Baba Farid University of Health Sciences

Ordinances & Syllabus

Bachelor of Science in Radiotherapy Technology

B.Sc. (RT)

(3 Years Degree Programme)

(Applicable w.e.f. academic session 2019-20)

Faridkot -151203

Ordinances
Bachelor of Science in Radiotherapy Technology
B.Sc. (RT)

1. Duration of course

Duration of course shall be 3 years.

2. Admission criteria and qualifications:

The students shall be admitted as per the admission criteria and qualifications prescribed in the Notification issued by the Government of Punjab or by Baba Farid University of Health Sciences, from time to time.

3. Medium of Instructions

The medium of instruction during the course and examinations shall be English.

4. Examination Schedule

4.1 The examination shall be held twice a year in the months of May/June and November/December or on such other dates as may be decided by the Board of Management on the recommendation of Faculty of Medical Sciences and Academic Council.

4.2 Normally, the University shall conduct not more than two examinations in a year, for any subject, with an interval of not less than four and not more than six months between the two examinations.

4.3 Normally, the last dates for receipt of examination form and late fee in the University Office shall be as under:-

Examination Session	**Date for without late fee**	**Date with late fee of Rs.200/-**	**Date with late fee of Rs.500/-**	**Date with late fee of Rs.1500/-**
May/June	March 1	March 15	March 31	April 15
Nov./Dec.	Sept. 15	Sept. 30	Oct. 15	Oct. 31

4.4 In the case of late declaration of result due to any reason, the last dates for receipt of examination form and fee in the University Office shall be as under:-

Up to 15 days from the date of declaration of result	**Up to 30 days from the date of declaration of result**	**Up to 45 days from the date of declaration of result**	**Up to 60 days from the date of declaration of result**
Without Late Fee	With a late fee of Rs.200/-	With a late fee of Rs.500/-	With a late fee of Rs.1500/-

Note: 1. Examination Fee including cost of form should be submitted in the shape of Demand Draft in favour of "The Registrar, BFUHS" payable at Faridkot.

2. The Vice chancellor may permit acceptance of admission form and fee ten days before the commencement of examination with a late fee of Rs.5000/.

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

The First Year B.Sc. Radiotherapy Technology Examination shall be open to a person who

a) has been enrolled for one academic year preceding the examination in a College of Health Sciences affiliated to this University.

b) has his/her name submitted to the Registrar by the Principal of the college with the following certificates:-

i) of having attended separately in theory and practical/clinical not less than 75% of the lectures delivered and practicals conducted in each of the subjects prescribed for the examination provided that deficiency in the number of lectures delivered and practicals conducted may be condoned by the Principal to the extent of 5% of the lectures delivered.

ii) of having secured at least 35% marks of the total marks fixed for internal assessment in each subject, separately, in order to be eligible to appear in all University examinations.

iii) of good moral character.

Note: If a candidate fulfils the condition laid down in clause 5(a) & (b) above for one or more subject (s) he/ she may be allowed to take the examination in such subject (s) in which he/ she fulfils the requirements.

(c) The First Year B.Sc. Radiotherapy Technology Examination shall be held in May/June and the supplementary within six months of the annual examinations.

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

Sr. No.	Subject	Theory				Practical			Grand Total
		Marks	Int. Assessment	Viva	Total	Marks	Int. Assessment	Total	
1.	Anatomy of Human Body	80	20	20	120	60	20	80	200
2.	Physiology of Human Body	80	20	20	120	60	20	80	200
3.	Basic Radiation Physics	80	20	20	120	60	20	80	200
4.	Oncopathology & Radiobiology	80	20	20	120	60	20	80	200
5.	English*	80	20	-	100	-	-	-	100

*Note: The Examination in the subject of English will be conducted at College level and minimum pass marks shall be 35% and marks will be sent to the University for final inclusion in the result.

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

The Second Year B.Sc. Radiotherapy Technology Examination shall be open to a person who

a) has been enrolled for one academic year preceding the examination in a College of Health Sciences affiliated to this University.
b) 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.
c) has his/her name submitted to the Registrar by the Principal of the college with the following certificates:-

i) of having attended separately in theory and practical/clinical not less than 75% of the lectures delivered and practicals conducted in each of the subjects prescribed for the examination provided that deficiency in the number of lectures delivered and practicals conducted may be condoned by the Principal to the extent of 5% of the lectures delivered.
ii) of having secured at least 35% marks of the total marks fixed for internal assessment in each subject, separately, in order to be eligible to appear in all University examinations.
iii) of good moral character.

Note: If a candidate fulfils the condition laid down in clause 6 (a), (b) and (c) above for one or more subject (s) he/ she may be allowed to take the examination in such subject (s) in which he/ she fulfils the requirements.

(d) The Second Year B.Sc. Radiotherapy Technology Annual Examination shall be held in May/June and the supplementary within six months of the annual examinations.

