



PRAVARA INSTITUTE OF MEDICAL SCIENCES (DEEMED TO BE UNIVERSITY)

**Loni, Tal. Rahata, Dist. Ahmednagar 413736
NAAC Re-accredited with 'A' Grade**

SYLLABUS

Degree Programme - Bachelor of Science in Radiotherapy Technology (B.Sc. RTT) (Department of Radiation & Oncology) (Academic Council Meeting Dated 6th September , 2019)

CONTENT

SECTION I- RULES AND REGULATIONS FOR B.Sc. RTT PROGRAM

1. Nomenclature of Degree

Bachelor of Science in Radiotherapy Technology (B.Sc. RTT).

2. University

Pravara Institute of Medical Sciences, Deemed University

3. Constituent unit

Department Of Radiotherapy & Oncology, Rural Medical College.

4. Faculty

This program is offered under the "Faculty of Allied Health Sciences"

5. Pattern of the program

The program adopts semester system.

6. Background of the program

This program has been specially designed to meet the ever increasing demand for well trained personnel with advanced & appropriate skills and knowledge of Medical Radiology and Imaging Technology.

7. Duration of the Program

Duration of this program will be three academic years with six semesters and one year rotational internship.

8. Medium of instruction- English

9. Program Objective

At the completion of this course, the student should be –

1. Able to execute all routine radio therapeutic procedures as per prescription and direction of Radiation Oncologist.
2. Able to operate the radiotherapy equipment used in treatment of cancer patient independently and maintain the equipment under the guidance of Medical Physicist.
3. Able to demonstrate and apply adequate knowledge about the safe handling of medical radiation sources, keeping in mind the radiation protection of staff, patients and public.
4. Able to demonstrate patient management skills.

Expectation from the future graduate in the providing patient care.

1. The coursework is designed to train students to work in conjunction with radiation oncology team including radiation oncologist, medical physicists and other members, in the application of prescribed doses of ionizing radiation for the treatment of malignant or benign disease.
2. Course work includes physics, anatomy and physiology, dosimetry, clinical oncology and radiation safety. The student will be skilled in management, administration of prescribed radiation treatment, and provisions of patient support.
3. Employment opportunities can be found in hospitals in both private and public sectors as well as in independent cancer treating centers.
4. 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.
5. RTT graduate is encouraged to pursue further qualification to attain senior position in the professional field, also to keep abreast with the advances and new technology, the professional should opt for continuous professional education credits offered by national and international institutes.

10. Eligibility for admission -

- Candidate should have passed 10 + 2 with science (PCB). Minimum percentage of marks: 50 % aggregate (45 % for Reserved Category Students).
- The students holding graduate degree in science/technology will be given preference for selection during admission procedure.

11. Selection Procedure

- Admissions will be purely on merit basis, aggregate marks obtained in the qualifying examination will be considered for deciding the merit. In case of equal marks in qualifying exam, the marks for PCB group will be compared for deciding merit.
- The selection procedure will be decided by the university from time to time and will be followed for the selection of candidates.

12. After Selection procedures

- After selection students have to report to the college and submit all necessary documents and pay the desired fees as applicable.
- Annual calendar and schedule will be announced by the university based on the inputs received from Rural Medical College.

13. Procedure for Cancellation of admission

A candidate who has confirmed the admission may cancel it by submitting an application to the Dean, Rural Medical College through HoD, Dept. of Radiation Oncology. The admission will be cancelled as per the rules applicable from time to time and as decided by the university.

14. Program structure

Subject code	Title of Paper/ Practical	Subject code	Title of Paper/ Practical
SEMESTER I		SEMESTER II	
BRTT 101	Introduction to National Healthcare System	BRTT 201	Basic Radiation Physics
BRTT 102	Basic computers and information science	BRTT 202	Conventional Radiography and equipment

BRTT 103	Introduction to Quality and patient safety	BRTT 203	Radiographic and Image processing Techniques
BRTT 104	Human Anatomy and Physiology Part 1	BRTT 204	English & Communication skills
BRTT 105	Practical's-I based on BRTT 101 to BRTT 105	BRTT 205	Practical's-II based on BRTT 201 to BRTT 205
BRTT 106	Medical terminologies, Medical Law and Ethics		
SEMESTER III		SEMESTER IV	
BRTT 301	Radiation Quantities and units	BRTT 401	Radiotherapy Equipment-II
BRTT 302	Oncology Science I & II	BRTT 402	Principles of Radiation therapy
BRTT 303	Radiotherapy Equipments I	BRTT 403	Basic radiotherapy physics
BRTT 304	Patient care, positioning and immobilization	BRTT 404	Biological Effects of Radiation
BRTT 305	Practical's-III based on BRTT 301 to BRTT 305	BRTT 405	Practical-IV

	SEMESTER V	SEMESTER VI	
BRTT 501	Clinical Radiobiology	BRTT 601	Radiological/Nuclear medicine/ Other Imaging techniques in Radiotherapy Planning
BRTT 502	Mould room/ Motion Management	BRTT 602	Radiotherapy Treatment Delivery.
BRTT 503	Special RT Techniques and Recent advances	BRTT 603	Operational Issue in Radiotherapy
BRTT 504	Quality assurance in Radiotherapy	BRTT 604	Radiation safety
BRTT 505 Practical's-V and Research projects			
SEMESTER VII		SEMESTER VIII	
Internship		Internship	

15. Attendance/Leave/Vacation

The student must meet the requirement of 75% attendance per semester per course for granting the term. The teacher handling a course shall be responsible for maintaining a record of attendance of students who have registered for the program.

