CURRICULUM FOR B.Sc. IN RADIOTHERAPY TECHNOLOGY

(Applicable w.e.f. academic session 2018-19)

COURSE NAME: B.Sc. (RADIOTHERAPY TECHNOLOGY)

DURATION OF COURSE: THREE YEARS

EXAMINATION SYSTEM: ANNUAL

FULL-TIME/ PART – TIME: FULL-TIME

SRI GURU RAMDAS UNIVERSITY OF HEALTH SCIENCES, SRI AMRITSAR, PUNJAB

SRI GURU RAMDAS ROTARY CANCER HOSPITAL SRI AMRITSAR, PUNJAB

ELORA REGISTRATION NO: PB- 00005

AERB

1. Bachelor of Science in Radiotherapy Technology

Radiation therapy (also called radiotherapy) is a cancer treatment that uses high doses of radiation to kill cancer cells and shrink tumors. At low doses, radiation is used in x-rays to see inside your body, as with x-rays of your teeth or broken bones. The main aim of this course is to instill skills and knowledge related to radiotherapy. B.Sc. Radiotherapy trains students into radiotherapy professionals and there is a huge demand for the same.

2. Duration of Course

The Bachelor of Science in Radiotherapy Technology Course is proposed to be a 3 years integrated degree course.

3. Eligibility Criteria for Admission

The students shall be admitted as per the admission criteria and qualification prescribed in the Notification issued by the Board of Management of Sri Guru Ram Das University of Health Sciences from time to time.

4. Medium of Instructions

The Medium of instruction during the course and for the university examination shall be in English.

5. Examination Scheme

5.1 The examination for the first, second and third year shall ordinarily be held twice year in the months of May/June and November/ December by the Institute as per University rules.

5.2 Annual Examination shall be held in May/June and supplementary within 6 months of annual examination.

5.3 The examination in theory/practical shall be held at the end of the 1st academic year (1st Year) and the end of 2nd academic year (2nd Year) and third exam at the end of the 3rd academic year (3rd Year) with one internal and one external examiners.

5.4 Date of examination and appointment of examiner will be made by the Board of Management on recommendation of Faculty of Medical Sciences.

5.5 The examination for the first, second and third year of B.Sc. Radiotherapy Technology Course would be held according to the prescribed syllabus.

5.6 The last dates for examination form and examination fee will be updated on University website time to time.

6. Rules of Examination for Bachelor of Science in Radiotherapy Technology Course:

6.1 The students shall submit his/her application for admission to the examination to Controller of Examinations SGRDUHS, Sri Amritsar through the Director Principal of the SGRDIMSAR, Sri Amritsar on the prescribed form with the required fee (the last date of which will be updated on university website after notification issued from Board of Management time to time).

6.2 The candidates will be given 25 marks for theory and 25 marks for practical as

internal assessment in each subject on the basis of their performance during the year. That a candidate will be eligible to appear in the examination provided he/she secured a minimum of 35% marks in internal assessment in theory and practical.

6.3 Internal Assessment must be submitted to the University at least two weeks before the commencement of theory Examination.

6.4 There will be fresh internal assessment and compulsory attendance for the students for the examination in which he/she has failed at the time of subsequent examination in that subject.

6.5 The students will not be allowed to appear in the examination unless he/she attends 75% of the total theory and practical in each subject separately.

6.6 Director Principal of the college is empowered to condone the shortage of attendance of lectures to the extent of 5% lectures delivered in each course of theory and practical.

6.7 A student will be deemed to have passed in the examination if he/she passes in each subject separately.

6.8 In case of students joining late owing to the late admission with the approval of the Vice-chancellor, their lecturers are to be counted from the date of joining. Deficiency in studies should be made up by attending special classes for them at the level of Head of the Department.

7. First Year B.Sc. Radiotherapy Technology Examination:

The First Year B.Sc. Radiotherapy Technology examination shall be in the following subjects and candidate shall be required to pass all the subjects:-

B.Sc. Part – I

Paper	Subject	Theory			Practical			Grand Total
		Marks	Internal Assessment	Total	Marks	Internal Assessment	Total	
Paper-I	Anatomy	100	25	125	25	25	50	175
Paper-II	Physiology and Pathology	100	25	125	25	25	50	175
Paper-III	Basic Radiation Physics	100	25	125	25	25	50	175
Paper-IV	Basic Principles of Radiotherapy	100	25	125	25	25	50	175
	Seminar	50						50

Note. The Seminar will be conducted at department level and marks will be sent to University for final inclusion in the result.

8. Second Year B.Sc. Radiotherapy Technology Examination:

The Second Year B.Sc. Radiotherapy Technology Examination shall be open to a person who has previously passed the First Year B.Sc. Radiotherapy Technology Examination of this University or an examination of any other recognized University/Institution in India considered equivalent for the purpose by the University.