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

Sr. No.	Subject	Theory				Practical			Grand Total
		Marks	Int. Assessment	Viva	Total	Marks	Int. Assessment	Total	
1.	Physics of Radiation Oncology	80	20	20	120	60	20	80	200
2.	Radiation Oncology Equipment & QA Procedures – Brachytherapy	80	20	20	120	60	20	80	200
3.	Radiation Oncology Equipment & QA Procedures-Teletherapy	80	20	20	120	60	20	80	200
4.	Radiation Oncology Planning & Techniques-Teletherapy	80	20	20	120	60	20	80	200

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

The Third Year B.Sc. Radiotherapy Technology Examination shall be open to a person who

a) has been enrolled for one academic year preceding the examination in a College of Health Sciences affiliated to this University.

b) has previously passed the Second 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.

c) his/her name submitted to the Registrar by the Principal of the college with the following certificates:-

i) of having attended separately in theory and practical/clinical not less than 75% of the lectures delivered and practicals conducted in each of the subjects prescribed for the examination provided that deficiency in the number of lectures delivered and practicals conducted may be condoned by the Principal to the extent of 5% of the lectures delivered.

ii) of having secured at least 35% marks of the total marks fixed for internal assessment in each subject, separately, in order to be eligible to appear in all University examinations.

iii) of good moral character.

Note: If a candidate fulfils the condition laid down in clause 7 (a), (b) & (c) above for one or more subject (s) he/ she may be allowed to take the examination in such subject (s) in which he/ she fulfils the requirements.

(d) The Third Year B.Sc. Radiotherapy Technology Annual Examination shall be held in May/June and the supplementary within six months of the annual examinations.

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

Sr. No.	Subject	Theory				Practical			Grand Total
		Marks	Int. Assessment	Viva	Total	Marks	Int. Assessment	Total	
1.	Clinical Oncology & Radiation Oncology Planning	80	20	20	120	60	20	80	200
2.	Radiation Oncology Planning & Techniques- Brachytherapy	80	20	20	120	60	20	80	200
3.	Radiation Protection and Monitoring	80	20	20	120	60	20	80	200
4.	Recent Advances in Radiation Oncology Techniques	80	20	20	120	60	20	80	200

8. Internal Assessment

i) Internal Assessment shall be submitted to the University at least two weeks before the commencement of theory examinations or within one week from the issuance of Roll Numbers by the University. All the colleges shall adopt uniform criteria for Internal Assessment as follows:-

a) Attendance above 90% to be acknowledged with 10% extra weight-age for Internal Assessment.

b) At least two tests to be held in each year in addition to the pre-final (send up) examination. The Internal Assessment should be the average of all awards of these tests taken together.

c) Criteria for calculation of Internal Assessment

i)	House Examinations	- 80%
ii)	Attendance (above 90%)	- 10%
iii)	Subject assessment (candidate's conduct and extra curricular participation)	- 10%

d) Additional mandatory requirement for Internal Assessment to be observed by all colleges.

i) All test marks obtained by candidates will be displayed on Notice Boards of respective departments as and when they are awarded.

ii) All computations of Internal Assessment of the entire class made by the HOD of the department shall be displayed on the notice board of the department showing individual test marks, advantage of all tests, attendance advantage and subjective assessment and the total Internal Assessment thus derived for at least one week before sending the awards to the Principal's office.

iii) Professor Incharge/HOD preparing Internal Assessment shall certify that the detailed assessment of the entire class has been displayed on the department Notice Board for at least one week prior to its being submitted for onward transmission to the University and that adequate opportunity has been given to all the students to file any objections and that the same have been addressed satisfactory.

iv) The Principal forwarding the Internal Assessment to the University shall countersign the above referred certificate of the HOD/Professor Incharge preparing the Internal Assessment.

e) The re-appear/fail students may be re-assessed for improvement in the Internal Assessment and awards of Internal Assessment of all the re-appear/fail students will be submitted to the University every time.

9. Promotion and number of attempts allowed

a) 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.

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

c) 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, he/she will be allowed to appear in the Second Year B.Sc. Radiotherapy Technology examination only after passing all the subjects of First Year B.Sc. Radiotherapy Technology Examination.

d) Candidate who passes in one or more subjects of First 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), failing which he/ she shall not be allowed to continue his studies.

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

f) 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, he/she will be allowed to appear in the Third Year B.Sc. Radiotherapy Technology examination only after passing all the subjects of Second Year B.Sc. Radiotherapy Technology Examination.

g) 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 appear in all the subjects of the examination.

h) 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), failing which he/ she will have to appear in all the subjects.