All other rules pertaining to the public holidays, Diwali/summer vacation and preparatory leaves will be as per the university guidelines effective from time to time.

16. Assessment/Examination

The final total assessment of the student shall be made in terms of an internal assessment and an external assessment. The internal and external assessment will constitute combine head of passing. For each paper meant for University evaluation, the ratio of marks for internal assessment in relation to external assessment shall be 30:70. The schedule of both the Internal and university examination will be communicated to the students through the academic calendar before starting the semester.

17.1- Internal Assessment (IA).

IA forms the Formative Assessment component of evaluation. It is structured to elicit the Students' domain knowledge, analytical and creativity skills. The IA for each paper will be conducted for 30 marks for theory and 60 marks for practical. The internal assessment will be conducted before the university examination of respective semester. The marks of the IA will be communicated to the university as per the time frame decided by the university. The marks awarded by a teacher in the internal evaluation shall be immediately communicated to the student. In order to appear for university examination students must secure minimum 35% in internal assessment of respective course. The subject BRTT 112 Medical terminologies, Medical Law and Ethics and BRTT 412 Environmental Studies will be assessed as internal subjects for 100 marks and the result will be communicated to the university. These subjects will be shown as Pass/Fail or grades will only appear on the final mark sheet. However, in order to appear for final year examination, the students must pass these subjects.

17.2- External/University Assessment.

The university assessment for theory subjects shall be based upon the written examination to be held at the end of each semester. The written examination will be conducted for 70 marks for theory and 140 marks for practical by the university. The schedule of the examination will be communicated by the university well in advance.

17. Scheme of Examination.

The distribution of the marks for all the courses under B.Sc. RTT will be as follows.

Subject code	Title of Paper/ Practical	Marks		
		Internal	External	Total
	Semester I			
BRTT 101	Introduction to National Healthcare System	30	70	100
BRTT 102	Basic computers and information science	30	70	100
BRTT 103	Introduction to Quality and patient safety	30	70	100
BRTT 104	Human Anatomy and Physiology Part 1	30	70	100
BRTT 105	Practical's-I based on BRTT 101 to BRTT 105	60	140	200
		Total Marks		600
BRTT 106	Medical terminologies, Medical Law and Ethics <i>(This course will be assessed through internal examination, however passing in this subject is compulsory in order to appear for final year examination)</i>	100	
	Semester II			
BRTT 201	Basic Radiation Physics	30	70	100
BRTT 202	Conventional Radiography and equipment	30	70	100

BRTT 203	Radiographic and Image processing Techniques	30	70	100
BRTT 204	English & Communication skills	30	70	100
BRTT 205	Practical's-II based on BRTT 201 to BRTT 205	60	140	200
		Total Marks		600
	Semester III	Internal	External	Total
BRTT 301	Radiation Quantities, Units and Detection/Measurement	30	70	100
BRTT 302	Oncology Science I & II	30	70	100
BRTT 303	Radiotherapy Equipments I	30	70	100
BRTT 304	Patient care, positioning and immobilization	30	70	100
BRTT 305	Practical's-III based on BRTT 301 to BRTT 305	60	140	200
		Total Marks		600
	Semester IV	Internal	External	Total
BRTT 401	Radiotherapy Equipment-II	30	70	100
BRTT 402	Principles of Radiation therapy	30	70	100
BRTT 403	Basic Radiation therapy Physics	30	70	100
BRTT 404	Biological Effects of Radiation	30	70	100
BRTT 405	Practical-IV Based on 401-404	60	140	200
Total Marks 600				
	Semester V	Internal	External	Total
BRTT 501	Clinical Radiobiology	30	70	100
BRTT 502	Mould room / Motion Management	30	70	100

BRTT 503	Special RT Techniques and Recent advances	30	70	100
BRTT 504	Quality Assurance of RT Equipments	30	70	100
BRTT 505	Practicals-V & Research Projects	60	140	200
		Total Marks		600
	Semester VI	Internal	External	Total
BRTT 601	Radiological/Nuclear medicine/ Other Imaging techniques in Radiotherapy Planning	30	70	100
BRTT 602	Radiotherapy Treatment Delivery & Project Work.	30	70	100
BRTT 603	Operational Issue in Radiotherapy	30	70	100
BRTT 604	Radiation safety	30	70	100
		Total Marks		400

The pattern of question paper will cover the entire syllabus. The theory paper will consist of MCQ, SAQ and LAQ. However, the practical examination will cover the entire aspects of practicals, field postings, field visits and all other aspects which are not included in theory. Following is the subject wise details of examination scheme.

Theory subjects carrying 70 marks for university examination will be assessed with following method (BRTT101, BRTT 102, BRTT 103, BRTT 104, BRTT 201, BRTT 202, BRTT 203, BRTT 204, BRTT 301, BRTT 302, BRTT 303, BRTT 304, BRTT 401, BRTT 402, BRTT 403, BRTT 404, BRTT 501, BRTT 502, BRTT 503, BRTT 504, BRTT 601, BRTT 602, BRTT 603, BRTT 604)

Section I	Multiple Choice Questions (MCQ's)		20 Marks
	20 MCQs with 1 Mark each (All are compulsory)	20	
Section II	Short Answer Questions (SAQ)- (Attempt any four out of five)		20 Marks
Q. 1	Short Answer Question 1	05 Marks	
Q. 2	Short Answer Question 2	05 Marks	
Q. 3	Short Answer Question 3	05 Marks	
Q. 4	Short Answer Question 4	05 Marks	
Q. 5	Short Answer Question 5	05 Marks	
Section III	Long Answer Questions (LAQ)-Attempt any three out of four		30 Marks
Q. 1	Long Answer Question 1	10 Marks	
Q. 2	Long Answer Question 2	10 Marks	
Q. 3	Long Answer Question 3	10 Marks	
Q. 4	Long Answer Question 3	10 Marks	
	Total Marks		70 Marks

The question paper should give equal weightage to all the topics in the course. The questions can be subdivided as per the demand of syllabus. The time allotted for the theory examination is 3 clock hours.