Paper	Subject	Theory			Practical			Grand Total
		Marks	Internal Assessment	Total	Marks	Internal Assessment	Total	
Paper-I	Clinical Oncology- I	100	25	125	25	25	50	175
Paper-II	Physics Of Radiotherapy- External And Brachytherapy	100	25	125	25	25	50	175
Paper-III	Radiobiology	100	25	125	25	25	50	175
Paper-IV	Simulation And Mould Room Techniques	100	25	125	25	25	50	175
	Seminar	50						50

9. Third Year

The Third Year B.Sc. Radiotherapy Technology Examination shall be open to a person who has previously passed the Second Year B.Sc. Radiotherapy Technology Examination of this University.

Paper	Subject	Theory			Practical			Grand Total
		Marks	Internal Assessment	Total	Marks	Internal Assessment	Total	
Paper-I	Clinical Oncology- II	100	25	125	25	25	50	175
Paper-II	Advanced Medical Physics	100	25	125	25	25	50	175
Paper-III	Radiation Detection And Protection	100	25	125	25	25	50	175
Paper-IV	Radiotherapy Planning And Quality Assurance	100	25	125	25	25	50	175
	Seminar	50						50

10. Promotion and Number of Attempts allowed

10.1 A candidate who fails in all the subjects in the First Year B.Sc. Radiotherapy Technology examination shall not be promoted to Second Year class.

10.2 A Candidate who fails in one more or more subjects will be given four attempts including first attempt as a regular candidate, plus one mercy chance at the discretion of the Vice-Chancellor at six monthly intervals. However, he/she will have to clear all these attempts within 6 years of admission to said course.

10.3 The candidate who will absent himself/herself from the examination will be deemed to have been failed in that subject.

10.4 A candidate who passes in at least one subject of University level First Year B.Sc. Radiotherapy Technology examination will be permitted to attend classes of Second Year. However, the candidate will be required to pass in all subjects of 1st Year examination at least 6 months before the final examination of 2nd Year examination.

10.5 A candidate who fails in all subjects in the second year B.Sc. Radiotherapy Technology examination shall not be promoted to Third Year class.

10.6 A candidate who passes in at least one subject of University level Second Year B.Sc. Radiotherapy Technology examination will be permitted to attend classes of Third Year. However, the candidate will be required to pass in all subjects of 2nd Year examination at least 6 months before the final examination of 3rd Year examination.

10.7 Candidate who passes in one or more subjects of Second Year B.Sc. Radiotherapy Technology examination shall be exempted from appearing in these subject at a subsequent examination, but the candidate must pass the examination in a maximum of four attempts including first attempt, as a regular candidate plus one mercy chance at the discretion of the Vice-Chancellor, failing which he/she will have to clear all these attempts within 6 years of admission to the said course.

10.8 Candidate who passes in one or more subjects of third Year B.Sc. Radiotherapy Technology examination shall be exempted from appearing in these subject at a subsequent examination, but the candidate must pass the examination in a maximum of four attempts (including first attempt, as a regular candidate), plus one mercy chance at the discretion of the Vice- Chancellor, failing al six months intervals. However, he/she will have to clear all these attempts within 6 years of admission to the said course.

11. Appointments of Examiners:

11.1 There shall be two examiners – One internal and one external.

11.2 Professor & head of the Department shall be Convener. The Examiner at least 3 years post PG teaching experience in that specification field will be appointed as Internal Examiner.

11.3 The external examiner shall be appointed from other Universities at least 3 years post PG teaching experience in that specification field.

12. Paper Setting and moderation of Question Papers

The questions papers for 1st Year, 2nd Year and 3rd Year will be set under the direction of Controller of Examinations.
Each Question Paper covering entire course consists of 10 MCQ questions carry 20 Marks and 10 questions carry 80 Marks.

13. Evaluation of Answer Books

The answer books shall be got evaluated by putting fictitious roll numbers thereon or spot evaluation (Table marking) or any other method under the direction of the Controller of Examinations.

14. Minimum Pass Marks

During all the three annual examinations in each subject paper the candidate shall have to obtain 50% in theory including internal assessment 50% practical including internal assessment each separately.

14.1 The successful candidates shall be classified into divisions as under:-

a) Those who obtain 60% or more marks First Division.
b) Those who obtain 50% or more marks but below 60% marks Second Division.
c) A candidate who will obtain 75% or more marks of the total marks in any subject shall be declared to have obtained distinction in that subject provided he/she passed in all the subjects of the courses in all the parts in the first attempt.

A candidate is eligible to appear in the examination provided he/she secures a minimum of 35% marks in internal assessment in theory and practical separately.

15. Grace Marks

There shall be no provision for grace marks.

16. Declaration of Result

The results will be tabulated and declared by the Controller of Examination's office.

17. Award of Degree

On successfully passing the Third Year B.Sc. Radiotherapy Technology examination the students shall be awarded the degree of Bachelor of Sciences in Radiotherapy Technology.

