

NAGALAND UNIVERSITY

Regulation and Syllabus for

Bachelor of Science in Radiotherapy

Technology (B.Sc. RTT)

(3+1 years) Degree Course

2024

Regulations for the Allied Health Sciences Bachelor Programs of the Nagaland University

The Regulations & syllabus are subject to modifications by the University from time to time.

1. Eligibility for Admission:

- (i) The candidate should have passed the Higher Secondary (10+2) from CBSE or State Education Board or any Govt. recognized Board with at least 50% marks for general candidates (UR) and 45% for SC/ST/OBC/NCL candidates in Physics, Chemistry, and Biology.
- (ii) For B.Sc. (Health Information Management) course, candidates with Physics, Chemistry, and Mathematics in 10+2 may also be considered.
- (iii) The candidate should have attained the minimum age of 17 years during the admission.
- (iv) **Lateral Entry:**

Candidates who have completed a two-year diploma programme in the concerned subject from Boards recognized by Central / State Government(s) / State / Central University with at least 50% marks in aggregate for (UR) candidates and 45% marks in aggregate for SC / ST / OBC / NCL candidates shall be eligible for Lateral Entry to the second year (3rd Semester) of Bachelor Programme in Allied Health Sciences.

2. Duration of the Course:

- (i) Group A: 4 years, i.e., 3 years or 6 semesters of academic studies and one year of internship (B.Sc.HIM, B.Sc.DTT, B.Sc.AOTT, BSc RTT, BSc. MRIT).
Group B: 4 and a half years, i.e., 4 years or 8 semesters of academic studies and six months of internship (BPT, BOT courses).
Group C: 4 years, i.e., 3 and a half year or 7 Semesters of academic studies and six months of internship (BMLS) during the 8th semester.
- (ii) The maximum duration of the Bachelor Programme for Group A, B & C above shall be N+2 where N is the normal duration of the programme. No student shall be allowed to continue beyond the maximum duration.

3. Medium of Instruction:

The medium of instruction for all the Allied Health Sciences courses shall be English.

4. Working Days Per Semester:

Each Semester consists of 90 working days, with eight hours of work per day and 40 hours per week, totalling 720 hours per Semester.

5. Internship Hours:

One-year Internship programs will include 1440 hours of practical training and Six Months Internship will include 720 hours of practical training.

6. Attendance:

- (i) A candidate must secure a minimum of 80% attendance in theory classes. Students who fail to meet the requirement due to illness may be eligible for a 5% condonation, provided they submit a medical certificate from a registered medical practitioner.
- (ii) 100% in skills training (practical/internship) to qualify for the award of degree. In case of insufficient attendance, the candidate's internship period will be extended accordingly. There are no other exceptions to these rules under any circumstances.

7. Submission of Log Books:

- a. At the time of practical examination, each candidate shall submit to the examiners his / her Log book duly certified by the Head of the Department as a bonafide record of the work done by the candidate.
- b. The practical record shall be evaluated by the concerned Head of the Department (Internal Evaluator) and the practical record marks shall be submitted to the University 15 days prior to the commencement of the theory Examinations.
- c. In respect of failed candidates, the marks awarded for record at previous examination will be carried over for the subsequent examination. The candidates shall have the option to improve his performance by submission of fresh records.

8. Revaluation / Scrutiny of Answer Papers:

- (i) There is no provision for candidate to request for revaluation of the answer papers of failed candidates in any examination. However, the failed candidates can apply for scrutiny.
- (ii) Nagaland University shall constitute a Result Moderation Committee of 3 members.

9. Pattern of Question Paper for University Examination:

Descriptive type Questions	=30%
Descriptive Short Notes	=30%
Short Answer questions	=20%
MCQ Type	=20%

10. Assessment:

- (i) Assessment for theory and practical examinations: - Students must attain at least 50% marks in each theory and practical component, both in internal assessments and in the final University examinations to pass the course. The final marks will be 75% from the University examination and 25% will be from the internal assessment.
- (ii) The distribution of marks between theory and practical shall be provided in the **Curriculum and Syllabi** of each course.
- (iii) Assessment for internship: - During the internship, students gain clinical experience and learn to document patient care effectively. Each student must maintain a logbook and a portfolio.

Activity	Marks %	Assessor
Log book	20	Supervisor
Portfolio*	20	Supervisor
Practical	40	Examiners
Viva voce	20	Examiners

*The portfolio provides one with an opportunity to demonstrate the breadth and depth of your knowledge on certain topics

The portfolio incorporates the follow documents:

- Curriculum vitae
- Progress reports
- “Summary of Competency Achievement” demonstrating the level of competency achieved in each sub-module.
- Samples of work prepared by the intern from at least 5 of the modules of internship training guide.

A presentation delivered covering key aspects of the module

The clinical supervisor will examine the portfolio at regular (at least once in three months) intervals and provide feedback to the Intern.

(iv) Mode of Evaluation: -

Evaluation for Theory papers during Odd End Semester Examination shall be internally done by the colleges and Theory papers during Even End Semester Examinations shall be externally evaluated or as notified by the University.

11. Internship Project:

As part of the internship, students are required to choose a relevant subject and prepare an in-depth project report, which should include the objective, scope of the project, and a detailed report.

12. Advancement to the Next Semester:

Advancement to the next semester is contingent upon meeting the following conditions and clearing any backlogs as described: -

A student may not fail in more than two papers in the preceding semester to be eligible to advance to the next semester.

13. Repeat examination for failed candidates:

Failed papers in odd semesters can be repeated during the exams of the subsequent odd semester. Similarly, failed papers in even semesters exams can be repeated during the subsequent even semester exams.

14. Vacation:

Maximum of 15 days including Saturdays and Sundays

15. Re-Admission after Break of Study:

Students shall be allowed to continue after break in studies provided the maximum duration as given in Clause- 2 (ii) is not exceeded.

16. Award of the Degree:

- a. Candidates who have passed all written examinations and successfully completed the compulsory internship as per the university's requirements will be awarded the degree.
- b. Final Consolidated Mark sheet shall be issued by the Nagaland University to the candidate after submission of his/her Internship Completion Certificate by the College.

17. Academic Calendar:

- a. Odd semester shall be from July to December, and Even semester shall be from January to June.
- b. The odd semester and even semester university (end) examinations shall be conducted in the months of December and June respectively.

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Bachelor of Science in Radiotherapy Technology (BSc RTT)

Semester Wise Distribution of Subjects

Total Credits= 120; Total Marks=3700.

