

(Max-Maximum and Min-Minimum for a pass, NA-not applicable)

Paper and Subjects	Theory						Practical						Grand Total	
	University		Internal		**Total**		University		Viva voce		**Total**			
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
Paper I Anatomy	100	50	50	25	150	75							150	75
Physiology II	100	50	50	25	150	75							150	75
Paper III Pathology	100	50	50	25	150	75							150	75
Paper IV General and Nuclear Physics	100	50	50	25	150	75							150	75
Paper V Foundation Course			100	50	100	50							100	50
Total	400		300		700	350							700	350

SECOND YEAR EXAMINATION

(Max-Maximum and Min-Minimum for a pass, NA-not applicable)

Paper and Subjects	Theory						Practical						**Grand Total**	
	University		Internal		**Total**		University		Viva voce		**Total**			
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
Paper VI (Radiation Physics I)	100	50	50	25	150	75			50	25	50		200	100
Paper VII (Radiotherapy I)	100	50	50	25	150	75			50	25	50		200	100
Paper VIII Radiological,Nuclear Medicine, Other Imaging Techniques	100	50	50	25	150	75			50	25	50		200	100
Total Marks	300	150	150	75	450	225			150				600	300

THIRD YEAR EXAMINATION

(Max-Maximum and Min-Minimum for a pass, NA-not applicable)

Paper and Subjects	Theory						Practical						Grand Total	
	University		Internal		Total		University		Viva voce		Total			
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
Paper IX (Radiotherapy II)	100	50	50	25	150	75	100	50	50	NA	150	75	300	150
Paper X (Radiation Physics II)	100	50	50	25	150	75	100	50	50	NA	150	75	300	150
Paper XI (Radiological Protection And statutory aspects)	100	50	50	25	150	75			50		50	25	200	100
Total Marks	300	150	150	100	450	300	200	100	150	NA	350	175	800	400

FOURTH YEAR EXAMINATION

Project and viva voce shall be valued by the university examiners in the final year.

Max-Maximum, Min-Minimum for a pass

PAPER		Postings and Project Work	
		Max	Min
	Project+ Posting (Viva Voce)	350	175
	Project Report	50	25
	Total Marks for Fourth Year	400	200

Total Marks for the whole course: **2500**

3.4 Model question paper for each subject with question paper pattern

All the question papers should be of standard type. Each theory paper will be of 3 hours' duration with a maximum of 100 marks. It predominantly consists of brief-answer- type questions and essay type questions,

MODEL QUESTION PAPERS

QP
CODE: Reg.No……

Name……

FIRST YEAR B.Sc.(RTT) DEGREE EXAMINATION 20…

Paper I

ANATOMY

Time3Hours **MaxMarks:100**

Answer all Questions.

Draw Diagrams where ever necessary.

Essay **(2x15=30)**

1. Describe the gross anatomy of lung. Mention the various structures at the right hilum and their relationships.
2. Name the paranasal sinuses. Describe the anatomy of maxillary sinus.

Short notes: **(8x5=40)**

3. Corpus callosum
4. Stomach
5. Spleen
6. Mediastinum and contents
7. Knee joint
8. Anal canal
9. Gallbladder
10. Middle ear

Answer briefly: **(10x3=30)**

11. Simple epithelium
12. Neuron

13. Haversian system
14. Fertilization
15. Carpal bones
16. Cardiac muscle
17. Mandible
18. Structure of lymph node
19. Mesentery
20. Palatine tonsil

QPCODE:

Reg.No……

Name……

FIRST YEAR B.Sc.(RTT)DEGREE EXAMINATION 20….

Paper II
PHYSIOLOGY

Time3Hours **MaxMarks:100**

Answer all Questions.

Draw Diagrams wherever necessary.

Essay **(2x15=30)**

1. Describe the stages of red blood cell formation
2. Name the 12 cranial nerves. Describe the functions of any two of them in detail

Short notes: **(8x5=40)**

3. Functions of insulin.
4. Digestion of fats.
5. Cardiac cycle.
6. Types of hypoxia.
7. Leukopenia and its clinical significance.
8. Menstrual cycle.
9. Non-respiratory functions of lungs.
10. Composition of semen.