SYLLABUS FOR B.Sc. RADIOTHERAPY TECHNOLOGY

FIRST YEAR

PAPER- I

SUBJECT NAME: INTRODUCTION TO ANATOMY

RATIONALE: The students need to know the surface anatomy to have idea for radiation fields, if any, marked on the patients during fractionated Radiotherapy.

OBJECTIVES: On completion of this subject the students will be able to understand the basic concepts of surface anatomy and Brachytherapy.

S.No.	CONTENTS	HOURS
	INTRODUCTION TO ANATOMY WITH RESPECT To	
1.	Introduction to the body as a whole	**40Hours**
2.	The cells, tissues of the body	
	Cell Structure and multiplication	
	Tissue types, structure, characteristics and functions	
	Cell regeneration	
	Membranes	
	Fibrosis	
3.	Osteology	
	Including whole skeleton, bones and joints	
	Development of bone (Osteogenesis)	
	Types and functions of bone	
	Types of joints and various movements, Healing of bones, Factors that delay healing	
4.	Brain and Spinal Cord	
5.	Head and neck	
6.	Thorax, Abdomen	
7.	Pelvis and pelvic organs	
8.	Skin	
9.	Sense organs	
10.	Surface Anatomy Axial Skelton Skull Vertebral column Sternum Ribs Appendicular Skeleton Upper & Lower limbs, pelvic girdle	
	TOTAL MARKS- 100	

FIRST YEAR

PAPER- II

SUBJECT NAME: INTRODUCTION TO PHYSIOLOGY AND PATHOLOGY

RATIONALE: In this paper, the students will study about the normal tissue reactions arising after radiotherapy. In the topics related to Physiology, the students will learn about the types of tumor and their pattern of spread.

OBJECTIVES: On completion of this subject the students will be able to understand the basic concepts of pathology and Physiology.

S. No.	CONTENTS	
	Introduction To Physiology With Respect To	
1.	Composition and function of blood and Lymphatic system	
2.	Digestive system, Liver and spleen	
3.	Urogenital System (Male and Female)	
4.	Endocrine system	
5.	Respiratory system	
6.	Nervous system	
7.	Hormones	**40Hours**
8.	Brain and Spinal Cord	
	Introduction To Pathology With Respect To	
1.	General pathology of tumors	
2.	Local and general effects of tumor and its spread	
3.	Sites and mechanism of metastasis	
4.	Environmental factors in tumor formation	
5.	Staging of tumors	
	TOTAL MARKS-100	

FIRST YEAR

PAPER- III

SUBJECT NAME: BASIC RADIATION PHYSICS

RATIONALE: This subject, Basic Radiation Physics is designed to acquaint the students with the basic principles underlying radiation physics.

OBJECTIVES: On completion of this subject the students will be able to understand the basic concepts of Radiation Physics

S.NO.	CONTENTS	HOURS
1.	SI units, Force, mass, momentum, work, energy, power, density, pressure, heat, sound, wave and oscillations.	

2.	Atomic structure: Atom, nucleus, Bohr theory of hydrogen atom, atomic mass and Energy units, distribution of orbital electrons atomic energy levels, nuclear forces, nuclear energy levels, particle radiations, electromagnetic radiations, electricity and magnetism.	**40Hours**
3.	Nuclear Transformations: Radioactivity, decay constant, activity half life, mean life, radioactive series, radioactive equilibrium, modes of decay: a-decay, 13-decay, electron capture, internal conversion, isomeric transition. Nuclear reactions: (a,p) reaction, (a, n) reaction, proton bombardment, deuteron bombardment, neutron bombardment, photodisintegration, fission, fusion, activation of nuclides, nuclear reactors.	
4.	Interaction of radiation with matter: ionization and excitation, various types of interaction processes (photoelectric effect, Compton scattering, pair production etc.) Interaction of charged particles and neutrons with matter. Comparative beam characteristics.	
5.	Production of X-rays: X-ray tube, anode, cathode construction and working principles of transformers and autotransformers used in x-ray circuits, voltage rectification and measurements in x-ray circuits. Physics of x-ray production (Bremstrahlung and Characteristic x-rays). Factors affecting quality of X-ray emission Angular distribution of X-rays around the target.	
6.	**Diagnostic Imaging:** Radiographic imaging, Films Radio-graphic & Fluoroscopic screens, intensifying screens. Image intensifier. Densitometry parameters of a radiographic film [Density, Contrast, gamma, Latitude and Speed]. Film processing procedure image & minimization of patient exposure in radiography & fluoroscopy.	
TOTAL MARKS-100		

PAPER- IV

SUBJECT NAME: BASIC PRINCIPLES OF RADIOTHERAPY

RATIONALE: This subject is designed to make the students know the basic principles of Radiotherapy.

OBJECTIVES: On completion of this subject, the students will have an idea about the basic radiotherapy equipments.