Semester	Code	Subject	Credits		Total	MARKS					Total Hours	
			Theory	Practical		Internal		Semester		Total	Theory	Practical
					Theory	Practical	Theory	Practical				
1st Semester	BSc RTT -101	Human Anatomy	4	1	5	30	20	100	50	200	72	36
	BSc RTT -102	Human Physiology	4	1	5	30	20	100	50	200	72	36
	BSc RTT -103	English, Computer, Ethics and Medical terminology	4	1	5	30	20	100	50	200	72	36
	BSc RTT -104	Biostatistics /sociology	2	3	5	30	20	100	50	200	36	108
		Total			20					800	252	216
2nd Semester	BSc RTT -201	Basic radiological physics	3	3	6	30	20	100	50	200	54	108
	BSc RTT -202	Physics of Radiographic equipment	3	3	6	30	20	100	50	200	54	108
	BSc RTT -203	Hospital practice and patient care	5	3	8	30	20	100	50	200	90	108
		Total			20					600	198	324
3rd	BSc RTT - 301	Physics of Radiotherapy and Radiotherapy equipment (Part 1)	3	3	6	30	20	100	50	200	54	108
	BSc RTT -302	Tumor Pathology	3	3	6	30	20	100	50	200	54	108
	BSc RTT -303	Patient care in radiotherapy	5	3	8	30	20	100	50	200	90	108
		Total			20					600	198	324

Semester	Code	Subject	Credits		Total	MARKS					Total Hours	
			Theory	Practical		Internal		Semester		Total	Theory	Practical
					Theory	Practical	Theory	Practical				
4th Semester	BSc RTT -401	Immobilization and planning	3	3	6	30	20	100	50	200	54	108
	BSc RTT -402	Physics of Radiotherapy and Radiotherapy equipment (Part 2)	3	3	6	30	20	100	50	200	54	108
	BSc RTT -403	Conventional Radiotherapy technique	5	3	8	30	20	100	50	200	90	108
		Total			20					600	176	288
5th Semester	BSc RTT - 501	Basic Radiobiology	4	-	4	25	-	75	-	100	72	
	BSc RTT -502	Radiation safety	5	3	8	30	20	100	50	200	90	108
	BSc RTT -503	Physics of Special techniques in radiotherapy and related equipment	5	3	8	30	20	100	50	200	90	108
		Total			20					500	252	216

6th Semester	BSc RTT -601	Advanced Radiotherapy technique	3	3	6	30	20	100	50	200	72	72
	BSc RTT -602	QA in Radiotherapy	3	3	6	30	20	100	50	200	72	72
	BSc RTT -603	Radiotherapy and physics practical	-	8	8	-	25	-	75	100		164
			Total		20					500	144	308
4th Year	Internship	12-month compulsory rotational clinical posting Project submission Mid-term assessment Final Practical & Viva			12					100		1440
		Course Titles					Hours			Weekly class hours		
							Theory	Practical	Total			
		Internships						1440 (minimum)	1440			NA
		Total							1440			

Except for the 6th semester papers, the rest of the practical Exam could be spotters and viva.

INTERNSHIP – Minimum 1440 hours (calculated based on 8 hours per day, if 180 working days in one-year span)

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DETAIL SYLLABUS FOR
BACHELOR OF SCIENCE IN RADIOTHERAPY TECHNOLOGY (BSc RTT) COURSE
SEMESTER-1: 20 CREDITS

BSc RTT-101: HUMAN ANATOMY

SUBJECT DESCRIPTION: Human anatomy is designed to provide students with the working knowledge of the structure of the human body which is essential foundation for their clinical studies.

Unit I: BASIC CONCEPTS OF ANATOMY:

Subdivisions of anatomy, anatomical position and anatomical terms: - Regions, cavities and systems of the body. General Tissues:- Definition of tissues, Classification, location and function of different types of tissues. General features of cartilage - Types of cartilage and their location. General features and classification of bones and joints: Parts of developing long bone, Classify bones with example, Synovial joint with diagram. General features of muscles, vessels and nerves: Classify the types of muscle, their location and functions, Parts of a muscle – belly and tendon, Differentiate artery and vein, Layers of blood vessel.

Unit II: SKELETAL SYSTEMS:

Describe the features of bones and joints of the skull, upper limb, lower limb, vertebral column, ribs, sternum - Parts of a long bone , Describe briefly the salient features of clavicle, scapula, humerus, radius, ulna, phalanges, hip bone, femur, fibula, tibia, sternum - Parts of a typical rib and the vertebra , Names of skull bone, carpal bones and tarsal bones , Description of major joints like shoulder, elbow, hip and knee joint.

RADIOLOGICAL ANATOMY: Introduction: Standard view of radiographs, Types of Radiographs, X-ray appearance of normal skeleton. Radiographic appearance of shoulder, elbow, wrist and hand, hip, knee, ankle foot

PATHOLOGICAL CONSIDERATION: Fracture, dislocation, arthritis, tumors of bone, healing of fractures, Kyphosis, scoliosis.

Unit III: MUSCULAR SYSTEMS:

Name the muscles and know the attachments, nerve supply and actions of important muscles of head & neck, trunk, upper limb and lower limb. Describe the location and nerve supply of: Deltoid, Pectoralis major, Intercostal muscles, Diaphragm, Gluteus maximus, Gluteus medius, Gluteus minimus, sternocleidomastoid

UNIT IV: CIRCULATORY SYSTEMS:

The heart – covering, chambers, and external features, Blood supply , Great vessels of the heart , Pericardium and pericardial cavity, Surface marking of apex of heart, Chambers of heart , Valves of heart , Coronary vessels supplying the heart , Branches of Aorta.

Blood vessels - position and distribution of major arteries and their branches, Position and the tributaries of superficial and deep veins, dural venous sinuses – Position and branches of brachial artery, radial artery, ulnar artery, palmar arches, femoral artery, popliteal artery, anterior and posterior tibial artery, dorsalis pedis artery – Position of cephalic, basilic and median cubital vein of the upper limb - Position of long and short saphenous vein of lower limb - Location of superior sagittal sinus, inferior sagittal sinus, straight sinus, transverse sinus and sigmoid sinus in the cranial cavity

RADIOLOGICAL ANATOMY: Chest – PA view, oblique view

PATHOLOGICAL CONSIDERATIONS: Congenital heart diseases, acquired heart diseases, infarction, collateral circulation

UNIT V: LYMPHATIC SYSTEM:

General and regional arrangements of the lymphatic system, the lymphatic organs, lymph nodes of axilla, inguinal region, thorax, abdomen and neck, Location and drainage areas of different groups of lymph nodes in the body, Location and functions of thymus, spleen, lymph nodes and tonsils

UNIT VI: RESPIRATORY SYSTEM:

The nasal cavity, larynx, trachea, lungs and pleura, the paranasal air sinuses - Describe briefly the conducting and respiratory part, Types and location of paranasal sinuses. Larynx - Extent and relation

of trachea with the esophagus, Pleura and pleural cavity, Lobes of lung and difference between the right and left lung.

RADIOLOGICAL ANATOMY: Plain X-ray chest, Bronchogram

PATHOLOGICAL CONSIDERATION: Tracheostomy, pleural effusion, pneumothorax, bronchoscopy

UNIT VII: DIGESTIVE SYSTEM:

Mouth, salivary glands, pharynx, esophagus, stomach, small and large intestine, the liver and biliary system, and the pancreas. Types of major salivary gland, their location and functions, Parts of pharynx, Location and the parts of stomach. Parts of large and small intestine and their location, Lobes of liver and portal triad. Location and parts of gall bladder - Parts of pancreas, its secretion and functions. Blood supply of the stomach and intestine, Portal vein formation

RADIOLOGICAL ANATOMY: Barium swallow, barium meal, barium enema, cholecystogram

PATHOLOGICAL CONSIDERATION: Hypertrophic congenital pyloric stenosis, peptic ulcers, carcinoma, cholecystitis, cholelithiasis, oesophagoscopy, gastroscopy, sigmoidoscopy gastrostomy, ileostomy, colostomy, gastrectomy, colectomy, cholecystectomy

Unit VIII: URINARY SYSTEM:

Kidneys, ureter, urinary bladder, urethra - Location and internal structure of kidney - Microscopic structure of a nephron - Extend of ureter and the constrictions - Position of urinary bladder and its relation in males and females.