10. Appointment of Examiners:

The examiners shall be appointed by the University on the recommendations of the Board of Studies in Medical Sciences (Undergraduates)/Faculty of Medical Sciences.

i) There shall be four examiners – two internal and two external.

ii) Professor& Head of the Department shall be the Convener. The second Internal Examiner will be appointed by annual rotation from amongst the Professors/Associate Professors/Assistant Professor with at least 3 years post PG teaching experience. In case of non-availability of Professors/Associate Professors/Assistant Professor in the department the teacher working in another Medical College affiliated to this University, who fulfils the minimum requirements as per MCI norms for appointment as examiner may be appointed as Internal Examiner.

iii) The examiners shall be appointed by the University from the teachers working in the Medical Colleges affiliated to it, preferably from the colleges where this course is being run, on the recommendations of the Board of Studies in Medical Sciences and Faculty of Medical Sciences.

iv) In case of non-availability of External Examiners from amongst the affiliated colleges of BFUHS, External Examiners may be appointed from the colleges which are not affiliated to BFUHS, Faridkot, in and outside the State of Punjab.

11. Paper setting and moderation of Question Papers

Each theory paper shall be of three hours duration. The paper setting and moderation of Question Papers will be got done under the direction of the Vice-Chancellor, if necessary.

The question paper covering the entire course shall be divided into two sections.

Section A:

Question 1: This will consist of five short answer questions with answer to each question up to 250 words in length. All questions will be compulsory. Each question will carry 5 marks total weight-age being 25 marks.

Question 2: This will consist of two long answer questions with answer to each question up to 1000 words in length in length. Two questions will be set by the examiner and the candidate will be required to attempt one. Each question will carry 15 marks.

Section B

Question 1: This will consist of five short answer questions with answer to each question up to 250 words in length. All questions will be compulsory. Each question will carry 5 marks total weight-age being 25 marks.

Question 2: This will consist of two long answer questions with answer to each question up to 1000 words in length. Two questions will be set by the examiner and the candidate will be required to attempt one. Each question will carry 15 marks.

12. 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 Vice-Chancellor.

13. Minimum pass marks:

The minimum number of marks to pass the examination shall be 50% in theory including Internal Assessment & Oral/Viva and 50% in practical including Internal Assessment in each subject separately except in the subject of English where minimum pass marks shall be 35%.

A successful candidate on the basis of theory and practical marks taken together shall be classified as under: -

Second Class **:** A candidate obtaining 50% or more marks but less than 60% marks
First Class **:** A candidate obtaining 60% or more marks
First Class with Distinction **:** A candidate obtaining 80% or more marks

14. Grace Marks:

That the grace marks up to 5 (five) be given to the best advantage of the students irrespective of Theory or Practical examinations.

15. Declaration of Result

The Registrar/Controller of Examinations shall publish the result after the examination. The candidates shall be issued Detailed Marks Certificate through their Principals.

16. Award of Degree

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

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SYLLABUS

First Year B.Sc. Radiotherapy Technology

Paper – I : Anatomy of Human Body

Theory: 70 Hours Practical: 20 Hours

THEORY:

1. **Introduction:**

- Definition of anatomy and its divisions, Terms of location, positions and planes.
- Cell and its organelles, Tissues & its classification, Glands.

2. **Musculoskeletal system:**

- Structure of Bone & its types.
- Joints- Classification of joints with examples; details of synovial joint.
- Bones & joints of upper limb, lower limb and their movements.
- Axial skeleton & appendicular skeleton.
- Skull, spine & its movements, intervertebral disc.
- Muscles & its types.
- Muscles of the upper limb, lower limb, trunk and neck.

3. **Cardiovascular System:**

- Arteries & veins, Capillaries & arterioles.
- Heart- size, location, chambers, blood supply of heart, pericardium.
- Systemic & pulmonary circulation.
- Major blood vessels of Heart- Aorta, pulmonary artery, common carotid artery, subclavian artery, axillary artery, brachial artery, common iliac artery, femoral artery.
- Inferior vena cava, portal circulation, great saphenous vein.

4. **Lymphatic System:**

- Lymph & Lymph vessels.
- Structure of lymph node, names of regional lymphatics, auxiliary and inguinal lymphnodes.

5. **Gastro-intestinal System:**

- Parts of GIT, structure of tongue, pharynx, salivary glands.
- Location & Gross structure of Oesophagus, stomach, intestine (small and large), liver,gall bladder, pancreas, spleen.

6. **Respiratory system:**

- Parts of Respiratory system; Structure of nose, nasal cavity, larynx, trachea, lungs, pleura, bronchopulmonary segments.

7. Urinary System:

- Parts of Urinary system, location and gross structure of kidney, ureter, urinary bladder, urethra.

8. Reproductive system:

- Parts of male reproductive system, gross structure of testis, vas deferens, epididymis, prostate.
- Parts of female reproductive system, gross structure of uterus, ovary, fallopian tube, mammary gland.

9. Endocrine glands:

- Name of all endocrine glands, gross structure & functions of pituitary gland, adrenal gland, thyroid gland and parathyroid gland.

10. Nervous system:

- Neuron, classification of NS.
- Meninges, ventricles, CSF.
- Gross features of cerebrum, midbrain, pons, medulla oblongata, cerebellum, name of basal nuclei.
- Blood supply of brain, cranial nerves.
- Spinal cord and spinal nerves.
- Autonomic nervous system.
- Visual & auditory pathways

11. Sensory Organs:

- Skin & its appendages.
- Structure of eye & lacrimal apparatus, name of extraocular muscles.
- Structure of ear: external, middle & inner ear.