- **Practical subjects carrying 140 marks for university examination will be assessed with following method (BRTT 111, BRTT 211, BRTT 311, BRTT 411, BRTT 511, BRTT 611,)**

Que.1	Practical Work	60 Marks
	A Practical 1	20 Marks
	B Practical 1	20 Marks
	C Practical 1	20 Marks
Que.2	Spots	20 Marks
	5 spots * 4 Marks	20 Marks
Que. 3	Viva voce	50 Marks
Que.5	Journal	10 Marks

All components of this assessment will be evaluated by two external examiners appointed by the university during the exam. The examiners should have qualification of MD (Radiodiagnosis) qualification and should be associated with teaching institute.

18. Rule of passing.

The student will be declared as pass only when she/he scores minimum 50 % marks in the semester end examination examination.

19. Promotion of student to next semester/year.

Students are permitted to carry-over 2 failed courses from first to second year. However, in order to get promoted to third year, students have to pass all subjects of first year and he/she can carry over 2 subjects from second year to third year.

20. Fees and payments.

The students have to pay the tuition fee at the start of respective semester year in order to undertake the program. The fee structure will be decided by the university and will be revised / updated from time to time as and when it is necessary.

21. Maximum Duration for completion of the Programme

The candidate shall complete the Program within maximum period of six academic years from the date of admission. The student will be finally declared as failed if s\he does not pass in all subjects within a total period of six years. After that, such students will have to seek fresh admission as per the admission rules prevailing at that time.

22. Grade/class Improvement

Grade/Class improvement will be as per the university regulations applicable at that time.

23. Saving Clause

In the event of any clarification and interpretation of the content of this curriculum, the Vice Chancellor is empowered to take appropriate decision.

SECTION II- Syllabus for B.Sc. RTT

SEMESTER I

BRTT 101 -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 are as follows:

- 1. Introduction to healthcare delivery system**
 - a. Healthcare delivery system in India at primary, secondary and tertiary care
 - b. Community participation in healthcare 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 Health 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
 - d. Epidemiology of communicable & non-communicable diseases, disease transmission, host defense immunizing agents, cold chain, immunization, disease monitoring and surveillance.

Practicals-

1. Visit to Sub centre, PHC, CHC, SDH, DH and Medical College, private hospitals, dispensaries and clinics.
2. Clinical visit to the respective professional department within the hospital.

RTT 102 -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 are as 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 worksheet, entering information, saving workbooks and formatting, printing the worksheet, 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 MS office: MS word, MS PowerPoint, MS Excel.
2. To install different software.
3. Data entry efficiency

BRTT 103 -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 quality 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 are as 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).
- g. Managing an emergency including moving a patient

At the end of this topic, focus should be to teach the students to perform the maneuvers 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.

3. **Bio medical 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 are as follows:
 - a. Definition of Biomedical Waste
 - b. Waste minimization
 - c. BMW – Segregation, collection, transportation, treatment and disposal (including color coding)
 - d. Liquid BMW, Radioactive waste, Metals / Chemicals / Drug waste
 - e. BMW Management & methods of disinfection
 - f. Modern technology for handling BMW
 - g. Use of Personal protective equipment (PPE)
 - h. Monitoring & controlling of cross infection (Protective devices)
4. **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 –

- a. Evidence-based infection control principles and practices [such as sterilization, disinfection, effective hand hygiene and use of Personal protective equipment (PPE)],
- b. Prevention & control of common healthcare associated infections,
- c. Components of an effective infection control program, and
- d. Guidelines (NABH and JCI) for Hospital Infection Control

5. Antibiotic Resistance-

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

6. 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.

BRTT 104 -Human Anatomy and Physiology Part -I

Anatomy is a key component of all education programmes for RTTs and should have a strong focus on organ position, orientation and relationships. The topics provide the student with an understanding of the structure and relationships of the systems and organs of the body which is essential in patient preparation and positioning. The radiographic anatomy component will enable RTTs to evaluate images prior to reporting by the radiologist.

Similarly Physiology provides the students with knowledge of the function of systems and organs and their relationships and underpins the understanding of how various imaging modalities are to be selected depending upon the clinical history.

1. Introduction to the body as a whole
2. The cells, tissues of the body
3. The cell: Structure, multiplication.
4. Tissue: Types, structure, characteristics, functions
5. Epithelium:
6. Simple : Squamous, Cuboidal, columnar, ciliated
7. Compound: Stratified, transitional
8. Connective: Areolar, adipose, fibrous, elastic, Cartilage, blood and bone
9. Muscle: Striated (Voluntary), Smooth (Involuntary, Cardiac)
10. Nervous tissue
11. Fibrous tissue
12. Cell regeneration
13. Membranes: Mucous, Serous, Synovial
14. Osteology (including whole Skelton, bones and joints)
15. Development of bone (ostogenesis) : Cells involved
16. Types and functions of bone, Types of joints and various movements.
17. AXIAL Skelton: Skull : Cranium, face, air sinuses, Vertebral column: regions, movements and characteristics, Sternum, Ribs
18. Appendicular Skelton: Bones involving -Shoulder girdle and Upper limb,

Pelvic girdle and lower limb, healing of bones: cellular activity, Factors that delay healing, Diseases of bones and joints.