RADIOLOGICAL ANATOMY: X-ray KUB, IVP

PATHOLOGICAL CONSIDERATION: Dysuria, cystitis, pyelonephritis, calculus kidney

Unit IX: REPRODUCTIVE SYSTEM:

Male reproductive organs – testes, epididymis, seminal vesicle and prostate - relation of prostate with the neck of urinary bladder.

Female reproductive organs - uterus, ovary, fallopian tube, cervix, vagina and mammary gland - Uterus – location, parts and layers - Parts of fallopian tube - Location of ovary and ovulation

RADIOLOGICAL ANATOMY: Hysterosalpingogram

PATHOLOGICAL CONSIDERATION: Abnormalities of uterus, polycystic ovary, cancer cervix, benign prostatic hypertrophy, cancer prostate.

Unit X: NERVOUS SYSTEM:

Central nervous system – Brain – lobes, sulci and gyri, ventricular system, blood supply, circle of Willis and spinal cord. Parts of brain, Lobes of brain, Major sulci - central sulcus, lateral sulcus, parietooccipital and calcarine sulcus, Major gyri - pre and postcentral gyrus. Important functional areas - Motor, sensory, visual and auditory areas - Ventricles of brain and Flow of Cerebrospinal fluid - Circle of Willis and significance - External features of spinal cord - Meninges

Unit XI: PERIPHERAL NERVOUS SYSTEM:

Cranial nerves and somatic nerves; Formation and branches of brachial, lumbar and sacral plexus. The basic organization of the autonomic nervous system - Spinal nerves - Cranial nerves in order, Major branches of brachial plexus - ulnar nerve, radial nerve, musculocutaneous nerve, axillary nerve and median nerve in the upper limb, Major nerves from the lumbosacral plexus - femoral nerve and sciatic nerve

RADIOLOGICAL ANATOMY: X-ray skull

PATHOLOGICAL CONSIDERATION: Hemiplegia, quadriplegia, paraplegia, hydrocephalus, Erb's paralysis, claw hand, wrist drop, foot drop

Unit XII: ENDOCRINE SYSTEM:

The location of pituitary, thyroid, parathyroid, pancreas, adrenal, testis and ovary Pathological consideration: Pituitary tumors, gigantism, acromegaly, thyrotoxicosis, goiter, hyperthyroidism, hypothyroidism, diabetes mellitus

Unit X III: SENSORY ORGANS

Basic structure and function of eye, ear and skin

BSc RTT -102: HUMAN PHYSIOLOGY

SUBJECT DESCRIPTION: The course in Physiology over the first year is designed to give the student an in-depth knowledge of fundamental reactions of living organisms, particularly in the human body.

Unit I: BLOOD:

Composition, properties and functions of blood, Blood groups, Blood indices - MCV, MHC, MCHC, ESR, PCV, Lymph – Formation, circulation, composition and functions of lymph.

Unit II: MUSCULAR SYSTEM:

Neuromuscular junction Muscle tone

Unit III: CARDIOVASCULAR SYSTEM:

Function of heart – systole, diastole, heart sound, cardiac output, conducting system of heart, blood pressure, circulation of blood

Unit IV: RESPIRATORY SYSTEM:

Mechanism of Respiration, Gaseous exchange in lungs and tissues, lung volume and capacities

Unit V: DIGESTIVE SYSTEM:

Deglutition, peristalsis, movements of the stomach, small intestine & large intestine, defecation, Functions of the liver, gall bladder, bile, pancreas

Unit VI: EXCRETORY SYSTEM:

Functions of kidneys, formation of urine, micturation

Unit VII: REPRODUCTIVE SYSTEM:

Oogenesis, Menstrual cycle, ovarian cycle, Spermatogenesis, maturation of sperm

Unit VIII: NERVOUS SYSTEM:

Reflex action, Sensory pathway, Motor pathway, CSF formation, circulation properties and composition, lumbar puncture

Unit IX: ENDOCRINE SYSTEM:

Functions of pituitary, thyroid, parathyroid, adrenals, pancreas, gonads

Unit X: SENSE ORGANS:

Visual and accommodation pathway, Mechanism of hearing

- References:**
- a) Textbook of Physiology by A.K. Jain
 - b) Textbook of Physiology by Chaudhuri Sujit K
 - c) Ghai's textbook of practical physiology by VP Varshney & Mona Bedi

BSc RTT -103: ENGLISH, COMPUTER, ETHICS AND MEDICAL TERMINOLOGY

SUBJECT DESCRIPTION: The subject is on communicative English, learning word processing, other basic computer application such as excel, power point, medical ethics and medical terminology for technologists.

- **ENGLISH:**

Unit I: STUDY TECHNIQUES: Organization of effective note taking and logical processes of analysis and synthesis Use of the dictionary. Enlargement of vocabulary Effective diction

Unit II: APPLIED GRAMMAR: Correct usage the structure of sentences, the structure of paragraphs Enlargements of Vocabulary

Unit III: WRITTEN COMPOSITION: Precise writing and summarizing Writing of bibliography Enlargement of Vocabulary

Unit IV: READING AND COMPREHENSION: Review of selected materials and express oneself in one's words. Enlargement of Vocabulary.

Unit V: THE STUDY OF THE VARIOUS FORMS OF COMPOSITION:

Paragraph, Essay, Letter, Summary, Practice in writing

Unit VI: VERBAL COMMUNICATION: Discussions and summarization, Debates, Oral reports, use in teaching

Unit VII: LANGUAGE AND COMMUNICATION SKILLS: Basic concepts in English communication - Grammar and Usage - Pronunciation. Communication Skills: Formal conversation, Informal conversation, Telephone conversation - Case Presentation - Interviews. Writing Skills: Writing paragraphs, formal letters, reports - Case study - E-mails. Study Skills: How to take notes – preparing assignments - listening to lectures – summary writing - exam preparation

MEDICAL ETHICS

Unit VIII: Medical ethics – Definition, Goal, Scope, Basic principles of medical ethics - Confidentiality, Malpractice and negligence, Autonomy and informed consent, Right of patients, Medico legal aspects of medical records, Medico legal case and type ,Records and documentation , Development of standardized protocol to avoid near miss or sentinel events - Obtaining an informed consent. Introduction to NABH guidelines

- **COMPUTER**

Unit IX: Introduction to computer - Input & output devices, CPU, Memory, Storage devices. Introduction of Windows OS - MS-Word: Creating, opening, inserting, formatting, saving, and printing the document, Spell check, Creating and editing table , Mail merge.

Unit X: MS Office: MS-Excel: Creating, data entry, formatting, saving, and printing the worksheet - Creating graphs. MS-Power point: Creating and formatting presentations, enhancing text, slides with graphs and tables.

Unit XI: Computer networks: Types of network - LAN, WAN, Intranet. The Internet and its Applications, Application of Computers in clinical settings.