PRACTICAL:

Demonstration of all bones AND organs of the human body.

Histology:

- Epithelium: Simple (squamous, cuboidal, columnar, ciliated), Stratified, Transitional
- Bone, muscles (skeletal, smooth, cardiac)
- Cartilage (hyaline, elastic, fibro cartilage).
- Connective Tissue (loose and dense).
- Arteries (large & medium sized), Veins.

Radiographs:

Normal Radiographs of Chest, Upper Limb, Lower Limb, pelvis & spine.

Reference Books

1. Ross and Wilson, Anatomy and Physiology, Chruchill Livingstone.
2. Companion Pocketbook for quick review
3. B.D. Chaurasia's Human Anatomy -Vol. (1,2,3)
4. Anatomy for B.Sc. Nursing – Dr Renu Chauhan

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SYLLABUS

First Year B.Sc. Radiotherapy Technology

Paper – II : Physiology of Human Body

Theory: 70 Hours Practical: 20 Hours

THEORY:

1. **Blood**

- Red Blood Cells- Functions, count, Physiological variations. Erythropoisis-stages
- Hemoglobin-Functions, Physiological variations.
- White Blood cells-Functions, count, morphology.
- Platelets-count, morphology, functions. Hemostasis-Definition, Mechanism, clotting factors.
- Blood groups-ABO system, Rh system, Blood transfusion- Indication, transfusion reactions.
- Anaemias-classification, morphological and Etiological, effects of anaemia on body.

2. Cardiovascular System

- Heart-Physiological Anatomy, Nerve supply, Properties of cardiac muscle.
- Cardiac Cycle-Events –systole, diastole
- Cardiac Output-Definition and factors affecting it.
- Heart sounds-normal heart sounds, its causes, areas of auscultations.
- Blood Pressure-Definition, normal value, Physiological variations, its measurement.
- ECG- normal waves.
- Shock-Definition, Types.

3. Gastrointestinal System

- Physiological Anatomy, functions of GIT.
- Salivary Gland-functions of saliva.
- Stomach- structure and functions, Gastric secretions-composition, functions, Mechanism
- Pancreas- structure, functions, composition of Pancreatic juice.
- Liver-Functions of liver.
- Bile-Composition, functions.
- Jaundice-Types and its causes.
- Gall Bladder- Functions
- Intestine- Movements of small and large intestine.
- Digestion and Absorption of Carbohydrates, Protiens, Fats.
- Hormones of GIT- Functions of Gastrin, Secretin, CCK-Pz.

4. **Respiratory System**

- Physiological Anatomy, Functions of the respiratory system.
- Types of respiration, respiratory membrane.
- Lung volumes and capacities, vital capacity and factors affecting it.
- Transport of Oxygen-Forms of transportation, Oxy-hemoglobin dissociation curve and factors affecting it.
- Transport of Carbon-Dioxide- Forms of transportation.

- Hypoxia-Definition, types, effects of hypoxia.
- Cyanosis-Definition and types.
- Artificial Respiration- CPR

5. Endocrine System

- Classification of Endocrine glands and their hormones.
- Thyroid Gland-Physiological Anatomy, hormones secreted, functions, disorders-Hypo and hyper secretion of hormone.
- Adrenal Gland-Adrenal Cortex-Physiological Anatomy, its hormones and functions.
- Adrenal Medulla-Hormones, functions.
- Pituitary Gland- Anterior and posterior pituitary hormones and their functions, disorders.
- Pancreas- Hormones and their functions, Diabetes Mellitus-types, pathophysiology, signs and symptoms.
- Parathyroid Gland- Hormones and their functions.

6. Central Nervous System

- Structure of neuron, functions of nervous system.
- Classification and properties of nerve fibres
- Synapse- structure and types
- Receptors-Definition, classification, properties, Reflex Arc
- Ascending and Descending tracts- names and functions
- Functions of Hypothalamus
- Functions of Cerebellum and Basal Ganglia
- Functions of Cerebral Cortex
- **Autonomic Nervous System-** Actions of sympathetic and parasympathetic system and their comparison.
- **Special Senses-**Eye-structure, functions of different parts, Visual acuity, Refractive errors, Ear-structure, functions, General mechanism of hearing

7. Excretory System

- Kidneys-structure of nephron, functions of kidney
- Glomerular filtration Rate(GFR) and factors affecting it
- Counter Current Mechanism
- Bladder-its innervation, micturition reflex

8. Reproductive System

- Male Reproductive System-Stages of spermatogenesis, function of Testosterone
- Female Reproductive System-Ovulation, menstrual cycle, functions of Estrogen and progesterone

9. Nerve Muscle Physiology

- Classification of Muscle, structure of skeletal muscle
- Neuromuscular Junction
- Excitation Contraction Coupling

PRACTICALS:

- Estimation of Hemoglobin Concentration
- Determination of Bleeding Time and Clotting Time
- Determination of Blood Groups
- Recording of normal Blood Pressure
- Clinical Examination of Arterial Pulse
- Determination of Vital Capacity

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SYLLABUS

First Year B.Sc. Radiotherapy Technology

PAPER – III Basic Radiation Physics

Theory: 70 Hours Practical: 30 Hours

No. of Lectures – 30.