19. The Respiratory System: Organs: Position and structure, Nose and nasal cavities, Functions: respiratory, Olfactory, Pharynx, and Larynx: Functions - respiratory, vocal, Trachea, Bronchi, lungs: lobes, lobules, pleura, and respiratory functions: External and internal respiration, common terms relating to disease and conditions of the system.

Practical's

1. Study of Human Skeleton parts with skeletal models.
2. Study with charts and models of all organ systems mentioned above.
3. Microscopic slides examination of elementary human tissues, cells.

BRTT 105 –Medical terminologies, Medical Law and Ethics

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 are as 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.

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 framework, increasing awareness of human rights and changing moral principles of the community at large, now result in frequent occurrences of healthcare 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:

1. Medical ethics - Definition - Goal - Scope
2. Introduction to Code of conduct
3. Basic principles of medical ethics – Confidentiality
4. Malpractice and negligence - Rational and irrational drug therapy
5. Autonomy and informed consent - Right of patients
6. Care of the terminally ill- Euthanasia
7. Organ transplantation
8. 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.
9. Professional Indemnity insurance policy
10. Development of standardized protocol to avoid near miss or sentinel events

11. Obtaining an informed consent.

Second Semester

BRTT 201 - Basic Radiation physics

1. 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.

BRTT 202 -Conventional Radiological Equipment

1. Production of x-rays: X-ray tube, gas filled x-ray tube, construction working and limitations; stationary anode x - ray tube; construction, working, methods of cooling the anode, rating chart and cooling chart; rotating anode x - ray tube: construction, working rating chart, speed of anode rotation, angle of anode inclination, dual focus and practical consideration in choice of focus, anode heel effect, grid controlled x - ray tube; effect of variation of anode voltage and filament temperature; continuous and characteristics spectrum of x - rays, inherent filter and added filter, their effect on quality of the spectrum.
2. High tension circuits: H.T. generator for x-ray machines, three phase rectifier circuits, three phase six rectifier circuit, three phase 12 rectifier circuit, high and medium frequency circuits; capacitance filter control and stabilizing equipment; mains voltage compensator, mains resistance compensator, compensation for frequency variation, control of tube voltage, kV compensator; high tension selector switch, filament circuit, control of tube current, space charge compensation.

3. Meters and exposure timers: Moving coil galvanometer: construction and working/conversion to millimeter, ammeter and voltmeter, meters commonly used in diagnostic x-ray machines, pre reading kV meter and millimeter, digital panel meters. Clockwork timers, synchronous motor timer, electronic timers, photo metric timers (fluorescent and photoelectric effect as applied in timers), ion chamber based timers, integrated timer.
4. Interlocking circuits: Relays: description and working, use of relays in diagnostic machines for over load protection, circuit diagram; simplified circuit and block diagrams illustrating sequence of events from mains supply to controlled emission of x-rays.
5. Control of scattered radiation: Beam limiting devices: cones, diaphragms, light beam collimator, beam centering device, methods to verify beam centering and field alignment; grids; design and control of scattered radiation, grid ratio, grid cut-off, parallel grid, focused grid, crossed grid, grided cassettes, stationary and moving grid potter bucky diaphragms, various types of grid movements; single stroke movement, oscillatory movement and reciprocatory movement.
6. Fluoroscopy: Fluorescence and phosphorescence - description, fluorescent materials used in fluoroscopic screens, construction of fluoroscopic screen and related accessories, tilting table, dark adaptation. Image intensifier - Construction and working, advantages over fluoroscopic device, principles and methods of visualising intensified image, basic principles of closed circuit television camera and picture tube. Vidicon camera, CCD. Automatic brightness control, automatic exposure control, chamber selection during fluoroscopy. Serial radiography: Manual cassette changer, rapid automatic film changer, basic principles of cine fluoroscopy and angiography use of grid controlled x-ray tube.

Care and Maintenance of X-ray equipment;

General care; functional tests; testing the performance of exposure timers, assessing the MA settings, testing the available KV, measurement of focal spot

of an x-ray tube, testing the light beam diaphragm, practical precautions pertaining to Brakes and locks, H.T. cables, meters and controls, tube stands and tracks as well as accessory equipment.

BRTT 203 -Radiographic and Image Processing Techniques

1. Appreciation and application of all the factors listed below will enable the student/technologist to produce X-ray films of good quality and diagnostic value. The lectures to be linked with practical demonstration to illustrate the importance of all that goes to make up correct exposure conditions.
2. Radiographic Film: Structure of film emulsion-film characteristics (speed, base + fog, gamma, latitude)-effect of grain size on film response to exposure, interpretation of characteristics curve-Grain technology-Gelatin-Basic film types-Film formats and packing-Direct exposure duplitised films-Single coated emulsions-Films for specialized use-manufacturing process. Structure, properties of different parts, handling, film wrappings. Handling of exposed and unexposed films. Types, applications, advantages/limitations of different types, safe light requirements.
3. Sensitometer: Photographic density-characteristic curve-information from the characteristic curve-speed Vs definition. Storage of X-ray film.
4. Control of scattered radiation: Methods of minimizing formation of scatter radiation, effectiveness of grids-grid ratio-preventing scattered radiation, use of cones, diaphragm light beam devices and effectiveness of collimation in reducing effects of scatter. Effects of scatter radiation on radiograph image quality, patient dose and occupational exposure.
5. Intensifying screens: Structure and functions, common phosphors used-types, screen mounting, care and maintenance of film screen contact. Intensifying factor-speed and detail-crossover effect-resolution-mottle-reciprocity-screen asymmetry-cleaning. New phosphor technology-influence of kilo voltage. Photo-stimulable phosphor Imaging.