Unit XII: Introduction to - PACS-Picture Archiving in Communication in Medicine - DICOM – Digital Imaging for Communication in Medicine

- **Medical Terminology**

References:

- a) Manipal Academy of higher education; English book for Nurse by Selva Rose, 3rd Edition
 - b) Selva Rose. 1997, Career English for Nurses. Published by: Orient Blackswan Ltd
 - c) Quirk Randolph and Greenbaum Sidney, 1987. A University Grammar of English, Hong Kong: Longman group (FE) Ltd/ Pearson.
 - d) Thomson A.J. and Maituiet A.V. 1987, A Practical English Grammar, Delhi: Oxford University Press.
 - e) Gimson A.C.1989, An Introduction to pronunciation of English. Hodder Arnold; 4th Revised edition (1 May 1989).
 - f) O'Connor J.D, 1986. Better English pronunciation
 - g) Quirk Randolph and Greenbaum Sidney, 1987. A University Grammar of English, Hong Kong: Longman group (FE) Ltd/ Pearson.
 - h) Computer Fundamentals: Pearl Software
 - i) Fundamentals of Computers: E.Balagurusamy
- Principles of Bioethics: Tom Beauchamp & Childress

BSc RTT 104: BIOSTATISTICS/SOCIOLOGY

SUBJECT DESCRIPTION: The subject is on biostatistics and sociology where students learn about different types of data and presentation of data and about sociology

- Unit I** : Biostatistics General Statistics
- Unit II : Definition and importance of biostatistics
- Unit III : Types of data, rates and ratio
- Unit IV : Methods of collection of data-primary and secondary data Sampling of data
- Unit VI : Measures of central tendency (Mean, median, mode) , Measures of Dispersion (Mean deviation, standard deviation, Range)
- Unit VII : Presentation of data (Bar diagram, Pie diagram, Histogram, Frequency, Polygon,
- Unit VIII : Frequency curve, Cumulative frequency curve, Line diagram) Correlation and Regression analysis, Basic concept of probability

References:

- (a) Croxton – elementary statistics
- (b) Biostatistics: Basic Concepts and Methodology for the Health Sciences- Wayne W. Daniel , Chad L. Cross
- (c) Introduction to Biostatistics and Research Methods Fifth Edition- P.S.S. Sundar Rao, J. Richard
- (d) Mahajan’s Methods in Biostatistics for Medical Students and Research Workers-Bratati Banerjee.
- (e) Sociology of Health and Medicine-Nagla madhu
- (f) Sociology: Principles of Sociology with an Introduction to Social Thoughts-C N Shankar Rao
- (g) Handbook Of Medical Sociology For Nursing,Physiotherapy And Paramedical Students-Varun Malhotra

SEMESTER-2: 20 CREDITS

BSc RTT -201: BASIC RADIOLOGICAL PHYSICS

SUBJECT DESCRIPTION –This subject will introduce student to the basic physics concepts, principles necessary to learn the physics related to Radiotherapy & Radiology.

Unit I: STRUCTURE OF MATTER:

Constituents of atoms, atomic and mass, energy units, electron shells, atomic energy levels, nuclear forces, Nuclear energy levels. Atomic structure Nucleus, Electromagnetic spectrum, Energy quantization, Relationship between wavelengths, Frequency, Energy.

Unit II: PHYSICS UNITS AND MEASUREMENTS

Force, Work, Power, energy temperature and heat SI units of above parameters. Atomic Number, Mass No., electron orbit and energy levels Periodic table, Isotopes, Isobars, Ionization and excitation. Electromagnetic radiation.

Unit III: ELECTRICITY AND MAGNETISM: Electric charges, Coulomb's law Unit of charge Electric potential, unit of potential Electric induction, capacitance and capacitors, series and parallel connection electric current, unit, resistance, ohm's law, electric power, Joule's law Magnetism: Magnetic induction magnetic Properties Hysteresis magnetic effect of current Electrical instruments, Galvanometer, voltmeter, ammeter and multimeter.

Unit IV: RECTIFICATION AND TRANSFORMERS: Principle of rectification, wave form of half wave and full wave current/voltage wave form; Rectifiers: Introduction, energy bands in solids, the semiconductor, p-type and n-type semiconductors, density of charge carriers and conductivity, p-n junction, p-n junction diode, p-n junction diode as rectifier (half- wave and full-wave rectifier), rectifiers relative merits and demerits; silicon, germanium diodes. Principles of transformer, Electromagnetic induction, transformer design, efficiency of transformer, source of power loss

Unit IV: ELECTROMAGNETIC RADIATION: Electromagnetic radiation spectrum, common properties of electromagnetic radiation; relationship between energy, frequency, wavelength and velocity e.g. X-rays and gamma rays. Properties of X-rays and gamma rays; General properties of X-rays, velocity, frequency etc., photographic effect, photochemical effect – discolouration of salts, heating effect, biological effect; ionization of gases e.g., air.

Unit V: RADIOACTIVITY:

Natural and artificial radioactivity, Isotope, isobar and isotone, alpha decay beta decay and spectra, gamma emission, positron decay, electron capture and internal conversion, , exponential decay. Half-life. activity, Curie, Becquerel specific activity

Radiation sources Natural and artificial production of radio isotopes Nuclear fission, nuclear reactor, reactor produced isotopes, fission products Gamma ray source for medical uses.

Unit VI: RADIATION QUANTITIES AND UNITS:

Photons, Fluence, Exposure – Roentgen, absorbed dose, rad, Gray, Roentgen to rad conversion, , equivalent dose, effective dose and their units., Flux-Fluence-absorbed dose and KERMA, exposure rate constant, gamma ray constant, Measurement of exposure, Free air chamber, Thimble chamber,

Unit VII: INTERACTION OF RADIATION WITH MATTER

Attenuation of X-ray or Gamma rays, absorption and scattering, half value layer, Coherent scattering, Photoelectric absorption, Compton scattering, Pair production and photo electric disintegration. X-ray transmission of through Medium, Linear, and mass attenuation coefficients, total attenuation coefficient, HVT, TVT and interaction of charged particle and neutrons with matter. LET, Interaction of X and Gamma rays with fat, soft tissue, and bone. Relative importance of different types of interactions.

References:

- a) The physics of radiation therapy, Faiz M. Khan, 5th edition (2014), Lippincott, Williams and Wilkins, USA.
- b) Christensen's Physics of Diagnostic Radiology – Christensen & Christense
- c) Fundamental of Xray Fundamental of Xray and Radium Physics Joseph
- d) Basic Medical Radiation Physics – Stanton
- e) Physics for Radiography - Hay and Hughs
- f) Ball and mores essential physics radiographers, IV edition, Blackwell publishing.
- g) Basic Medical Radiation physics – Stanton.
- h) Christensen's Physics of Diagnostic Radiology – Christensen

BSc RTT - 202: PHYSICS OF RADIOGRAPHIC EQUIPMENT

SUBJECT DESCRIPTION: The students will be able to understand and appreciate the construction, essential parts and functioning of radiographic equipment used for imaging and treatment

□ **RADIOGRAPHIC IMAGE:**

Primary radiological image formation, use of contrast media. Density, contrast, brightness, X-ray film construction and film characteristics, exposure to x-rays, developer, effect of temperature and development time, constituents of developer, film processing methods • Optical density measurements. Image quality • Unsharpness, Resolution, Fog and noise. Grid, digital radiography.

