

**Sri Guru Ram Das University of Health Sciences, Amritsar**  
**Course Structure for the Bachelors in Radiotherapy (Code-BRT.2.7)**

Course code	Course Title	Course Type	L+T+P	Total Credits/ Week	Weightage Theory/ Practical IA+UE
<b>Semester-I</b>					
BRT-ANT.201	Anatomy-I	Foundation	3+0+2	5	25+25=50T 50P
BRT-PHY.201	Physiology-I	Foundation	3+0+2	5	25+25=50T 50P
BRT-PAT.201	Pathology	Foundation	2+1+0	3	25+25=50T
BRT.201	Basic Radiation Physics	Core	3+0+2	3	50+50=100T 50P
ECO.250	English/ Communication skills	Elective	2+0+0	2	only grade
<b>Total Credits</b>			<b>13+1+6</b>	<b>20</b>	<b>400</b>
<b>Semester-II</b>					
BRT-ANT.202	Anatomy-II	Foundation	3+0+1	4	25+25=50T 50P
BRT-PHY.202	Physiology-II	Foundation	3+0+1	4	25+25=50T 50P
BRT.202	Basic Principles of Radiotherapy	Core	4+0+4	8	50+50=100T 100P
COM.250	Computer applications	Elective	2+0+0	2	NC
<b>Total Credits</b>			<b>12+0+8</b>	<b>20</b>	<b>400</b>
<b>Semester-III</b>					
BRT.301	Clinical Oncology- I	Core	3+1+4	8	50+50=100T 100P
BRT.302	Physics of Radiotherapy- External and Brachytherapy	Core	3+1+4	8	50+50=100T 100P
HVE.350	Human Values & Ethics	Elective	3+0+0	3	NC
<b>Total Credits</b>			<b>9+2+10</b>	<b>21</b>	<b>400</b>
<b>Semester-IV (new)</b>					
BRT.303	Radiotherapy Equipment	Core	3+0+2	5	30+70=100T 30+70=100P
BRT.304	Quality Assurance in Radiotherapy	Core	2+0+2	4	30+70=100T 10+40=50
BRT.305	Basic Radiotherapy Physics	Core	3+0+1	4	30+70=100T 10+40=50P
BRT.306	Biological Effects of Radiation	Core	1+0+1	2	10+40=50T 10+40=50P
BRT.350	RTT Directed Clinical Education –I	Core	0+0+5	5	NC
<b>Total Credits</b>			<b>9+0+11</b>	<b>20</b>	<b>600</b>
<b>Semester-V</b>					
BRT.401	Clinical Radiobiology	Core	3+0+2	5	30+70=100T 30+70=100P
BRT.402	Mould Room /Motion Management Techniques	Core	2+0+3	5	30+70=100T 30+70=100P
BRT.403	Special RT Techniques and Recent advances	Core	2+0+2	4	10+40=50T 10+40=50P
BRT.450	RTT Directed Clinical Education – II	Core	0+0+10	10	NC
<b>Total Credits</b>			<b>7+0+17</b>	<b>24</b>	<b>500</b>

<b>Semester-VI</b>					
BRT.404	Radiological/Nuclear Medicine/Other Imaging Techniques in Radiotherapy Planning	Core	2+0+2	4	30+70=100T 30+70=100P
BRT.405	Radiotherapy treatment delivery	Core	2+0+2	4	30+70=100T 30+70=100P
BRT.406	Operational Issues in Radiation Therapy	Core	2+0+2	4	30+70=100T 30+70=100P
BRT.450	RTT Directed Clinical Education –III	Core	0+0+10	10	NC
<b>Total Credits</b>			<b>6+0+16</b>	<b>22</b>	<b>600</b>
<b>Semester-VII (Internship six month)</b> minimum 840 hours (calculated based on 6 hours per day for six months of internship)					
<b>Grand Total</b>			<b>55+4+63</b>	<b>122</b>	<b>2600</b>

## Fourth Semester

### BRT.303: Radiotherapy Equipment

In this paper, the students learn more about the accessories used along with radiotherapy equipment such as on-board imaging, dosimetry accessories, use of computers in RT and various types of networking used in RT:

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

Brachytherapy- Design features, Radiation sources, Technique, High dose-rate (HDR), Low dose-rate (LDR), Pulsed dose-rate (PDR), various types of applicators.

Teletherapy Machines & Accessories:

- Telecobalt Machines
- Medical linear accelerators.
- Tomotherapy
- Machine properties.
- Beam directing, modifying and defining devices.

### BRT.304: Quality Assurance in Radiotherapy

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

Accessories and tools used for QA tests in Radiotherapy such as Front pointer, Back pointer, Laser Alignment etc. Optical and radiation field congruence, Beam shaping blocks, Beam shaping jaws, Delineator/Diaphragm movements, Isocentre alignment, Patient support system, Beam on and off mechanisms, Technician's role in QA tests on telecobalt /Linear Accelerator / Brachytherapy/ Gamma knife/Simulator/CT Simulator machines.