Answer briefly: **(10x3=30)**

11. Functions of thrombocytes
12. Functions of mineralo corticoids
13. Ovulation

14. Anti-diuretic hormone
15. Functions of Gallbladder
16. Functions of progesterone
17. Cretinism
18. Cryptorchidism
19. Functions of kidney
20. Primary taste sensations

QPCODE: Reg.No……

Name……

FIRSTYEAR B.Sc.(RTT)DEGREEEXAMINATION…20

Paper III PATHOLGY

Time3Hours **MaxMarks:100**

Answer all questions

Draw Diagrams where ever necessary

Essays: **(2x15=30)**

1. Describe five important characteristics of a malignant cell. Discuss the differences between benign and malignant tumors.
2. What are renal calculi? Describe the etiology, pathogenesis, types and effects of renal calculi.

Short notes: **(8x5=40)**

3. Morphological features of tuberculous infection
4. Pathogenesis of thrombosis
5. Pathogenic calcification
6. Gross and microscopy of infective endocarditis
7. Gross and microscopy of peptic ulcer
8. Breast Cancer
9. Fibro adenoma
10. Microcytic, hypochromic anemia

Answer briefly: **(10x3=30)**

11. Papillary carcinoma thyroid
12. Osteomyelitis
13. Psoriasis
14. Nephrotic syndrome
15. Chronic myeloid leukemia
16. Leiomyomauterus
17. Acute appendicitis
18. Chroniccholecystitis
19. Hydrocele
20. Asthma

QPCODE: Reg.No……

Name……

FIRST YEAR B.Sc.(RTT)DEGREEEXAMINATION 20

Paper III

General and Nuclear physics

Time:3Hours **MaxMarks:100**

Answer all Questions.

Draw Diagrams wherever necessary.

Essay: (2x15=30)

1. Explain in detail of, working of Moving coil Galvanometer.
2. What is nuclear reactor?Explain in details of construction and working.

Short notes: (8x5=40)

3. Describe electromagnetic radiation
4. Explain the formation of the depletion region in an open circuited PN junction.
5. Derive the differential equation of angular SHM in case of compound pendulum
6. What are the properties of complex numbers
7. State the principle and types of transformer.
8. Define the electromagnetic induction. State Faraday's laws of electromagnetic induction.
9. What do you mean by doping state the necessary condition for doping and methods of doping
10. Describe nuclear reactions

Answer briefly: (10x3=30)

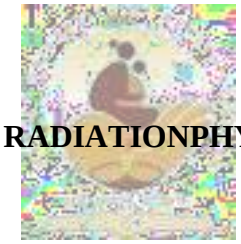
11. Define current and voltage. Give its SI units.
12. What is lens law.
13. Mention one assumption of DE Broglie's relation.
14. Define Capacitance

15. What are super conductors and their use?
16. Obtain the expression for self-inductance.
17. Distinguish between single and three phase circuits.
18. A100Hz AC is flowing in 15mHcoil.Find its reactance.
19. Define conductor and insulator on the basis of electrical conductivity. Give its examples
20. Define time constant for growth of charge in R-Circuit.

QPCODE: Reg.No……

Name……

SECOND YEAR B.Sc.(RTT)DEGREEEXAMINATION…



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Paper VI RADIATIONPHYSICS I

Time3Hours **MaxMarks:100**

Answer all Questions.

Draw Diagram wherever necessary.

Essays: **(2x15=30)**

1. Describe the components of an X-ray tube with the help of a neat diagram. Explain the functions of each component.
2. What is mammography? Explain the importance of heavy metal filters in mammography X-ray unit.

Short notes: **(8x5=40)**

3. Structure of an X-ray film and explain emulsion layer.
4. Self-rectification
5. What is photoelectric effect? Explain its importance.
6. G.M.Counter
7. Potter Bucky grid.
8. Digital radiography
9. Basic principles of radiation detection
10. Calculate the optical density of an x-ray film if the percentage of light transmitted by it is 50%.

Answer briefly: **(10x3=30)**

11. Thermionic emission

12. Heel effect

13. Dose and KERMA

14. CT generation

15. OPG

16. Speed of a film

17. Exposure rate constant

18. Subject contrast

19. Energy to mass conversion interaction

20. Grid ratio.

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QPCODE: **Reg.No……**

Name……

SECOND YEARB.Sc.(RTT)DEGREEEXAMINATION… 20

Paper VII
RADIOTHERAPY I

Time3Hours **MaxMarks:100**

Answer all Questions.