□ **FLUOROSCOPY:**

Direct fluoroscopy – fluoroscopic image, fluorescent screen in Radiology Factors affecting the Fluoroscopic image. Image intensifiers – principle, construction, and function regarding intensified image. The television process – The Television camera tube, the Cathode ray tube, Television image, Modern fluoroscopy.

□ **TOMOGRAPHY:**

Theory of tomography – multi section radiography, tomographic equipment Computed tomography, Scanning principle, Generations of CT, Reconstruction of image, storing the image, viewing the image, evaluation of the image. Equipment for computed tomography, Table, scanning gantry X-ray generator, image quality

□ **MRI**

Magnetic Resonance imaging – Basic principle, Imaging methods, Slice section, Image contrast, Factors affecting Image quality, Difference CT and MRI images, Instrumentation. imaging sequences Bio effects of MRI

□ **BASICS OF SPECT AND PET CT**

Gamma Camera — Single photon emission computed tomography (SPECT) and Positron emission tomography(PET) and PET-CT, Physics principles and construction

- References:**
- a) Christensen's Physics of Diagnostic Radiology – Christensen & Christensen
 - b) Physics for Radiography Hay and Hughes
 - c) Handbook of Physics in Diagnostic Imaging - Roshan S. Livingstone
 - d) The Essential Physics of Medical Imaging - Jerrold T. Bushberg
 - e) Physics of Radiology and Imaging by Thayalan

SUBJECT DESCRIPTION: The students will be able to learn and appreciate the role of technologists in patient care, hospital practice, their principles and procedures such as first aid, managing infections and departmental procedures

□ **GENERAL PRINCIPLE OF HOSPITAL PRACTICES:**

Modern hospital treatment is based on teamwork; it is essential that the student should appreciate the technologists' role and that the importance of co-operation with wards and other departments. The students should be attached to wards or the accident and emergency department for a definite training period, the length of time being suited to the individual hospital.

Hospital procedure: Hospital staffing and organization; records relating to patients and departmental statistics; professional attitude of the technologist to patients and other members of 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.

□ **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 patient who has a colostomy; bedpans and urinals; simple application of a sterile dressing.

□ **FIRST AID:**

Aims and objectives of first aid; wounds and bleeding, dressing and bandages; pressure and splints, supports etc. Shock; insensibility; asphyxia; convulsions; resuscitation, use of suction apparatus, drug reactions; prophylactic measures; administration of oxygen; electric shock; burns; scalds; hemorrhage; pressure points; compression band. Fractures; splints, bandaging; dressing, foreign bodies; poisons; Basic life support, CPR

□ **INFECTION:**

Bacteria, their nature and appearance; spread of infections; auto•infection or cross

infection; the inflammatory process; local tissue reaction, general body reaction; ulceration; asepsis and antisepsis

□ **PRINCIPLES OF ASEPSIS:**

Sterilization • methods of sterilization; use of central sterile supply department; care of identification

of instruments, surgical dressings in common use, including filamented swabs, elementary operating theatre procedure; setting of trays and trolleys in the radiotherapy department (for study by radiotherapy students only)

□ **DEPARTMENTAL PROCEDURES:**

Department staffing and organization; records relating to patients and departmental statistics; professional attitudes of the technologist to patients and other members of the staff, medico•legal aspects accidents in the department; appointments; organization; minimizing waiting time; out•patient and follow up clinics; stock taking and stockkeeping.

□ **DRUGS IN THE DEPARTMENT:**

Storage: classification; labelling and checking, regulations regarding dangerous and other drugs; units of measurement, special drugs, anti-depressive, anti•hypertensive etc.

References: a) Principles of Hospital Practice and Patient Care by P Srinivasulu Reddy,

Paras Medical Books Pvt Ltd

b) Textbook of nursing foundation-I Clement

b) Principles and practice of nursing –Sr Nancy .Vol 1&2

SEMESTER-3: 20 CREDITS

BSc RTT - 301: PHYSICS OF RADIOTHERAPY AND RADIOTHERAPY EQUIPMENT (PART 1)

SUBJECT DESCRIPTION: The students should learn and appreciate the physics principles and technology of basic radiotherapy equipment.

□ RADIOTHERAPY EQUIPMENTS:

Historical developments in Radiotherapy • Kilo voltage Unit, Grenz Ray Therapy, contact therapy, superficial therapy, Deep Therapy, Megavoltage therapy. Van de Graff generator Radio Isotope units –Physical Components of Cobalt 60 unit, source housing, beam collimation penumbra, penumbra trimmers, wedge, shielding. Caesium 137 units, Advantages and Disadvantages descriptions

Electron Accelerator - Betatron, microtron , Cyclotron , Physical components of Linear accelerator , detailed description of modern, dual mode linear accelerator, head and its constituents, safety mechanisms, computer controlled linear accelerators, record and verify systems , accuracy of mechanical or digital readout for gantry, couch, and collimator rotation. Beam symmetry, jaw symmetry, uniformity checks, field flatness, wedges, physical and virtual wedges (dynamic and motorized) , mechanical safety , collision devices check.

Radiotherapy Simulator: Conventional simulator - Sim CT, CT simulator. lasers – moving and fixed. 4D CT.

Brachytherapy – Low dose rate (LDR), medium dose rate (MDR) and High dose rate (HDR), Pulse dose rate (PDR) Manual brachytherapy, Remote after loading Brachytherapy Unit, Brachy therapy source and their properties, Methods of brachytherapy – Interstitial, Intra luminal, intra cavitory and mould, permanent implant brachytherapy.

□ PHYSICS PARAMETERS FOR DOSE CALCULATION:

Source to skin distance (SSD) – Source to Axis distance (SAD), Focus to Axis

distance (FAD). Isocentre, Percentage depth dose (PDD), off axis factor (OAR), beam profile, Tissue Air Ratio (TAR), Tissue maximum Ratio (TMR), Tissue Phantom Ratio (TPR), Back scatter factor, ScatterAir Ratio (SAR), Scatter Maximum Ratio (SMR), Physics of Bolus and phantom materials. Fieldsize, equivalent square , output, output factor or relative dose factor , shielding tray factor ,wedge factor ,determination of treatment time / monitor unit

Physics of electron beam –electron depth dose curve, range and clinical application of electron beams, Calibration of therapy beams

References: 1. The physics of radiology by H.E. Johns and Cunningham

2. The Modern Technology of Radiation Oncology (vol 1-4), A Compendium for Medical Physicists and Radiation Oncologists Editor: Jacob Van Dyk : Publisher: Medical Physics Publishing Madison, Wisconsin

SUBJECT DESCRIPTION - The course in tumour pathology, the student is expected to understand pathology related to Radiotherapy practice.

□ **INTRODUCTION:**

Basic functioning of various organ systems, central of vital functions, path physiological alternation in diseased states, interpretation of symptoms & sign in relation to path physiology • Pathological changes in various organs associated with tumors • Scope of radiotherapy, growth, the cell, Reproduction of cell, Tumors, benign and malignant, cause of cancer, spread of cancer in the body, Lymphatic, Metastasis, other uses of Radiotherapy, Biopsy purpose and method.