Unit – I SI Units, Force, mass, momentum, work, energy, power, density, pressure, heat, sound, wave and oscillations.

Unit-II 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.

Unit-III Nuclear Transformations : Radioactivity, decay constant, activity half life, mean life, radioactive series, radioactive equilibrium, modes of decay : α-decay, β-decay, electron capture, internal conversion, isomeric transition. Nuclear reactions: (α,*p*) reaction, (α, n) reaction, proton bombardment, deuteron bombardment, neutron bombardment, photodisintegration, fission, fusion, activation of nuclides, nuclear reactors.

Unit-IV 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. Orthovoltage and megavoltage beam, their interactions and clinical applications.

Unit-V 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 (Bremsstrahlung and Characteristic x-rays).

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SYLLABUS

First Year B.Sc. Radiotherapy Technology

Paper-IV Oncopathology & Radiobiology

Theory: 70 Hours Practical: 30 Hours

No. of lectures – 30

Unit-I Neoplasia, nomenclature of tumors, general pathology of tumors, cancer genetics (oncogenes, tumor suppressor genes), local and general effects of malignant tumors and its spread, molecular basis of cancer & carcinogenesis (chemical, radiation, microbial), host defence against tumors, tumor markers, co-morbidities, prevention, early detection, public awareness on early signs and symptoms, high risk groups. Malignant and non-malignant tumors treated by Radiation Oncology.

Unit-II Introduction to

1. Malignant and non-malignant tumours.
2. Radioactivity and types of ionizing radiations used in treatment of malignancy, sources and techniques.
3. Tissue tolerance, tumour lethal dose, therapeutic ratio and radio sensitivity.
4. Units of exposure and radiation, prescription of radiation treatment.
5. General principles of documentation of radiation reactions and normal tissue tolerance (Emami & Quantec). LD5 & LD50. Grading (RTOG & CTCAE) of Radiation Reactions in Skin and Mucosa, Upper & Lower GI tract, Genito-Urinary system, Respiratory system, CNS.
6. Classification of radiation Damage (Lethal, Potential Lethal and Sub Lethal damage)
7. Tissue structure of organs (Serial & Parallel) and classification tissue radiation sensitivity (Casarett & Michalowski).

Unit – III Biological effects of radiation: Direct and indirect action of radiation, cell cycle effect, somatic and genetic effects. Chromosomal aberration and its application for the biological dosimetry, repair of radiation damage & dose rate effect, Effects on tissues and organs: (Stochastic and non-stochastic or deterministic effects, radiation carcinogenesis, acute effects, late effects), acute effects of total body irradiation, Effects of radiation on Embryo & fetus: (lethal effects, organ malformation, growth impairment, cancer induction, genetic effects), Late or delayed effects : (cataract formation, cancer induction).

Unit – IV Cell kinetics, Cell cycle regulatory control mechanisms , Tumour biology, Cell Survival Curve, LET, RBE , OER, The four 'R's of radiobiology , Tissue structure and radiation effect , The Linear Quadratic (LQ) model , Tumour control probability (TCP), Normal Tissue Complications Probability (NTCP).

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SYLLABUS

First Year B.Sc. Radiotherapy Technology

Paper-V

ENGLISH

Theory : 35 hours

Communication:-

Role of communication Defining Communication Classification of communication Purpose of communication
Major difficulties in communication Barriers to communication
Characteristics of successful communication – The seven Cs Communication at the work place
Human needs and communication "Mind mapping" Information communication

Comprehension passage:-

Reading purposefully
Understanding what is read
Drawing conclusion
Finding and analysis

Explaining:-

How to explain clearly
Defining and giving reasons
Explaining differences
Explaining procedures
Giving directions

Writing business letters:-

How to construct correctly
Formal language
Address
Salutation
Body
Conclusion

Report writing:-

Reporting an accident
Reporting what happened at a session
Reporting what happened at a meeting

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SYLLABUS

Second Year B.Sc. Radiotherapy Technology

Paper-I : Physics of Radiation Oncology

Theory: 70 Hours Practical: 30 Hours

No. of lectures – 30

Unit – I. Radiation protection units & quantities: Activity, Becquerel (Bq), exposure, roentgen, absorbed dose, rad, Gray, rem, Sievert, KERMA. Dose equivalent (H). Committed dose equivalent (H_T), effective dose equivalent (H_E), Equivalent dose (H_{TR}), effective dose (E). ALI, DAC.