Draw Diagrams wherever necessary.

Essays: **(2x15=30)**

1. Howwouldyouinvestigateandtreatapatientofcarcinomaesophagusmiddlethird. Explain various techniques of radiation.
2. Describe pathology and staging of carcinoma cervix and discuss the management

Short notes: **(8x5=40)**

3. Cranio spinal radiation.
4. Neuroblastoma
5. Cell survival curve
6. Mammography
7. Bone marrow toxicity following chemotherapy.
8. SVC syndrome
9. Beam modifying devices
10. Beam Directed Therapy

Answer briefly: **(10x3=30)**

11. Staging of Hodgkin's lymphoma

12. Radio protectors and sensitizers
13. Oncogenes
14. Spinal cord compression
15. HDR Brachytherapy
16. Simulator
17. Gamma knife
18. Hormonotherapy in carcinoma prostate
19. bolus
20. Carcinoma cervix stage I IIB.

QPCode: **Reg.No……**

Name……

SECOND YEAR B.Sc.(RTT)DEGREEEXAMINATION20…

PAPERVIII

RADIOLOGICAL ,NUCLEARMEDICINE AND OTHERIMAGING TECHNIQUES

Time:3hrs **MaxMarks:100**

Answer all Questions.

Draw Diagrams wherever necessary.

Essays **(2x15=30)**

1. Discuss on CT imaging and its applications.
2. Discuss the radiological anatomy of hip joint and various projections to demonstrate hip joint.

Short Notes **(8X5=40)**

3. Contrast Media
4. MRI
5. Grids in radiography.
6. Development of film after exposure.
7. Unsharpness in radiography.
8. Replenisher in film processing.
9. Darkroom design.
10. Developer chemistry.

Answer briefly **(10x3=30)**

11. Double coated films in radiology.
12. Digital Radiography
13. Fixer chemistry.

14. PACS

15. Apical view of chest.

16. Fog in x ray film.

17. Precautions for a woman coming for radiography.

18. Fluoroscopic screens.

19. Mammography.

20. Collimators.

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QPCODE: Reg.No……

Name……

THIRD YEAR B.Sc.(RTT)DEGREEEXAMINATION20

Paper IX
RADIOTHERAPY-II

Time3Hours **MaxMarks:100**

Answer all questions

Draw Diagrams wherever necessary

Essays: **(2x20=40)**

1. Describe the staging of Carcinoma Nasopharynx. Discuss in detail the steps of radiotherapy planning ,portals with special emphasis on newer modalities.
2. What are the different types of brachytherapy and explain brachytherapy in the case of carcinoma cervix.

Write briefly: **(6x10=60)**

3. Short notes on
   a) Role of radiation in Hodgkin's lymphoma and technique of mantle field irradiation.
   b) IMRT
4. Short notes on
   a) Stereotactic radiotherapy and surgery
   b) Cranio-spinal irradiation.
5. Treatment of Ca breast stage IIIB with explaining Radiotherapy planning and newer trends.
6. Describe in detail Simulation in Radiotherapy.
7. Indication and techniques of cranio-spinal irradiation

8. Role, techniques, and side effects of radiation in carcinoma of esophagus.

QPCODE: Reg.No……

Name……

THIRD YEAR B.Sc.(RTT)DEGREEEXAMINATION 20

Paper X
RADIATIONPHYSICS-II

Time: 3Hours **MaxMarks:100**

Answer all questions

Draw Diagrams wherever necessary

Essays: **(2x20=40)**

1. Compare various characteristics of Ion chamber, Proportional counter, and GM counter.
2. Explain angular distribution of X-ray in thin and thick target. What is a transmission target and what are the materials used for the same. How do we obtain a useful electron beam from a LINAC?

Write briefly: **(6x10=60)**

3. Short notes on
   a) Wedge filters.
   b) Define wedge angle and Hinge angle with suitable equations.
4. What is isodose chart? How do you measure isodose curves? What is the difference between an SSD chart and SAD chart?
5. Explain with neat diagram the construction and working of medical linear accelerator.
6. Briefly describe Electronic portal imaging devices.
7. Briefly describe MLC ,its composition and its properties.