S.NO.	CONTENTS	HOURS
1.	Kilo voltage units : Grenz-ray, contact, superficial and orthovoltage or deep therapy units, construction of therapy tube, Rectifiers, transformers in therapy units. Supervoltage therapy units. Megavoltage therapy units: Overview of Vande Graff Generator, Betatron, Microtron, Cyclotron.	**40 Hours**
2.	Teletherapy Units: Telegamma units, Sources and their properties, preparation of Telegamma sources housing, source movement mechanisms. Fixed Gantry units, isocentric units, Beam collimation and penumbra. Head leakage in on/off position, collimator leakage in on position.	
3.	Linear Accelerator : block diagram of LINAC, power supply, modulator, electron gun, magnetron/klystron, wave guide system, accelerator tube (traveling wave and standing wave type), bending magnet, exit window, target, flattening filter, scattering foil, monitoring system. Collimator system, gantry couch. Heavy charged particle beam generators. Neutron generators : D-T generator, cyclotron. Proton and heavy ions generators and negative pions generators.	
4.	Brachytherapy: Basic introduction to Brachytherapy, basic principles, radium and its substitutes used, techniques used in brachytherapy. Overview of brachytherapy manual sources and applicators. Manual source preparation station, L-bench, lead blocks. Transport container, main safe, procedure to prepare manual brachy sources. Radiation hazards during manual source handling. QA tests and procedures in manual brachytherapy.	
5.	Simulator: Design and working principles of conventional simulator, simulator-CT and CT- Simulator. Basic principles of CT scanner and its image processing along with interconnectivity with treatment planning system. Brief overview of different generations of CT-scanners. Use of simulators in radiotherapy.	

6.	Overview of MRI, USG, PET, PET-CT, Angiography, Mammography, C-Arm, X-ray Machine.	
TOTAL MARKS -100		

LIST OF PRACTICALS:

1. Technological aspects of Co-60 Teletherapy unit- parts and functioning.
2. Technological aspects of Brachytherapy unit.
3. Demonstration of beam modifying devices on Co-60 unit.
4. Technological aspects of linear Accelerator parts and function.
5. Basic overview of simulator.
6. Demonstration of MRI, Mammography, X-ray machine, Ultrasound.
7. Demonstration of various body parts of human body.
8. Role of Screening and Prevention of cancer.
9. Histopathology classification of tumors.
10. What is the use of staging of cases: How it is applicable in management of cancer.

NOTE: As per the AERB guidelines for Radiation Dose Limits ,the candidates (interns) of B.Sc radiotherapy technology are considered as Trainees not Radiation Professionals as their dose limits are as mentioned below:

Radiation Professional : **20mSv per Year(100mSv for consecutive five years)**
Trainees : 6mSv per year

SECOND YEAR

PAPER- I

SUBJECT NAME: CLINICAL ONCOLOGY- I

RATIONALE: This subject is designed to acquaint the students with the basic concepts of Radiation Oncology.

OBJECTIVES: After completion of this subject the students will gain knowledge about the concepts of Oncology.

S.NO.	CONTENTS	HOURS
1.	Introduction to 1.1 Malignant and non-malignant tumors treated by radiotherapy. 1.2 Radioactivity and ionizing radiations used in treatment of malignancy, sources and techniques. 1.3 Tissue tolerance, tumor lethal dose, therapeutic ratio and radio sensitivity. 1.4 Units of exposure and radiation, prescription of radiation treatment. 1.5 General principles of documentation of radiation reactions and normal tissue tolerance.	**30Hours**
2.	2.1 What is Oncology? Detection and Diagnosis, and Extent of Disease, 2.2 Anatomic Staging of the Disease, 2.3 Histopathology Classification, Molecular Oncology 2.4 Treatment of Cancer, 2.5 Principles of Radiation Oncology and Cancer Radiotherapy, 2.6 Brachytherapy: Intracavitory Insertions, Interstitial Implants, Surface Applicators, Quality of life (Curative or Radical Intent, Palliative Intent, 2.7 Patient selection criteria for different radiotherapy units	
3.	3.1 General Aspect of Radiotherapy: Form of treatment, 3.2 Radio sensitive tumors, Radiosensitivity, Radio resistant Tumors, Tumors of limited sensitivity, 3.3 Curability of Cancer, 3.4 General Principles – Radiation Factors , Tumor Lethal Dose – TLD, Normal Tissue Tolerance, Therapeutic Ratio, Methods of Increasing Therapeutic Ratio, 3.5 Units of quality of Radiation – Given dose, Incident Dose, Skin dose, Model Dose, Quality or Wave Length of	