6. Cassettes: Structure and function-Types-single, gridded, film holder-Design features and consideration with loading/unloading-Care and maintenance (cleaning).
7. Photochemistry: Principles: Acidity, alkalinity, pH, the processing cycle, development, developer solution. Fixing, fixer solution, washing, drying replenishment, checking and adjusting-latent image formation--nature of development-constitution of developer- development time-factors in the use of developer. Fixers-constitution of fixing solution- factors affecting the fixer-replenishment of fixer-silver conservation-Drying-developer and fixer for automatic film processor-rinsing-washing and drying. Replenishment rates in manual and automatic processing-Silver recovery-Auto and manual chemicals.
8. Processing: manual processing-care of processing equipment-automatic processor-manual VS automatic processing-principles and typical equipment Microprocessor controlled-Cine processing-Daylight systems-Processing faults-maintenance.
9. Automatic Film Processor.
 - a. Functions of various components.
 - b. Film roller transport-transport time, film feed system.
 - c. Importance and relation to temp, fixed and variable time cycles.
 - d. Care and maintenance (cleaning routine and methods of cleaning).
10. Radiographic image-components of image quality-unsharpness in radiographic image- contrast of the radiographic image-distinctness of the radiographic image-size, shape and spatial relationships.
11. Factors affecting Image Quality: Meaning of radiographic image contrast, density, resolution, sharpness, magnification and distortion of image, noise and blur. Radiographic illuminators and viewing conditions, visual acuity and resolution.
12. Presentation of radiographs-opaque letters and markers-Identification of dental films- preparation of stereo radiographs-viewing conditions.
13. Monitor images-Characteristics of the video image-television camera-imaging

camera. Laser-light and laser-laser imaging-laser imagers-imaging plates-Dry cameras.

Processing room: location of the dark room-dark room illumination-equipment and layout-X-ray viewing room-Day light processing-Daylight handling-daylight systems with cassettes-without cassettes.

Dark Room

1. The processing area.
2. Dark room design, construction, illumination, entrance safe lighting-types.
3. Room storage, shelving of films.
4. Cleaning and maintenance.

Dark Room Planning:

1. For A Small Hospital, for A Large Hospital Location of Dark Room and construction of Dark Room.
2. Ventilation, Wall Protection Entrance to Dark Room - Single Door, Double Door, Labyrinth.

Dark Room:

1. Instruction to Staff, Dry Bench, Drawer, Cupboard.
2. Loading and Unloading Cassettes.
3. Hangers, Types of Hangers and Storage of Hangers
4. Wet Bench Cleanliness, Control of Dust, Dark Room Sink
5. Hatches and Drier
6. Safe Lights, Direct and Indirect, Uses, Factors Affecting Safelight Performance, Safelight Tests.
7. Viewing Room, Film Dispensing

BRTT - 204- English and Communication skills:

Preamble:

The purpose of this course is to introduce students to the theory, fundamentals and tools of communication and to develop in them vital communication skills which should be integral to personal, social and professional interactions. One of the

critical links among human beings and an important thread that binds society together is the ability to share thoughts, emotions and ideas through various means of communication: both verbal and non-verbal. In the context of rapid globalization and increasing recognition of social and cultural pluralities, the significance of clear and effective communication has substantially enhanced.

The present course hopes to address some of these aspects through an interactive mode of teaching-learning process and by focusing on various dimensions of communication skills. Some of these are:

Language of communication, various speaking skills such as personal communication, social interactions and communication in professional situations such as interviews, group discussions and office environments, important reading skills as well as writing skills such as report writing, note taking etc.

While, to an extent, the art of communication is natural to all living beings, in today's world of complexities, it has also acquired some elements of science. It is hoped that after studying this course, students will find a difference in their personal and professional interactions.

The recommended readings given at the end are only suggestive; the students and teachers have the freedom to consult other materials on various units/topics given below. Similarly, the questions in the examination will be aimed towards assessing the skills learnt by the students rather than the textual content of the recommended books.

1. Introduction: Theory of Communication, Types and modes of Communication
2. Language of Communication: Verbal and Non-verbal (Spoken and Written)
Personal, Social and Business Barriers and Strategies Intra-personal, Inter-personal and Group communication
3. Speaking Skills: Monologue Dialogue Group Discussion Effective Communication/
Mis- Communication Interview Public Speech
4. Reading and Understanding Close Reading Comprehension Summary Paraphrasing
Analysis and Interpretation Translation (from Indian language to English and

vice-versa) Literary/Knowledge Texts

5. Writing Skills Documenting Report Writing Making notes Letter writing

Communication and soft skills

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

BRTT-205 RT Directed Clinical Education – part I (studentship)

BASED ON SYLLABUS 201-204

Students will gain additional skills in clinical procedures, interaction with patients and professional personnel. Students apply knowledge from previous clinical learning experience under the supervision of a registered radiation therapist. Students are tested on intermediate clinical radiation therapy *second semester*

Third Semester

BRTT-301 Radiation Quantities, Units and Detection/Measurement

In this paper the students will learn about the various radiation quantities, their measuring units and various types of survey meters/dosimeters.