□ **PATHOLOGY RELATED TO ONCO-RADIOTHERAPY PRACTICE:**

Therapeutic intervention, possible distinction between different types of tumors, grading immunological effects & genetic alterations - various microorganisms - their pathogenic potential, important organism commonly seen - levels of therapeutic interventions possible in preventing and /or eradicating organism. Volume doubling times, potential volume doubling times, repopulation, and accelerated repopulation

□ **INTRODUCTION TO MALIGNANT TUMOR:**

Basic pathology Carcinoma, Sarcoma & Lymphoma - Pattern of Spread, Biopsy/Investigations related to malignant tumor staging work up and TNM.

Introduction of different malignant tumor treated in radiotherapy department including TNM Skin – lip- oral cavity & Paranasal sinus

Nasopharynx-oropharynx-hypopharynx-larynx-thyroid-postcricoid—oesophagus-mediastinum-lungs-pancreas-liver-breast-cervix-body of the

Uterus-vagina-vulva-kidney, ureter, bladder, rectum prostate, penis, testis poreticulum tissue- bone marrow - CNS ,eye, orbit- soft tissue & bone - pediatric tumor, retinoblastoma, Wilms tumor, rhabdomyosarcoma

□ **TUMOUR LOCALIZATION:**

Radiological diagnostic procedures – X-ray, ultrasound, CT scan, MRI, Mammogram- Radio nuclide investigation Tumor localization & check film and application of simulation in radiotherapy.

BENIGN DISEASES Radiotherapy in non-malignant diseases Application of radiotherapy in malignant condition

- References:** a) Fletcher Diagnostic and Histopathology of tumors.
b) Introduction to Clinical Pathology – Harsh Mohan
c) Short textbook of radiotherapy Walter and Miller
d) Cancer explained, Sultan and Maurice
e) Radiation therapy in the management of cancers; Fletcher, Gilbert

BSc RTT -303: PATIENT CARE IN RADIOTHERAPY

SUBJECT DESCRIPTION - The students should learn and appreciate the principles and practice of patient care in relation to radiotherapy planning and treatment.

- **PREPARATION OF PATIENTS FOR GENERAL RADIOTHERAPY PROCEDURES:**
Departmental instructions to outpatients or ward staff - use of aperients; enemas and colonic irrigations flatulence and flatus, causes and methods of relief principles of catheterization and intubation, premedication. Its uses and methods; anesthetized patients; diabetic patients' special attention to food hazards of trauma. Preparation of the patients of biopsy and trolley setup; trolley set up for ENT examination, preparation of the patients for pelvic examination and trolley set up, general welfare of the patients during and after the treatment including the care of any inter current diseases (diabetes, tuberculosis, arthritis), diet and fluid intake.
The observation and reporting any change in the signs and symptoms of patients receiving treatment, the use of blood count in the control of certain treatment, the care of blood counts, the care of local and systematic reaction, local reaction showed include those in the ear, nose, throat and eye and those arising from treatment given to the pelvis, instrumentation, the absolute necessity for accuracy in every aspect of each individual treatment, the terminal care of dying patients.

□ **CARE OF PATIENTS RECEIVING R.T:**

General welfare of the patient during and after the treatment including the care any inter current disease (diabetic, tuberculosis, arthritis). Diet and fluid intake. The observation and reporting any change in the signs and symptoms of patients receiving treatment...Identification and care of radiation reaction (Mucositis, Dermatitis, Cystitis, and proctitis) - Use of blood counts - Diet and nutrition - Communication and counselling.

Management of special procedures (Tracheostomy, Colostomy, Ileal bladder, Breast prosthesis). The use of blood count in the control of certain treatment. The care of local and systemic reaction

□ **ORGANIZATION OF RADIOTHERAPY:**

Department practice, appointment organization in the planning room, treatment area. Management of waiting patients.

□ **DRUGS USED IN RADIOTHERAPY:**

Basic knowledge on drugs used in the dept.

- References:** a) A guide to Oncology nursing - (Livingstone) Deeley
b) Practical nursing and first aid- Ross and Wilson. Livingstone
c) Radiation therapy in the management of cancers -Fletcher, Gilbert:

SEMESTER-4: 20 CREDITS

BSc RTT -401: IMMOBILIZATION AND PLANNING

SUBJECT DESCRIPTION: The students will be able to understand the concepts, different types and application of immobilization for various radiotherapy treatment techniques.

□ **IMPORTANCE OF IMMOBILIZATION IN RADIOTHERAPY:**

Immobilization methods • Method of beam alignment, Treatment execution, Treatment verification changes in patient position, target volume and critical volume during course of treatment

□ **MOULD ROOM TECHNIQUE:**

Construction of casts, Construction of applicator and moulds, Construction of shields

□ **CT PLANNING - MRI PLANNING:**

Interpretation of treatment prescription Record keeping relevant to planning – patient position, support, immobilization, Landmarks, Mould room techniques and immobilization. Treatment positioning in radiotherapy to various cancers; CNS, benign pituitary, craniopharyngioma etc. Malignant tumor, primary and secondary; orbit eye – middle ear, parotid buccal mucosa, tongue, hard palate, maxillary antrum, nasopharynx, oropharynx, hypo pharynx, larynx, oesophagus, media sternum, lung, bladder, prostate. Penis, testis, cervix, body of the uterus—vagina, vulva, lymphoma.

□ **CHEMOTHERAPY•CHEMO•RADIATION:**

Concepts of combined modality treatment and the significance of radiation and chemotherapy in comprehensive management of cancer.

Sequelae associated with multimodality therapy and their management.

References: a) The physics of radiation therapy, Faiz M. Khan, 5th edition (2014), Lippincott, Williams and Wilkins, USA.

SUBJECT DESCRIPTION: The students should learn and appreciate the physics principles and technology of advanced radiotherapy equipment.

□ **CONVENTIONAL TREATMENT PLANNING CONCEPT:**

Physics of Bolus & Phantom material • Isodose Curves, Comparison of isodose curves, measurement of isodose curve, factors affecting the isodose distribution, isodose curves for wedge fields, compensating filters, Shielding Blocks, Patient immobilization devices, Port film, Processing and development, Dose calculations with isodose curves and wedge fields, Isodose curves for electron beam, computerized Treatment planning system (TPS), Tissue compensation, Field blocks, field shaping, Independent jaws, Asymmetric fields, multileaf collimator, separation and gap calculation of adjacent fields. • Electron contamination, penumbra
Beam directional devices - front and back pointer, pin and arc • lasers, their application in radiotherapy.

□ **TEST CASES:**

Periodic checks of decay correction of output, repetition of quality assurance tests after software up gradation, speed of processor. Measurement of entry and exit doses, doses to critical organs.

□ **BODY INHOMOGENITIES:**

Effects of patient contour, Bone, Lung cavities, Prosthesis on dose distribution. Dose within bone

/lung cavities, Interface effects, Electronic disequilibrium

□ **BEAM MODIFYING AND SHAPING DEVICES:**

Wedge filters and their use, wedge angle, Wedge Factors, Wedge systems, Wedge Isodose curves Bolus, Build-up material, Compensators, Merits and Demerits.- Shielding of dose limiting tissue: Non-divergent and Divergent beam blocks, - Multileaf collimators, Merits and Demerits.