Unit – II. 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 their influencing factors. Relation between TAR and PDD. Scatter-air-ratio.

Unit – III. 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. Scatter maximum ratio (SMR). Dose calculations for linear accelerator and Co-60 unit using Sc, Sp factors for SSD and SAD methods.

Unit – IV. Electron beam therapy: Electron interactions, rate of energy loss, collisional losses (ionization and excitation) radiation losses (bremsstrahlung), stopping power, absorbed dose, electron scattering, most probable energy, mean energy, energy at depth. Field flatness and symmetry, beam collimation, field size dependence, electron source, x-ray contamination.

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SYLLABUS

Second Year B.Sc. Radiotherapy Technology

Paper-II :Radiation Oncology Equipment & QA Procedures-Brachytherapy

Theory: 70 Hours Practical: 30 Hours

No. of lectures – 30

Unit – I. 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.

Unit – II. Principles of remote controlled afterloading 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 afterloading brachytherapy units.

Unit – III. Concept of low dose rate brachytherapy units – sources used in low dose rate brachytherapy applications. Construction, QAs and working mechanism of LDR remote controlled brachytherapy units. Sources and procedures of permanent brachytherapy applications.

Unit – IV. 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 and PDR units.

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SYLLABUS

Second Year B.Sc. Radiotherapy Technology

Paper – III : Radiation Oncology Equipment & QA Procedures-Teletherapy

Theory: 70 Hours Practical: 30 Hours

No. of lectures – 30.

Unit-I Kilovoltage units: Grenz-ray, contact, superficial and orthovoltage or deep therapy units, construction of therapy tube, Supervoltage therapy units.
Megavoltage therapy units: Vande Graaff Generator, Betatron, Microtron, Cyclotron.

Unit-II Telegamma Units : Sources and their properties, preparation of telegamma sources Co-60 units: source housing, source movement mechanisms. Fixed Gantry units, isocentric units, Beam collimation and penumbra. Head leakage in on/off position, collimator leakage in on position. QA procedures of telegamma units.

Unit-III 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, complete QA procedures of the LINAC. Heave charged particle (Proton & negative pions) beam generators. Neutron generators: D-T generator, cyclotron.

Unit-IV Design and working principles of conventional simulator, simulator-CT, CT-Simulator. QA procedures of simulators. Basic principles of CT scanner and its image processing along with interconnectivity with treatment planning system. Brief overview of different generations of CT-scanners.

Unit-V Physics of MRI. Brief introduction of tissue relaxation parameters and its applications in different types of imaging. Application of MRI in Radiation Oncology planning.
Physics of ultrasound. Design and construction of US transducer Doppler principle and its application in diagnostic imaging and Radiation Oncology plannings.

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SYLLABUS

Second Year B.Sc. Radiotherapy Technology

Paper IV : Radiation Oncology Planning & Techniques-Teletherapy

Theory: 70 Hours Practical: 30 Hours

No. of Lectures : 30.

Unit – I. Basic principles and clinical applications of beam direction and modification devices in Radiation Oncology planning. Clinical application of mould room techniques: Immobilization & Positioning aids-Breast boards, Lung boards, Belly boards, Head-and-neck fixation devices, Vacuum packs, Stereotactic frames. Internal organ motion control- Bite blocks, Gating systems. Laser/ positioning systems, Marking systems, Isocentre determination, Reference points, Treatment couch.

Unit – II. Isodose curves, isodose charts, measurements of isodose curves. Influency parameters of isodose curves: beam quality source size, SSD, SDD, penumbra, collimation & flattening filter, field size. Wedge filters: wedge angle, wedge factor, wedge systems, effect of beam quality, design of wedge filters. **Combination of radiation fields**: (1) parallel opposed fields; patient thickness Vs dose uniformity, edge effect (lateral tissue damage), integral dose. (2) Multiple fields: three fields, four fields box technique, four field cross fire technique. **Isocentric techniques:** (1) stationary beams & (2) rotation therapy. Wedge field techniques. Definitions of following terms: Gross tumor volume (GTV), clinical target volume (CTV), planning target volume (PTV), irradiated volume cold and hot spots.

Unit – III. Acquisition of patient data: body contours, internal structures using radiographs, CT, MRI, US etc.; for 2-D & 3-D treatment planning. Treatment simulation using conventional simulator, Simulator CT, CT simulator and virtual simulator. Treatment verification using port films, electronic portal imaging devices. Concept of Corrections done for tissue inhomogeneties and contour irregularities. Tissue compensator, bolus, patient positioning.

Unit IV. 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, effect of absorber to skin distance, effect of field size, electron filters. Separation of adjacent fields; orthogonal field junction, craniospinal fields, guidelines for field matching

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SYLLABUS

Third Year B.Sc. Radiotherapy Technology

Paper-I : Clinical Oncology & Radiation Oncology Planning

Theory: 70 Hours Practical: 30 Hours

No. of lectures – 40

Unit – I Epidemiology, etiology, pathology, route of spread (local, regional lymphatic & distant hematogenous), performance status, signs and symptoms, clinical examination, diagnosis (FNAC, biopsy, laboratory tests, imaging methods), staging and grading (TNM staging system, other commonly used systems), prognosis, stage wise overall treatment flowchart (neo-adjuvant, radical, adjuvant, palliative) of different site wise malignancies & non-malignant diseases.