1. Radioactivity, Flux, Fluence, Kerma, Exposure, Absorbed Dose, Equivalent Dose, Weighting Factors, Effective Dose, Natural Background Radiation, Occupational Exposure Limits, Dose limits to Public.
2. Detection and measurement of radiation - 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.

BRTT-302 Oncology Science- I

This subject puts cancer, the treatment methods available and the patient pathway into context. It provides the student with an understanding of the other disciplines involved in the management of patients from diagnosis to follow up and how they interact with the radiotherapy department in the overall management of the cancer patient. This underpins how the information gained at the various stages can be used most effectively and appropriately. The topics related specifically to radiotherapy will enable students to analyze and evaluate treatment options and the associated side effects and how this information is used in defining the most appropriate treatment for each individual patient. It will provide students with knowledge of other therapies that patients may avail of and how quality of life issues can be addressed.

1. Pathology- general pathology of tumours
2. Malignancies- local and general effects of tumours and its spread
3. Carcinogenesis
4. Co-morbidities
5. Etiology and epidemiology
6. Genetics
7. Prevention
8. Early detection
9. Signs and symptoms
10. Public awareness on early signs and symptoms
11. High risk groups

12. Staging of tumours

Oncology Science- II

This subject puts cancer, the treatment methods available and the patient pathway into context. It provides the student with an understanding of the other disciplines involved in the management of patients from diagnosis to follow up and how they interact with the radiotherapy department in the overall management of the cancer patient. This underpins how the information gained at the various stages can be used most effectively and appropriately. The topics related specifically to radiotherapy will enable students to analyze and evaluate treatment options and the associated side effects and how this information is used in defining the most appropriate treatment for each individual patient. It will provide students with knowledge of other therapies that patients may avail of and how quality of life issues can be addressed.

1. Clinical examination
2. Biopsy
3. Laboratory tests
4. Imaging methods
5. Staging and grading
6. TNM staging system, other commonly used systems
7. Treatment intent- radical, adjuvant , palliative
8. Non-malignant diseases
9. Primary management of malignancy
10. Performance status

BRTT-303 Radiotherapy Equipment -I

In this paper, the students acquire knowledge about various teletherapy machines, such as telecobalt machines, linear accelerators etc wherein the student learns about the operational and functional aspects of accelerators along with machine properties. Also in this paper the student studies about equipment accessories needed during treatment.

1. Brachytherapy- Design features, Radiation sources, Technique, High dose-rate (HDR),Low dose-rate (LDR),Pulsed dose-rate (PDR), various types of applicators.
2. Teletherapy Machines & Accessories:
 - a. Telecobalt Machines
 - b. Medical linear accelerators.
 - c. Tomotherapy
 - d. Machine properties.

- e. Beam directing, modifying and defining devices.
- f. Other accessories.

BRTT-304 Patient care, positioning and immobilization

In this context, patient care refers to all non-radiotherapy related aspects of the work that the RTT does while interacting with patients. This ranges from communication to the identification and referral for radiation related toxicities to cardio-pulmonary resuscitation. The RTT must also be able to apply the principles of positioning to the preparation of the immobilization device. Consideration must be taken of the practical aspects of immobilization device preparation.

1. 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 the departments appointments organization; minimizing waiting time, out -patient and follow-up clinics; stock-taking and stock keeping.
2. 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.).
3. 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
4. Principles of positioning and immobilization
 - a. Positioning aids-Breast boards,Lung boards, Belly boards, Head-and-neck fixation devices, Vacuum packs, Stereotactic systems
 - b. Internal organ motion control- Bite blocks, Gating systems, Active breathing control, Diaphragm compression, Prostate immobilization, Tracking systems. Laser/ positioning systems
 - c. Marking systems
 - d. Isocentre determination
 - e. Reference points
 - f. Treatment couch
 - g. Image acquisition for planning (and/or verification)

- h. Modalities for image acquisition for planning
- i. Simulation- Conventional Simulation, CT Simulation, Virtual Simulation
- j. Image processing and archiving
- k. Treatment verification

- l. Protocols- Imaging protocols: development and implementation, Non-action levels (NAL), On-line/off-line corrections, Matching/co-registration procedures, Geometric uncertainties, Documentation, Adaptive radiotherapy, Information management.

BRTT-305 RTT Directed Clinical Education - part III (studentship)

BASED ON SYLLABUS 301-304

Students will gain additional skills in clinical procedures, interaction with patients and professional personnel. Students apply knowledge from previous clinical learning experience under the supervision of a registered radiation therapist. Students are tested on intermediate clinical radiation therapy skills.

FOURTH SEMESTER

BRTT-401 Radiotherapy Equipment -II

In this paper, the students learn more 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:

1. Familiarization with treatment planning systems-external beam planning and brachytherapy
2. Various types of phantoms including the water-phantoms, RFA
3. Various types of dosimeters including in-vivo dosimeters
4. EPID and other on-board imaging systems
5. Record and Verify Systems, Oncology Information Systems, Image/Patient data archiving, storage and transfer.
6. CT Simulator

BRTT-402 Principles of Radiotherapy and Radiotherapy Techniques

This paper is designed for students to have complete knowledge about various basic treatment techniques in the field of radiation therapy. In this paper, the students study the various technical aspects of treatment techniques, such as FIX, ROTATION, ARC & SKIP therapy techniques, for individual patients. The students study about the various treatment accessories such as Mid Line Block (MLB), customized blocks, wedges, etc., for various sites of interest.