### **BRT.305: Basic Radiotherapy Physics**

Historical developments in Radiotherapy, Physical components of Telecobalt Unit / Linear Accelerator Unit / Remote After Loading Brachytherapy Unit / Gamma Knife Unit / Simulator/Brachytherapy units and their descriptions, Various types of sources used in Radiotherapy and their properties, Physics of Photons, electrons, protons and neutrons in radiotherapy, Physical parameters of dosimetry such as Percentage Depth Dose, Tissue-Air Ratio, Tissue Maximum Ratio, Physics of Bolus and Phantom materials, Compensators, Wedges, Shielding Blocks, Patient immobilization devices, Port film, processing and development, Special techniques in Radiotherapy such as SRS, SRT, IMRT, IGRT and Tomotherapy.

### **BRT.306: Biological Effects of Radiation**

The Cell, Effect of ionising radiation on Cell, Chromosomal aberration and its application for the biological dosimetry, Somatic effects and hereditary effects, stochastic and deterministic effects, Acute exposure and Chronic exposure, LD<sub>50/60</sub>. Role of RTT in managing the acute effects of radiation.

### **BRT.350: RTT Directed Clinical Education-I**

Students will improve their skills in clinical procedures. Progressive interaction with patients and professional personnel are monitored as students practice radiation therapy in a supervised setting. Additional areas include problem solving, identifying machine components and basic side effect management. Students will demonstrate competence in beginning, intermediate, and advanced procedures.

### **Practical & Demonstration:**

#### **Practical part-1:**

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

#### **Practical part-2:**

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

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

### Clinical Radiobiology

In simplest terms, radiobiology is the study of the action of ionizing radiation on living structures and organisms. Radiobiology is the basic science behind radiotherapy and it can explain, and occasionally also predict responses of tumours and normal tissues to radiation. Knowledge of the principles of radiobiology allows the RTT to comprehend the effects of different types of radiation, fractionation schemes, the use of radio sensitizers and other interactions he/she observes on a daily basis.

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

### Mould Room /Motion Management Techniques

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

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

### Special RT Techniques and Recent advances

1. Wedges-tissue compensator-irregular field-SSD&SAD technique-oblique field-arc-rotational and moving field
  2. Mantle field-irregular field-Hemi body irradiation-whole body irradiation-total body skin irradiation
  3. Special techniques in Radiation Therapy, (SRT) – Stereo tactic Radio surgery (SRS) – . Methods – BRW and CRW frames – angiographic localizer box – preparation of target sheets – Quality Assurance – Isocentric check – Treatment execution – care to be taken – check list.
  4. Conformal Radiotherapy: Principles of 3 D treatment.
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5. Recent developments in radiotherapy and treatment techniques
  6. Proton therapy and carbon ion therapy
  7. artificial intelligence

#### RTT Directed Clinical Education –II

The course provides students the opportunity to continue to develop confidence and increased skill in simulation and treatment delivery. Students will demonstrate competence in beginning, intermediate, and advanced procedures in both areas. Students will participate in advanced and specialized treatment procedures.

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## Sixth Semester

### Radiological/Nuclear Medicine/Other Imaging Techniques in Radiotherapy Planning

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

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

### Radiotherapy treatment delivery

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

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

### Operational Issues in Radiotherapy.

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

### RTT Directed Clinical Education –III

This course is the final in a series of five directed clinical courses. The student will complete the clinical training by practicing all the skills learned in classroom and clinical instruction.

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## Seventh Semester

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

The internship will span at least 06 months (1 semester). This will include 8 hours (min) of practice a day, totaling to 720 hours for one semester assuming 90 working days in a semester. As a part of this, the students will choose a relevant subject and prepare an in-depth project report of not less than 1000 words which will be handed over to the supervisor or trainer. The report can include objective, scope of the project and an in-depth report.

## Skills based outcomes and monitorable indicators for Radiation Therapist

Competency statements

1. Demonstrate knowledge to interpret and evaluate a treatment prescription
  2. Understands the place of treatment planning processes in RT and performs RTTs role in it (appropriate patient-set-up, immobilization and image scanning with relevant protocols).
  3. Communicates relevant information to other members and completes accurate documentation
  4. Demonstrates ability to prepare the shielding devices
  5. Conducts the simulation and mark-up procedure for all standard treatment techniques
  6. Demonstrates ability to carry out the daily organization of the treatment unit
  7. Practices accurate treatment documentation
  8. Demonstrates ability to interpret, apply and disseminate information as a member of the radiotherapy team
  9. Demonstrates professional behaviour
  10. Demonstrates a sensitive and caring attitude towards the patient
  11. Demonstrates ability to accurately and consistently set-up and treat the patient
  12. Demonstrates ability to prepare the patient for their first treatment
  13. Evaluates and monitors the patient performance status
  14. Monitors, manages and records the patient's side effects throughout the course of treatment
  15. Advises patient on appropriate nutrition, sexual function, rest, skin care, nausea and other symptoms
  16. Demonstrates skill to support and care for the patient during a brachytherapy procedure
  17. Demonstrates ability to carry out the necessary data transfer checks
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18. Acquires the initial verification images
  19. Demonstrates ability to carry out treatment verification as per protocol/under supervision
  20. Demonstrates ability to carry out corrective actions as per instructions
  21. Follows health and safety procedures
  22. Demonstrates ability to interpret, apply and disseminate information as a member of the radiotherapy team
  23. Follows necessary radiation protection regulations as per instructions
  24. Demonstrates knowledge and skills to carry out the daily patient related QA as per protocols.
  25. Participates in research activities
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