References: a) The physics of radiology by H.E. Johns and Cunningham
b) The Modern Technology of Radiation Oncology (vol 1-4), A Compendium for Medical Physicists and Radiation Oncologists Editor: Jacob Van Dyk : Publisher: Medical Physics Publishing Madison, Wisconsin

BSc RTT -403: CONVENTIONAL RADIOTHERAPY TECHNIQUE

SUBJECT DESCRIPTION: The students should learn and appreciate the procedures, principles, and technique of conventional radiotherapy treatments.

□ **EXTERNAL BEAM THERAPY PRACTICAL EXPERIENCE:**

Technique of fixed beam treatments • single field, parallel fields, multiple fields, regional fields. The use of wedge filters, compensators and shaping blocks, diaphragms and applicators.

Immobilization of the patient • Rotation and arc therapy • beta ray and electron beam therapy. Care of machine • Set up single, multiple fields. Use of wedges, shields and tissue compensators, Use of beam directional devices, methods of patient immobilization, Knowledge of technique involving electron beam therapy moving beam therapy, conformal therapy, stereo tactic radio surgery and radiotherapy, Handling emergencies in Tele therapy.

□ **ELECTRON BEAM THERAPY:**

Production of electron beams: using accelerators • Characteristics of electrons. Surface dose, percentage depth dose, beam profiles, Isodose curves and charts, Flatness and symmetry. Beam collimation, variation of percentage depth dose and output with field size, and SSD, photon contamination. Energy spectrum Energy and field size choice, air gaps, and obliquity, Tissue in homogeneity lung, bone, air filled cavities. Field junctions, External and internal shielding. Arc therapy, use of bolus in electron beam. • Total skin Electron Irradiation, Intraoperative Radiation Therapy.

□ **BRACHYTHERAPY:**

Radioactive sources – exposures rate constant, calibration of Brachytherapy sources - Brachytherapy methods - Mould, Implant, intracavitary - radiography examination of implant – radiographic examination of intracavitary application and implant dosimetry – Radiographic verification of implant- Orthogonal verification of intracavitary application - dose calculation in intracavitary application - dose calculation methods. After loading systems -BARC Cs-137 kit - LDR remote after loading system and HDR remote after loading system •Physical components of LDR, HDR Brachy unit. Various type of sources used in brachytherapy and their properties.

SEMESTER-5: 20 CREDITS

BSc RTT - 501: BASIC RADIOBIOLOGY

SUBJECT DESCRIPTION: The students should learn and appreciate the mechanism of radiation effects in human body and its application in radiotherapy.

□ **BIOLOGICAL EFFECTS OF RADIATION:**

Mechanism of Radiation Damage – DNA - Direct effect, indirect effect, overview of DNA strand breaks, single strand break and double strand break. The Cell cycle and radio sensitivity - Linear Energy Transfer – Oxygen Enhancement Ratio – Relative Biologic Effectiveness - Cell survival curves – Shape of Cell survival curves.

Serial and Parallel organs - Dose Fractionation – Therapeutic Ratio – Radiobiological Models – Time Dose Fractionation (TDF) – Linear Quadratic Model (LQ) – Tumor control probability (TCP) – Normal Tissue Complication Probability (NTCP) – Classification of Radiation Effects – Tumor doubling time - 4 R's of radiobiology.

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 - Effects of radiation on living cell, action on cancer tissue Radio sensitivity of different tissues, skin reaction and their treatment, Reaction on muscle membrane, Late effects on workers, effects on blood, effects on reproductive organs, effects on other organs, Radiation sickness. Effect of low LET and high LET radiation on cell.

Effect of sensitizing and protective agents. Dose modifying factors and their determination. Variation of response with growth and the progression of cell through the phases of cell cycle. Hyper thermic and photodynamic injury. Chromosomal aberration and application for biological dosimetry.

Acute and chronic exposure, LD50/60

Biological hazards of irradiation • effects on the embryo and the fetus, life shortening, leukemogenesis and carcinogenesis, genetic and somatic hazards for exposed individuals and population. Biological basis of radiological protection. Importance of correct dosage,

Blood supply, time factor, fractionation, Quality Radical and palliative treatment.

□ **FACTORS INFLUENCING RADIATION RESPONSE:**

Physical factors: dose, dose quality, dose rate temperature - Chemical factor: Oxygen, radio sensitizers, radio protectors- Biological factors: Type of organism, cell type and stage, cell density and configuration, age, sex.-Host factors: Partial and whole body exposure,

□ **METHODS OF TREATMENT OF MALIGNANT DISEASE:**

Principle affecting the treatment of malignant disease; Chemotherapy, Hormone therapy, Radiotherapy and surgery in management of malignant disease, relative value of each method for individual tumors or tumor sites.

□ **CHOICE OF TREATMENT:**

Anatomical site, relation to other tissue, extent of tumor and histology, place of previous treatment, place of radical and palliative therapy.

□ **CHOICE OF RADIOTHERAPY:**

Tumor sensitivity, anatomical site, relation to other structure availability of equipment.

References: a) Radiobiology for the Radiologist 8th Edition by Eric J Hall

b) Handbook of Radiobiology 1st Edition by K. Thayalan

c) Radiation Biology for Medical Physicists, By C. S. Sureka, Christina Armpilia

BSc RTT - 502: RADIATION SAFETY

SUBJECT DESCRIPTION: The students should learn and appreciate the principles and practice of Radiation Protection in general and to radiation therapy.

□ **RADIATION QUANTITIES AND UNITS:**

Equivalent Dose, Weighting Factors, Effective Dose • RBE • LET • quality factor • dose equivalent

• rem, Sievert. Natural Background Radiation,

RADIATION EFFECT: Somatic and genetic effect, stochastic and deterministic effect, tissue reaction

□ **RADIATION PROTECTION METHODS & PRINCIPLES:**

Time, Distance and shielding. Concept of “As Low As Reasonable Achievable” (ALARA), Justification, optimization and dose limits, dose limits for radiation worker and 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 radiotherapy practices.

□ **RADIATION EMERGENCY PREPAREDNESS:**

Safety and security of radiation sources, case histories of emergency situations and preparedness, equipment and tools. Regulatory requirements and prevention of emergency, Preventive maintenance and Safety Culture, Role of technicians in handling radiation emergencies.

□ **DETECTION AND MEASUREMENT OF RADIATION & MEASURING INSTRUMENTS:**

Radiation Detectors: Gas. Solid state, Scintillation, Thermoluminescence, Ionisation chambers, Proportional counters, G.M. Counters, Liquid scintillator, Visual Imaging (Film, Fluorescent screens) and their examples. Concepts, Phantoms, protocols - dose determination in practice— Advantages & disadvantages of various detectors & its appropriateness of different detectors for different type of radiation measurement

□ **PERSONNEL AND AREA MONITORING:**

Need for personnel monitoring, Principle of film badge - TLD badge used for personnel monitoring. Pocket dosimeter, Need for area monitoring, Gamma Zone Monitors, Survey meters. Pocket dosimeter Radiation survey meter• wide range survey meter, zone monitor contamination monitor,their principle, function and uses.