1. Effects of various radiation on normal tissues and malignant tumor: Early and late reaction on Skin, Mucous membrane, GI tract, Genito urinary system, respiratory system, CNS
2. Application of radiotherapy in benign conditions
3. Application of radiotherapy in malignant condition
4. Single and multiple field techniques for all treatment sites (from Head to Feet) with appropriate immobilizing device(s).
5. Fix, Rotation, Arc and Skip therapy procedures.
6. Use of Rubber traction, POP, Orfit, Body Frame in treatment technique.
7. Evaluation of patient setup for simple techniques.
8. Use of Beam Modifying devices, such as wedges, Tissue compensators, Mid Line Block (MLB) in the treatment of respective sites.
9. Customized shielding blocks and its properties.

10. Asymmetric jaws
11. Motorized wedge
12. Simulation procedures including CT simulation

BRTT-403 Basic Radiotherapy Physics

Historical developments in Radiotherapy, Physical components of Telecobalt Unit / Linear Accelerator Unit / Remote After Loading Brachytherapy Unit / Gamma Knife Unit / Simulator / Brachytherapy units 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.

BRTT-404 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, LD_{50/60}. Role of RTT in managing the acute effects of radiation.

BRTT-405 Practical-III & Demonstration:

Practical part-1:

1. Preparation of Mould for head & neck case.
2. Preparation of Mould for Pelvis case.
3. Study of mould room equipment in Radiotherapy.
4. Preparation of customize shielding block for Cobalt unit.
5. Preparation of patient set-up in SAD technique.
6. Study of difference between SSD & SAD technique.

Practical part-2:

1. Study of Record and Verify system in External Radiotherapy.
2. Study of operational safety mechanism of Medical Linear Accelerator.
3. Study to Radiological Safety mechanism of Cobalt Unit.
4. Online verification of patient set-up by EPID (Head & Neck).
5. Online verification of patient set-up by EPID (Pelvic).
6. Daily Quality Assurance in Cobalt unit.
7. Daily Quality Assurance in Remote After loader Brachytherapy Unit.

Demonstration:

1. Time Distance and Shielding, measurement of HVT & TVT
2. Familiarization of Radiation survey meters and their function performance checks.
3. Radiation survey of Cobalt and Brachytherapy Units.
4. Time Distance and Shielding, measurement of HVT & TVT
5. Familiarization of Radiation survey meters and their function performance checks.
6. Radiation survey of Cobalt and Brachytherapy Units.
7. Daily Quality Assurance test for Tele cobalt and Brachytherapy unit.

Fifth Semester

BRTT-501 Clinical Radiobiology

In simplest terms, radiobiology is the study of the action of ionizing radiation on living structures and organisms. Radiobiology is the basic science behind radiotherapy and it can explain, and occasionally also predict responses of tumours and normal tissues to radiation.

Knowledge of the principles of radiobiology allows the RTT to comprehend the effects of different types of radiation, fractionation schemes, the use of radio sensitizers and other interactions he/she observes on a daily basis.

1. Cell kinetics
2. Cell cycle control mechanisms
3. Tumour biology
4. The five 'R's of radiobiology
5. Tissue structure and radiation effect
6. The Linear Quadratic (LQ) model
7. Tumour control probability (TCP), Normal Tissue Complications Probability (NTCP) models
8. Acute and late side effects
9. Sensitizers/protectors/side effect reduction
10. Fractionation
11. Treatment combinations

BRTT-502 Mould Room/Motion Management Techniques

Mould room and motion management techniques are essential part of modern precision radiotherapy. An RTT has to be competent in designing various types of moulds for patient immobilization and applicator fixation (in brachytherapy) as well as in various motion management techniques:

1. Historical evolution of the mould materials and techniques to make moulds
2. Thermoplastic moulds
3. Breath hold, motion reduction, tracking and gating techniques

BRTT-503 Special RT Techniques and Recent advances

1. Wedges-tissue compensator-irregular field-SSD&SAD technique-oblique field-arc- rotational and moving field
2. Mantle field-irregular field-Hemi body irradiation-whole body irradiation-total body skin irradiation

3. 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.
4. Conformal Radiotherapy: Principles of 3 D treatment.
5. Recent developments in radiotherapy and treatment techniques

BRTT-504 Quality Assurance in Radiotherapy.

Quality assurance (QA) refers to the systematic activities implemented in a quality system so that quality requirements for a product or service will be fulfilled. It is the systematic measurement, comparison with a standard, monitoring of processes and an associated feedback loop that confers error prevention and provides accuracy of treatment. The following topics will be covered: Accessories and tools used for QA tests in Radiotherapy such as Front pointer, Back pointer, Laser Alignment 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

BRTT 505 Practical's-V and Research projects

BASED ON CLINICAL AND RADIOTHERAPY EQUIPMENTS

Sixth Semester

BRTT-601 Radiological/Nuclear Medicine/Other Imaging Techniques in Radiotherapy Planning

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

1. 2D (radiography, fluoroscopic, USG), 3D (CT, MRI) and functional (PET/SPECT) imaging and their application in radiotherapy planning
2. Understand Gross Tumour Volume (GTV), Clinical Target Volume (CTV), Internal Target Volume (ITV), Planning Target Volume (PTV), Organs at Risk (OAR) delineation
3. Conduct image fusion at the treatment machine console
4. Do bony matching
5. Do soft tissue matching for estimating the preliminary data for applying shifts
6. Prepare documentation
7. The RTT should understand the principles of: Four-dimensional (4D) planning and be familiarized with IMRT and IGRT planning.