8. Explain the differences between 3DCRT, IMRT, IGRT.

QPCODE: Reg.No……

Name……

THIRD YEAR B.Sc.(RTT)DEGREEEXAMINATION20

Paper XI

RADIOLOGICAL PROTECTION AND STATUTORYASPECTS

Time: 3Hours **MaxMarks:100**

Answer all questions

Draw Diagrams wherever necessary

Essays: **(2x20=40)**

1. Define HVL and TVL and derive the relation between them.
2. Radiation safety aspects of Telecobalt room design.

Write briefly: **(6x10=60)**

3. Short notes on
   a) Explain the principle of ALARA
   b) Equivalent Dose
4. Write short notes on
   a) Pocket dosimeters
   b) TLD
5. Distinguish between tissue weighting factors and radiation weighting factors.
6. Basic Principles of Radiation Protection
7. Draw a LINAC room layout and label it.
8. DiscussvariousmethodsforreducingpatientexposuresinDiagnosticRadiology

9. Effective Dose limits

10. ALARA principle

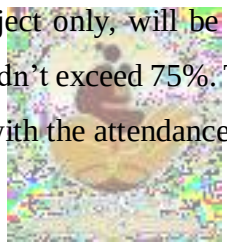
11. Safety Aspects of Brachytherapy room

12. Quality assurance of Telecobalt machine

4.0 Internal assessment component

Sl.No	Items	Maximum. Marks	Splitup
1	Attendance	5	96%andabove- 5marks 92.1%–95.9% - 4marks 88.1%–92% - 3marks 84.1%–88% - 2marks 80%-84% - 1mark
2	Assignments	20	Must be hand written. Valuation is based on content, presentation, and originality. Plagiarism will not be accepted and treated seriously and those assignments will be rejected.
4	Class tests and viva	25	The affiliated colleges shall conduct at least three internal examinations/tests in each subject. Marks in best out of 2 examinations shall be taken for internal assessment. However model examination is mandatory.
TOTAL		50	

The maximum marks of internal assessment in each paper will be 50. Those who obtain 50% of aggregate in each subject only, will be eligible for appearing the university examinations. The class average shouldn't exceed 75%. The internal assessment marks should be intimated to the University along with the attendance and application.



5. Details of practical/clinical practicum exams

See clause 3.3

6. Number of examiners needed (Internal & External) and their qualifications

See clause 7.2(annexure)

ANNEXURES

7.1 Checklists for Monitoring: Seminar Assessment etc.to be formulated by the curriculum committee of The concerned Institution

7.2 Institutional Requirements

The institution and the Departments

The Institution should have well-established Departments/divisions of Radiotherapy, Medical/Radiation Physics with all radiation measuring tools required for calibration of equipment and radiation protection, diagnostic radiology- all should be AERB licensed. The institution should also have other clinical and preclinical departments to impart training.

Teacher Student Ratio

	Teacher: student
Professor/Associate Professor/Reader	1:10
Assistant Professor	1:5
In each of the departments of Radiotherapy, Radiation physics and Nuclear Medicine and radio diagnosis taken together.	

7.2.1 Qualification of Teachers, Examiner and Guide.

Qualifications of Teacher in concerned specialties

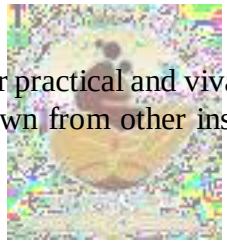
Master's Degree in the concerned subject (MD/DNB) approved by the Kerala University of Health Sciences and Government of Kerala

Dip RP or MSc Medical/Radiation Physics and RSO approved by the Kerala University Of Health Sciences, AERB and Government of Kerala

MSc RTT approved by the Kerala University of Health Sciences and Government of Kerala.

Qualification of Examiner

There shall be two examiners for practical and viva voce–one internal and one external. The external examiner shall be drawn from other institutions where a similar course is being



conducted. Both internal and external examiners should have qualification as specified in section 7.2.1 and those who are fulltime teachers of the concerned specialty with at least two years teaching experience in concerned specialty after acquisition of Master's Degree qualification in the concerned subject. The theory papers should also be evaluated by teachers with above qualifications.

3. Qualification of Guide for Project.

The supervising Teacher should have minimum 3 years' full time teaching experience after acquisition of Master's Degree in the concerned subject.