□ **RADIATION PROTECTION AND REGULATORY ASPECTS:**

Principle underlying international Commission on Radiation• recommendations. ICRP and National radiation protection rules, Atomic Energy Regulatory Board (AERB) standards• Organizations, Safety standards, Codes & Guides, Responsibilities of licenses, Registrants and employers and Enforcement of Regulatory requirements. Effective dose limits- radiation worker, trainees, pregnant woman and Public, Regulatory consent: NOCs, periodical report to AERB and Radiological Physics and Advisory Division of Bhabha Atomic Research Centre (BARC).

References: a) Textbook of Radiological Safety by K Thayalan

b) AERB safety code of practice

BSc RTT -503: PHYSICS OF SPECIAL TECHNIQUES IN RADIOTHERAPY AND RELATED EQUIPMENT

SUBJECT DESCRIPTION: The students should learn and appreciate the physics principles of advanced radiotherapy techniques and the technology of radiotherapy equipment used for advanced and special techniques.

□ **INTRODUCTION TO SPECIAL TECHNIQUES IN RADIOTHERAPY:**

SRS, SRT, IMRT, IGRT & Helical Tomotherapy, and Volumetric modulated arc therapy, Robotic radiotherapy, PET in radiotherapy treatment planning, Particle therapy with proton beam and heavy ions and Challenges in technologist's job due to the introduction of new technologies.

□ **CONFORMAL RADIOTHERAPY (CRT):**

Principles, Advantages over conventional methods Virtual Simulation: Principles, CT simulation, TPS based simulation, Differences, Merits and Demerits, Practical considerations • Essential requirements for conformal radiotherapy -various methods of CRT, Modulated Radiation Therapy (IMRT) - Using 3 D compensators - Static IMRT - Dynamic IMRT - Dynamic arc IMRT - Micro - MLC - Tomotherapy methods - Time gated (4D) radiotherapy - Merits and demerits of IMRT – Volumetric Modulated Arc Therapy (VMAT) and Image Guided Radiotherapy (IGRT).

□ **STEREOTACTIC IRRADIATION METHODS:**

Physics principles, Merits and demerits, stereo tactic Radio surgery (SRS) and stereo tactic Radiotherapy (SRT), whole body stereotactic frame.

- **Total Body Irradiation (TBI) :** Physics principles of TBI, commissioning, calibration and in-vivo dosimetry for TBI

□ **TOTAL SKIN ELECTRON TREATMENT (TSET):** Physics principles of TSET, commissioning and in-vivo dosimetry requirements.

□ **HIGH LET RADIATION:**

Comparison and contrast with low LET radiation. Proton therapy, Neutron source and boron neutron capture Advantages and disadvantages, RBE values, hazards of low dose and low energy neutrons, RBE values, hazards of low dose and low energy neutron, use in radiotherapy, combination with low LET, current clinical results.

□ **HYPERTHERMIA:**

Sources, rationale, advantages and disadvantages, thermo tolerance. Cellular damage: comparison and contrast with radiation, thermal and non-thermal effects of ultrasound, microwaves, radiofrequency, etc. General host responses Use along with radiotherapy and chemotherapy: optimum sequencing of combined modalities. Current limitations to the clinical use of hyperthermia

Reference: a) The physics of radiology by H.E. Johns and Cunningham

b) The Modern Technology of Radiation Oncology (vol 1-4), A Compendium for Medical Physicists and Radiation Oncologists Editor: Jacob Van Dyk : Publisher: Medical Physics Publishing Madison, Wisconsin

SEMESTER-6: 20 CREDITS

BSc RTT -601: ADVANCED RADIOTHERAPY TECHNIQUES

SUBJECT DESCRIPTION - The students should learn and appreciate the principles of advanced radiotherapy techniques, treatment methods

□ **ADVANCE TECHNIQUES IN RADIOTHERAPY**

3D dimensional Radiotherapy – Intensity modulated radiotherapy (IMRT) – Volumetric modulated Arc therapy (VMAT) – Tomotherapy Surface Guided Radiotherapy (SGRT) – optical system - structured light system – camera Stereotactic Irradiation – methods of Stereotactic Radiosurgery - stereotactic radiotherapy – stereotactic bodyradiotherapy (SBRT) - Image Guided Radiotherapy – 2D image guidance - Electronic portal imaging devices –(EPID) – Kv Planarimaging (OBI) – 3D image guided Radiotherapy - In-room CT –Kv CBCT - MV CBCT – MV CT (Tomotherapy) – MR guided Radiotherapy (MRgRT)

Total Body Irradiation (TBI) – Historical development – current methods of delivering TBI – Total lymphoid irradiation (TLI) – Total Marrow and Lymphoid irradiation – planning – patient positioning and simulation – treatment - Total Skin Electron Treatment (TSET) – methods of treatment – patient positioning – delivery.

- References:**
- a) The Modern Technology of Radiation Oncology, Volume 4 (4th Edition) – Jacob Van Dyk
 - b) Johns and Cunningham's the Physics of Radiology
 - c) The physics of radiation therapy, Faiz M. Khan, 5th edition (2014), Lippincott, Williams and Wilkins, USA.

BSc RTT -602: QUALITY ASSURANCE IN RADIOTHERAPY

SUBJECT DESCRIPTION - The students should learn and appreciate the physics quality assurance methods for radiotherapy equipment and treatment procedures.

QUALITY ASSURANCE IN RADIOTHERAPY:

Definition and practical advantages, Construction, Development and Implementation of Quality System

Acceptance testing of simulator, Treatment planning system, ^{60}Co unit, linear accelerator.

Quality Assurance of Simulator: image quality check – verification isocentre, field size and field delineator.

Quality assurance of Treatment Planning system: verification of DICOM import –export, export of treatment plan to linac console – verification of dose calculation algorithm - Quality assurance of ^{60}Co unit - verification isocentre, field size and output - safety interlock verification - verification of gamma zone monitor functioning.

Quality assurance of linear accelerator: verification isocentre, field size and output - safety interlock verification.

Accessories tools used in for QA tests in Radiotherapy: front pointer, Back pointer, Laser alignment tool, - Optical and radiation field congruence, Beam shaping blocks, Diaphragm movements, Patient support system, Beam ON & OFF mechanisms, Technicians role in QA test on Tele Cobalt/ Linear Accelerator/ Brachytherapy/ Gamma Knife/Simulator/ CT Simulator machines.

Quality assurance of Brachytherapy: HDR remote after-loading – verification of safety interlocks – functioning of gamma zone monitor and CCTV system. Source position check – verification of source activity.

Quality assurance for multi-leaf collimator: Step and shoot movement and dynamic MLC – verification of virtual wedges – wedge angle, wedge profile and wedge factor (as required)

Quality assurance of IGRT system: Quality assurance of Electronic portal imaging system – kV cone beam CT – geometric accuracy and image quality

References: a) The physics of radiation therapy, Faiz M. Khan, 5th edition (2014), Lippincott, Williams and Wilkins, USA.

BSc RTT -603: RADIOTHERAPY AND PHYSICS PRACTICAL :

□ **Clinical**

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.

□ **Safety & Quality Assurance**

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.

□ **Physics**

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. Daily Quality Assurance test for Tele cobalt and Brachytherapy unit.