BRTT-602 Radiotherapy treatment delivery/ Project Work

Based on Bloom's taxonomy, students should be able to analyze, synthesize and evaluate the information acquired in the radiotherapy specific modules in radiotherapy preparation, delivery and patient support. From Bloom's taxonomy, 'analysis' is the ability to break down the information into its component parts and look for interrelationships and ideas, 'synthesis' is combining information from a range of settings or experiences and 'evaluation' is judging the value of the information and how it is best applied.

1. Orthovoltage / superficial
2. Supervoltage / Megavoltage
3. Brachytherapy
4. Stereotactic radiotherapy- Stereotactic radiosurgery, Stereotactic radiotherapy, Cranial Extra cranial (Stereotactic body radiotherapy SBRT), Total Body Irradiation , Total Skin Electron Irradiation (TSEI), Radiation therapy with neutrons, protons, and heavy ions

BRTT-603 Operational Issues in Radiotherapy.

Course content is designed to focus on various radiation therapy operational issues. Accreditation, CQI development and assessment techniques will be presented. Human resource issues and regulations impacting the radiation therapist will be examined. Topics include the role of network information systems within the radiation oncology department.

BRTT-604 Radiation safety

The radiation therapy needs to be carried out carefully with adequate measuring system for the radiation workers, such as technologists, which helps in knowing the dose level he/she has received while working in the radiation area.

1. 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.
2. 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 RTT in handling radiation emergencies.

3. Regulatory requirements

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

4. Demonstration:

- Time, Distance and Shielding, measurement of HVT & TVT
- Familiarisation of radiation survey meters and their functional performance checks
- 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 instrument

Seventh and Eighth Semester

The internship time period provides the students the opportunity to continue to develop confidence and increased skill in simulation and treatment delivery. Students will demonstrate competence in beginning, intermediate, and advanced procedures in both areas. Students will participate in advanced and specialized treatment procedures. The student will complete the clinical training by practicing all the skills learned in classroom and clinical instruction.

The internship will span at least 06 months (1 semester). This will include 8 hours (min) of practice a day, totaling to 720 hours for one semester assuming 90 working days in a semester. As a part of this, the students will choose a relevant subject and prepare an in-depth project report 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

Skills based outcomes and monitorable indicators for Radiotherapy Technologist

Competency statements

1. Demonstrate knowledge to interpret and evaluate a treatment prescription
2. Understands the place of treatment planning processes in RT and performs RTTs role in it (appropriate patient-set-up, immobilization and image scanning with relevant protocols).
3. Communicates relevant information to other members and completes accurate documentation
4. Demonstrates ability to prepare the shielding devices
5. Conducts the simulation and mark-up procedure for all standard treatment techniques
6. Demonstrates ability to carry out the daily organization of the treatment unit
7. Practices accurate treatment documentation
8. Demonstrates ability to interpret, apply and disseminate information as a member of the radiotherapy team
9. Demonstrates professional behavior
10. Demonstrates a sensitive and caring attitude towards the patient
11. Demonstrates ability to accurately and consistently set-up and treat the patient
12. Demonstrates ability to prepare the patient for their first treatment
13. Evaluates and monitors the patient performance status
14. Monitors, manages and records the patient's side effects throughout the course of treatment

15. Advises patient on appropriate nutrition, sexual function, rest, skin care, nausea and other symptoms
 16. Demonstrates skill to support and care for the patient during a brachytherapy procedure
 17. Demonstrates ability to carry out the necessary data transfer checks
 18. Acquires the initial verification images
 19. Demonstrates ability to carry out treatment verification as per protocol/under supervision
 20. Demonstrates ability to carry out corrective actions as per instructions
 21. Follows health and safety procedures
- Demonstrates ability to interpret, apply and disseminate information as a member of the radiotherapy team

Sl no	Learning outcomes	Knowledge/Comprehension	Applications / Synthesis/ Evaluation	Hours
1	Be able to interpret and evaluate a treatment prescription	Identify the area for treatment.	Discuss the tumour stage in the context of treatment	200
		Quantify the practical problems associated with machine and accessory equipment limitations	Create and evaluate treatment plans	
2	Be able to conduct the simulation and mark-up procedure for all standard treatment techniques	Be familiar with the techniques and equipment used	Analyze the information to prepare the patient for treatment according to departmental protocols	200
		Know the protocols used in the department	Operate the simulation equipment safely and accurately	
			Perform daily QA procedures for simulation equipment and mark-up procedures as per protocol.	

3	Understand the place of treatment planning in the radiotherapy process.	Be familiar with the TPS used	Decide and finalize with other RT team members suitable patient position and appropriate immobilization system. Prepare the patient and perform imaging/ scanning for planning as per protocols.	200
		Know the protocols used in the department	Understand all planning techniques for the clinical site/s	
4	Be able to transfer all relevant information and complete accurate documentation	Recognize the importance of accurate transfer of information to allow for accurate treatment set-up according to the treatment plan and prescription	Construct the most appropriate device for the individual patient within the context of the protocol	100
		Know what should be included	Apply the necessary precautions in production	
		Know to whom or where the documentation and information should be sent	Implement correct QC, storage and handling procedures for shielding devices	
		Be aware of the legal issues relating to documentation		
5	Be able to prepare the shielding devices	Know the shielding devices/ methods available	Construct the most appropriate device for the individual patient as per the protocol	100
		Know how to use these devices	Apply the necessary precautions in production	
		Recognize the associated health and safety issues	Implement correct QC, storage and handling procedures for immobilization devices	

6	Be able to carry out the daily organization of the treatment unit	Recognize the importance of team interactions	Participate in the organization of the daily work schedule to maximize efficiency	50
		Explain the principles of effective communication	Inform the patient about the procedure	
		Review the individual		