	Radiation, Beam flattening, Beam Wedging, Time Factors, Fractionation. 3.6 Importance of Beam directed X-ray therapy	
4.	4.1 Oropharynx Cancers, Nasopharynx, Hypopharynx, Pyriform Fossa 4.2 Post wall and P.C. area 4.3Tumours of Larynx and Paranasal Sinus: Incidence, Aeitology, Anatomy, Lymphatic drainage, Pathology, Symptoms at presentation, Diagnosis, Staging, Treatment	
5.	**Central Nervous System:** Incidence, Aeitology, Anatomy, Lymphatic drainage, Pathology, Symptoms at presentation, Diagnosis, Staging, Treatment	
6.	**Eye Tumors' and Spinal Cord Tumors**: Incidence, Aeitology, Anatomy, Lymphatic drainage, Pathology, Symptoms at presentation, Diagnosis, Staging, Treatment	
7.	**Carcinoma Breast: Incidence**, Aeitology, Anatomy, Lymphatic drainage, Pathology, Symptoms at presentation, Diagnosis, Staging, Treatment	
8.	**Lung and Mediastinum**: Incidence, Aeitology, Anatomy, Lymphatic drainage, Pathology, Symptoms at presentation, Diagnosis, Staging, Treatment	
TOTAL MARKS- 100		

PAPER- II

SUBJECT NAME: PHYSICS OF RADIOTHERAPY- EXTERNAL AND BRACHYTHERAPY

RATIONALE: In this subject the students will be taught about both external as well as internal radiotherapeutic procedures in detail.

OBJECTIVES: On completion of this subject the students will gain in – depth knowledge about physics of radiotherapy.

S.NO.	CONTENTS	HOURS
1.	Radiation Units: Activity, Becquerel(Bq), exposure, roentgen, absorbed dose, rad, Gray, dose-equivalent, rem, Sievert, KERMA. Relation between absorbed dose, exposure and KERMA. Calculation of absorbed dose from exposure, Absorbed dose to air, Absorbed dose to any medium, Bragg-Gray cavity theory, Stopping power. Transfer of absorbed dose from one medium to another of photons, electrons. Exposure from radioactive sources, exposure rate constant.	

2.	Dose distribution and scattering in medium : Properties of phantom materials and various types of phantoms, depth dose distribution, dose build-up, percentage depth dose and its influencing factors. Back scatter factor, tissue-air-ratio and influencing factors. Relation between TAR and PDD. Scatter-air-ratio. Introduction of Clarkson ' s method.	**45 hours**
3.	Basics of Dosimetric calculations: Dose calculation parameters, collimator scatter factor (Sc), phantom scatter factor (Sp), Tissue phantom ratio (TPR), tissue maximum ratio (TMR), and their influencing factors. Relationship between TMR and **PDD.** Scatter maximum ratio (SMR).	
4.	Isodose distribution of photon beam : Isodose charts, measurement of Isodose curves, parameters of Isodose curves : beam quality, source size, SSD and SDD — penumbra effect, collimation and flattening filter, field size, Wedge filters : wedge angle, wedge transmission factor, wedge systems, effect of beam quality, design of wedge filters. Bolus, tissue compensators, shielding blocks- block thickness, block divergence, Field shaping : custom blocking, independent jaws, multileaf collimators, skin dose, electron contamination of photon beams, dose distribution in build-up region, skin sparing effect of absorber skin distance effect of field size.	
5.	Combination of radiation fields: Definitions of following terms according to **ICRU 50**, Gross tumor volume (GTV), clinical target volume (CTV), planning target volume, irradiated volume cold and hot spots.	
6.	Electron beam therapy : Electron interactions, rate of energy loss, collisional losses (ionization and excitation) radiation losses (bremsstrahlung), polarization, stopping power, absorbed dose, electron scattering, most probable energy, mean energy, energy at depth. Introduction of absorbed dose, output calibration, phantom, reference depth and field size, depth dose distribution, central axis depth dose curves, isodose curves for different electron energies. Basic of Field flatness and symmetry, beam collimation, field size dependence, electron source, x-ray contamination.	
7.	Principles of remote controlled after loading brachytherapy units. Description and working mechanism of remote controlled brachytherapy units and their use in various applications. Advantage	

	and disadvantage of remote controlled brachytherapy units over manual after loading brachytherapy units. Concept of low dose rate brachytherapy units — sources used in low dose rate brachytherapy applications. QAs and working mechanism of LDR remote controlled brachytherapy units. Sources and procedures of permanent brachytherapy applications. Concept of high-dose rate and pulse dose rate remote controlled brachytherapy units. Sources of high dose rate brachytherapy units and their properties. Co-60 HDR units and its Intracavitory applicators. Ir- 192 HDR units, working mechanism and its applicators. QA tests and procedures of HDR unit.	
TOTAL MARKS- 100		

PAPER- III

SUBJECT NAME: RADIOBIOLOGY

RATIONALE: This subject covers the basic radiobiology principles.

OBJECTIVES: On completion of this subject the students will learn the basic radiobiology concepts.