Unit – II Primary management of malignancy (surgery, Radiation Oncology, chemotherapy) with special focus to indications of Radiation Oncology, Radiation Oncology treatment technique, planning (2D conventional, 3D conformal), dose prescription & OAR constraints in radiation treatment for cancer of different anatomic sites: brain, pituitary, oral cavity, nasopharynx, oropharynx, hypopharynx, larynx, maxillary antrum, parotid, thyroid, unknown primary with neck node, breast, esophagus, lung, stomach, hepato-billiary, rectum, anal canal, bladder, prostate, cervix, uterus, vagina, vulva, penis, testes, bone, sarcoma, lymphoma & unknown primary.

Unit – III Special treatment techniques like craniospinal radiation in medulloblastoma, german helmet technique in leukemia, mantle field irradiation, inverted Y, involved field Radiation Oncology (IFRT & INRT) in lymphoma, dog leg technique in testicular tumors, ophthalmic tumors, Hemi body irradiation, TBI, TSET, irradiation techniques using photons and electrons.

Unit – IV Time dose & fractionation in Radiation Oncology, radio-biologic principles in fractionation, various altered fractionation, various treatment combinations and treatment scheduling in Radiation Oncology, radio sensitizers, radio protectors and side effect reduction in Radiation Oncology.

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SYLLABUS

Third Year B.Sc. Radiotherapy Technology

Paper – II : Radiation Oncology Planning & Techniques- Brachytherapy

Theory: 70 Hours Practical: 30 Hours

No. of Lectures – 30

Unit – I. 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. Calibration of brachytherapy (mgRa), 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. Exposure rate constant, exposure rate and effect of inverse square law

Unit – II. Interstitial implant dosimetry systems :

1. **Manchester system** : Distribution rules, dose specification, Paterson Parker. tables for planar and volume implants.
2. **Quimby system** : Distribution rules, and dose specification
3. **Paris system** : Distribution rules and dose specification. Definitions of implant plane, basal dose points, reference dose/dose rate, implant length, width, height and safety margin in single and double plane implants.

Unit – III. Intracavitory brachytherapy(Ca.Cx.) dosimetry systems :

1. **Stockholm system** : Source placement and dose prescription rules. Type of applicators and their packing.
2. **Paris system :** Source placement and dose prescription roles. Type of applicators and its packing.
3. **Manchester system :** Definition of points. A, B and point P. Manchester applicators, radium loading as per Manchester criteria. Dose/dose-rate to points Z & B for different tandom 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.

Unit – IV. Applicators of Ca Cx : Pre-loaded applicators (Stockholm, Paris etc.), Fletcher suit applicators. Henschke applicators, ring applicators, vaginal applicators. Different tools, catheters and other necessary items required for interstitial implant.
Templates : Syed/Neblelt template, Martinez universal perineal interstitial template(MUPIT) , rectal templates, prostate implant templates, breast template..
Others : Esophageal applicators, bronchial applicators, intravascular applicators, surface moulds.

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SYLLABUS

Third Year B.Sc. Radiotherapy Technology

Paper – III : Radiation Protection and Monitoring

Theory: 70 Hours Practical: 30 Hours

No. of Lectures – 30

Unit – I. Sources of radiation exposure: Natural sources and human made sources. Internal and external hazards. Standards and regulations, philosophies of exposure limit, occupational limits, non-occupational limits. AERB/ICRP recommendations.
Personal dosimetry devices: Film badges, TLD badges, pocket ion chambers,

Unit – II. Principles of gas filled 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. Scintillation counters, semiconductor detectors, gamma & x-ray monitoring, neutron monitoring detectors. Area monitors, survey monitors, GM counters.

Unit – III. Principles of Radiation Protection, ALARA. Methods for reduction of radiation exposure: Time, Distance & Shielding. Attenuation by a shield with build-up and without build-up. Shielding principle : X-ray shielding, β particle shielding and neutron shielding

Unit – IV. Model layouts of Telecobalt, Medical Linear Accelerator and Remote Afterloading Brachytherapy facilities. Installation shieldings: maximum permissible exposure through shielding barriers; workload, use factor, occupancy factor, shielding: primary barrier; secondary barrier, leakage and scatter radiation. General formula for calculation of primary & Secondary barrier thickness. Maze design, width of the maze wall, scatter radiation reaching door, neutron shielding.