S.NO.	CONTENTS	HOURS
1.	Principles of basic radiobiology. i) Cell cycle. ii) Cell survival curve. iii) LET, RBE and OER. iv) Time dose and fractionation in radiotherapy. v) Acute and chronic radiation effects, radiation protection.	**30 Hours**
2.	Basic structure of a cell, Effect of radiation on cells, radio sensitizing agents, Radio protectors, Immediate cell death, effects on cancer cells- direct and indirect	
3.	Effects of radiation on Normal tissues: Introduction, Pathogenesis of early and late effects, Normal tissues and organs Effects of radiation on skin, Oral cavity, Oropharynx and salivary glands, Orbit, Lung, GI tract, Hematopoietic tissues, Bone and cartilage, Kidney, testicle, Ovary, Nervous system, Systemic effects of radiation, Carcinogenic effects	
4.	Radiation modifiers- Radio sensitizers, Radio protectors, Hyperthermia	

5.	Irradiation Side Effects - Early and Late Complications. The biological hazards of irradiation: effects on the Whole body, effects on the embryo and the foetus, like Shortening, leukarmogenesis and carcinogenesis, genetic and somatic hazards for exposed individuals and populations.	
6.	**Biological Effects of Radiation:** • Sources of exposure in environment. • Somatic – general effects. • Genetic effects. • Effects on cellular levels. • Effects on Organs. • Stochastic and Non- stochastic effects.	
7.	**Biological Models** • Treatment fractionation • NSD (Nominal Standard Dose) • CRE (Cumulative Radiation Effect) • TDF (Time Dose Fractionation) • LQM (linear Quadratic Models) and their practical Application.	
TOTAL MARKS- 100		

PAPER- IV

SUBJECT NAME: SIMULATION AND MOULD ROOM TECHNIQUES

RATIONALE: This subject has been designed to acquaint the students practically with the simulation and mould room techniques.

OBJECTIVES: On completion of this subject the students will get to know the procedures for mould room and simulation techniques which is the mainstay of this course.

S.NO.	CONTENTS	HOURS
1.	**DIAGNOSTIC IMAGING**: Radiographic imaging, Films Radio-graphic & Fluoroscopic screens, intensifying screens. Image intensifier. Densitometry parameters of a radiographic film [Density, Contrast, Gamma, Latitude and Speed]. Film processing procedure, screens & grids. Factors affecting image & minimization of patient exposure in radiography & fluoroscopy.	

		30hours
2.	**SIMULATOR:** Simulator including technology – machine parameters, Mechanism, Image receptor, Lasers and Image Intensifier, Various simulation techniques for different sites **CT Simulator: Basic concepts and clinical application** **Moving Lasers and Virtual simulations**	
3.	**Immobilization Devices**: Use of rubber traction, POP, orfit, body frame in treatment, mouth gag, breast board, pelvis board, all-in-one base plate	
4.	Use of beam modifying devices such as tissue compensator, bolus, mid-line block in the treatment of respective sites Customized shielding blocks and its properties Asymmetric jaws Motorized wedges Breast cone	
5.	Patient set-ups for different treatment sites. Acquisition of patient data, body contours, internal structures using radiographs, CT, MRI, US etc for 2-D and 3-D text planning, text simulation.	
	TOTAL MARKS-100	

LIST OF PRACTICALS:

1. Measurement of Telecobalt Unit Output
2. Various set-ups on Cobalt Teletherapy Unit
3. Patient treatment demonstration on Brachytherapy, STS, esophagus ,
4. Measurement of CADD.
5. Simple 2-D Treatment simulation, simple Head& Neck, CNS, Eye tumor, Breast, Lung
6. Fabrication of customizes shielding, blocks, bolus, tissue compensator.
7. Preparation of various immobilization devices.
8. Demonstration of Isodose charts
9. Demonstration of Accessories of LINAC

NOTE: As per the AERB guidelines for Radiation Dose Limits ,the candidates (interns) of B.Sc radiotherapy technology are considered as Trainees not Radiation Professionals as their dose limits are as mentioned below:

Radiation Professional : **20mSv per Year(100mSv for consecutive five years)**

Trainees : 6mSv per year

THIRD YEAR

PAPER- I

SUBJECT NAME: CLINICAL ONCOLOGY- II

RATIONALE: In this paper, the students will learn about

OBJECTIVES:

S.NO.	CONTENTS	HOURS
1.	**Patient care**: Before, during and after radiotherapy.	**40Hours**
2.	**Esophagus Cancers**: Incidence, Aeitology, Anatomy, Lymphatic drainage, Pathology, Symptoms at presentation, Diagnosis, Staging, Treatment	
3.	**Cervix, Body Uterus Cancers**: Incidence, Aeitology, Anatomy, Lymphatic drainage, Pathology, Symptoms at presentation, Diagnosis, Staging, Treatment	
4.	**Ovary, Vagina and Vulva Cancers:** Incidence, Aeitology, Anatomy, Lymphatic drainage, Pathology, Symptoms at presentation, Diagnosis, Staging, Treatment	
5.	**Testicular Cancers, Prostate, Penis and Urethra Tumours:** Incidence, Aeitology , Anatomy, Lymphatic drainage, Pathology, Symptoms at presentation, Diagnosis, Staging, Treatment	
6.	**Lymphoma and Leukemia:** Incidence, Aeitology, Anatomy, Pathology, Symptoms at presentation, Diagnosis, Staging, Treatment	
7.	**Pediatrics Tumors:** Incidence, Aeitology, Anatomy, Lymphatic drainage, Pathology, Symptoms at presentation, Diagnosis, Staging, Treatment	
8.	**Tumors of Kidney, Tumors of Bladder:** Incidence, Aeitology, Anatomy, Lymphatic drainage, Pathology, Symptoms at presentation, Diagnosis, Staging, Treatment	
9.	**Carcinoma Rectum and Anal Canal :** Incidence, Aeitology, Anatomy, Lymphatic drainage, Pathology, Symptoms at presentation, Diagnosis, Staging, Treatment	
10.	**Soft Tissue Sarcomas and Osteosarcomas:** Incidence, Aeitology, Anatomy, Lymphatic drainage, Pathology, Symptoms at presentation, Diagnosis, Staging, Treatment	
11.	**Metastatic Lesion- Lung, Brain, Bone and Liver:** Incidence, Aeitology, Anatomy, Pathology, Symptoms at presentation, Diagnosis, Staging, Treatment	
12.	Radiation Syndromes, Radiotherapy Emergencies.	
	TOTAL MARKS-100	

PAPER- II

SUBJECT NAME: ADVANCED MEDICAL PHYSICS

RATIONALE: In this subject, the students will be taught about the latest advancements in the field of Medical Physics.

OBJECTIVES: On completion of this subjects the students will be able to understand the latest techniques in radiotherapy.

S.NO.	CONTENTS	HOURS
1.	**Medical Linear Accelerator** (3D-CRT, IGRT, IMRT, SRS, SRT, Portal imaging kV imaging) and heavy-ion accelerator **Tomotherapy** Machine properties and accessories (Concept of static wedge, dynamic wedge, comparison and properties of enhanced dynamic wedge)	**30Hours**
2.	**Gamma Knife**, design and working principles. Introduction to QA procedures and different clinical applications of gamma knife. Dose prescription criteria in the treatment of gamma knife.	
3.	**X-knife**, modification of LINAC, necessary accessories required for X-knife, energy choice of x-ray photons in X-knife, Introduction to QA procedures and application and techniques in the treatment using circular cones and their planning.	
4.	Principles and working of asymmetric jaws in radiotherapy. Techniques in which asymmetric jaws are used. Use of asymmetric jaw movement to get virtual wedge, central shielding, matching of adjacent beams in breast medulloblastoma etc.	
5.	Physical aspects and properties of three dimensional conformal radiotherapy Role of Multileaf Collimator, Micro- multileaf collimator in conformal therapy and its comparison with conformal block	
6.	TSET, TBI, three dimensional electronic tissue compensator	
7.	Explanation of PDR unit and their use in brachytherapy. Radiobiological explanation of PDR treatment techniques. Advantage and disadvantage of PDR brachytherapy. Introduction of QA procedures. Cobalt-60 Brachytherapy machines and their overview.	
	TOTAL MARKS-100	

PAPER- III

SUBJECT NAME: RADIATION DETECTION AND PROTECTION

RATIONALE: In this subject the students will learn about the basic radiation detection and protection procedures adopted in radiotherapy department.

OBJECTIVES: On completion of this subject the students will be aware about the radiation protection principles followed in radiotherapy.

S.NO.	CONTENTS	HOURS
1.	**Basic principles of gas field detectors**: Characteristic curve of gas filled detectors. Regions of the characteristic curve: ionization region, proportional region, GM region, construction of gas filled detectors and their working. GM counter resolving time, true count rate. Scintillation counters, semiconductor detectors, alpha particle monitoring, gamma & x-ray monitoring, neutron monitoring detectors.	**40Hours**
2.	**Radiation detection:** 2.1 Basic principles of radiation detection. 2.2 Ionization chambers and G.M counters. 2.3 X-ray spectrometer. 2.4 High Purity Germanium Detector. 2.5 Multi-channel analyzer. 2.6 Photographic film Dosimeters. 2.7 Thermoluminiscence dosimeter (TLD) 2.8 Film badges. 2.9 Semiconductor detector, In –Vivo Dosimetry 2.10 MOSFET 2.11 Clinical Dosimeter such as secondary standard Dosimeters. 2.12 EPID Analysis 2.13 Radiographic and Radiochronic films ***2.14 Detector Array***	
3.	**Radiation protection quantities and units** : exposure, absorbed dose, KERMA, dose equivalent(H). Committed dose equivalent (H_T), effective dose equivalent (HE), Equivalent dose ((H_{TR}), effective dose (E). Sources of radiation exposure : Natural sources and human made sources. Standards and regulations, philosophies of exposure limit, occupational limits, non-occupational	
4.	**Overview of external dosimetry and shielding:** source	