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SYLLABUS

Third Year B.Sc. Radiotherapy Technology

Paper – IV : Recent Advances in Radiation Oncology Techniques

Theory: 70 Hours Practical: 30 Hours

No. of Lectures – 30

Unit – I. Gamma Knife: construction, design and working principles. QA procedures and different clinical applications of gamma knife. Dose prescription criteria in the treatment of gamma knife. X-knife, necessary accessories required for X-knife, energy choice of x-ray photons in X-knife

Unit – II. Design and working of MLC and MMLC. QA procedures of MLC and MMLC, use of MLC and MMLC in conformal Radiation Oncology (CRT) and intensity modulated Radiation Oncology (IMRT). Use of MMLC in stereotactic Radiation Oncology and IMRT. Inverse planning system.

Unit – III. Principles of 2-D and 3-D treatment planning of Radiation Oncology. Use of computers in Radiation Oncology treatment planning's. Concept of DRR and virtual simulator, 3-D conformal Radiation Oncology (3DCRT), intensity modulated Radiation Oncology (IMRT), image guided Radiation Oncology (IGRT), Volumetric Arc Therapy (VMAT), Tomotherapy, Cyber Knife, SRS, SRT, SBRT, 4DCT planning with gating or other motion management techniques like ABC.

Unit – IV. Explanation of PDR unit and their use in brachytherapy. Radiobiological explanation of PDR treatment techniques. Advantage and disadvantage of PDR brachytherapy. QA procedures.

Unit-V Principles and working of asymmetric jaws in Radiation Oncology. Techniques in which asymmetric jaws are used. Use of asymmetric jaw movement to get virtual wedge, matching of adjacent beams in breast & medulloblastoma etc.

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BOOKS RECOMMENDED

Sr. No.	Title Of Book, Edition / Year	Name (S) Of Author (S)	Publishers
1.	Radiobiology For The Radiologist. , 2012	Hall, E.J., & Giaccia, A.J.	Lippincott Williams & Wilkins, Philadelphia.
2.	Central Axis Depth Dose Data For Use In Radiation Oncology, 1996	-	British Journal Of Radiology, Bjr Suppl. 25, London.
3.	Fundamental Physics Of Radiology, 3rd Edition, 1976	Meredith & Massey	A John Wright & Sons Ltd.
4.	Radiation Oncology Physics, A Hand Book For Teachers And Students, 2005	Eb Podgorsak	International Atomic Energy Agency
5.	The Physics Of Radiology, 4th Edition, 1983	Harold Eleford Johns And John Robert Cunningham	Charles C Thomas, Springfield, Illinois, Usa
6.	The Physics Of Radiation Therapy, 3rd Edition, 2003	Faiz M. Khan,	Lippincott William & Wilkins
7.	Radiation Detection And Measurement , 2nd Edition 1988	Glenn F. Knoll	John Wiley & Sons
8.	The Basic Physics of Radiation Therapy (3rd Edition, 1990).	Joseph Solman	Charles C. Thomas
9.	Principles of Radiation Therapy	Beeley	Butterworth
10.	Foundations of Anatomy and Physiology	Ross and Wilson	Churchill Livingstone
11.	An Atlas of Radiological Anatomy	Weir and Abrahms	Pitman Medical
12.	Treatment Simulators British Journal of Radiology Supplement	-	Medical Physics Corporation, U.S.A.
13.	Radionuclides in Brachytherapy Radium and After B.J.R. Supplement	-	- do -
14.	Quality Assurance in Radiation Therapy. A Manual for Technologists	M.J. Wizenberg	American College of Radiology, Chicago
15.	Essential Physics for Radiographers	Ball and Moore	Blackwell Scientific Wreight
16.	Surface Anatomy for Radiographers	Mekears and Owen	- do -
17.	Fundamental Physics for Radiology	Meredith and massey	Wright
18.	Clark's Positioning in Radiography	Kreel	Heinemann
19.	Principles of Radiation Oncology	Paterson	
20.	X-ray Physics and Equipment	Ashuworth	Blackwell Scientific Publishers
21.	Physics of Radiology	Johns Charles Thomas	Springfield, U.S.A.
22.	Technological basic of Radiation Therapy : Practical, Clinical Application.	Hope and Stone	Crosby Lockwood and Staples
23.	Radiographic Anatomy of the Human Skeleton	Markin and Harbison	
24.	Radium Dosage Manchester System	M.M. Bleehen	Marcel Dekker Int. New York.

25.	Radiation Oncology in Modern Clinical Practice	Paterson & Parken	B.J. Radiology, 1934,36,38.
26.	Introduction to Radiation Protection	Paterson	Edwar Arnold London.
27.	Radiation Therapy Planning	Perez and Brady	Lippincott & Raven, New York.
28.	A Dosage System for Gamma Ray Therapy	M.S. Aggarwal	Khandelwal Offsets, Varanasi.
29.	The Treatment of Malignant Disease by Radiation Oncology	Hope and Stone	Crosby Lockwood and Staples
30.	Principles & Practice of Radiation Oncology	Markin and Harbison	
31.	Hankbook of Physics for Radiotherapists	M.M. Bleehen	Marcel Dekker Int. New York.

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