	configurations : no shielding, point source geometry, line source geometry. Attenuation by a shield with build-up and without build-up. Activation sources, shielding principle : ALARA, X-ray shielding, r3 particle shielding and neutron shielding. Source shielding, head leakage, structural shielding, workload, use factor, occupancy factor.	
5.	**Introduction to Installation shielding:** maximum permissible exposure through shielding barriers; workload, use factor, occupancy factor, overview of shielding calculations: primary barrier; secondary barrier, leakage and scatter. Maze design, leakage scatter contribution and patient scatter contribution. Total dose at door (photons), door construction.	
6.	**Radiation Protection:** 6.1 Maximum permissible levels for radiation workers and general public. 6.2 ICRP recommendations. 6.3 Shielding calculations for Tele-therapy and Brachy-therapy installations. 6.4 Principles of Time, Distance, Shielding. 6.5 Personnel Monitoring. 6.6 National/International agencies associated In Radiation safety. 6.7 Planning of radiotherapy department. 6.8 Half Value Thickness (HVT)& Tenth Value Thickness (TVT) and its relevance in shielding calculations.	
	TOTAL MARKS-100	

PAPER- IV

SUBJECT NAME: RADIOTHERAPY PLANNING AND QUALITY ASSURANCE

RATIONALE: In this subject the students will learn about the radiotherapy planning and Quality Assurance procedures of Radiotherapy equipments.

OBJECTIVES: On completion of this subject the students will know the basic Radiotherapy planning and Quality Assurance procedures.

S.NO.	CONTENTS	HOURS
1.	Principles of 2-D & 3-D treatment planning of Radiotherapy, use of computers in Radiotherapy treatment plannings. Concept of DRR & virtual simulators.	
2.	Basic terminology of brachytherapy, brachytherapy sources,	

	properties of ideal brachytherapy sources, construction of Ra^{226}, Cs^{137} & Co^{60} tubes and needles and Ir^{192} wires. To decay processes of brachytherapy sources, calibration of brachytherapy (mg Ra). Overview of Air Kerma Strength, Reference-Air-Kerma, Radium mass equivalent (Ra mg Eq.), apparent Activity, milligram-hours, integrated reference Air-kerma total reference-air-kerma, Exposure rate calibration	
3.	**Treatment Planning System:** Hardware- Treatment planning Computer principles – input data – peripherals- Digitizer – printer – plotter – CT based – PC based Systems – Radiotherapy planning. Basics of Three-dimensional beam data acquisition System, Radiation Field Analyzer (RFA) Record Keeping, Treatment chart – notes – Computerization. VARiS/ARIA/LANTIS, Hospital Network. Simple 2D treatment planning	**30Hours**
4.	**Quality Assurance:** LINAC, Telecobalt, Brachytherapy, CT	
5.	**5.1** Basic Concept of Intracavitory brachytherapy(Ca. Cx.) dosimetry systems : **Stockholm system:** Source placement and dose prescription rules. Type of applicators and their packing **Paris system:** Source placement and dose prescription roles. Type of applicators and its packing. **Manchester system:** Definition of points. A, B and MIR point P. Manchester applicators, radium loading as per Manchester and MIR criteria. Dose/dose-rate to points Z & B for different tandem and ovoid loadings. Tolerance doses of rectum and bladder**. ICRU-38** : Dose rate classifications, reference height, width & length. Reference volume. Reference points of rectum and bladder lymphatic trapezoid; pelvic wall points. Concept of 60Gy. **5.2** Introduction to TG-43 report **5.3** Applicators of Ca Cervix: Pre-loaded applicators (Stockholm, Paris etc.), **5.4** Fletcher suit applicators, Henschke applicators, ring applicators, vaginal applicators. Different tools, catheters and other necessary items required for interstitial implant. Templates: Seed/Nebelt template, Martinez universal perineal interstitial template, rectal template prostate implant template. Esophageal applicators, bronchial applicators, intervascular applicators.	
TOTAL MARKS-100		

LIST OF PRACTICALS:

1. Esophageal Cancer, Text simulation , Pelvis, Pediatrics tumors
2. Radiation Field Analyzer (RFA) Blue Phantom
3. Demonstration of Radiation Safety devices.
4. Overview of Quality Assurance for Brachytherapy
5. Overview of Quality Assurance for LINAC
6. Overview of Quality Assurance for COBALT
7. Overview of Quality Assurance for CT simulator.
8. Radiological Protection survey.
9. Patient set-up & treatment verification (Portal Imaging)
10. Patient set-up of electron treatment
11. Radiation protection survey of Installation
12. Emergency procedures.
13. Overview to Dosimetric tools.

NOTE: As per the AERB guidelines for Radiation Dose Limits ,the candidates (interns) of B.Sc radiotherapy technology are considered as Trainees not Radiation Professionals as their dose limits are as mentioned below:

Radiation Professional : **20mSv per Year(100mSv for consecutive five years)**

Trainees : 6mSv per year