Course Plan: Radiation Therapy Physics 1 (2 Credits)

Course Information

Course Title: Radiation therapy Physics
Level: M.Sc. In Medical Physics
Credits: 2 Credit Hours
Format: 2 Hours Lecture per Week

Course Description

This course provides a comprehensive introduction to the physical principles underlying radiation therapy. Topics include atomic structure, radioactive decay, production of x-rays, photon and charged-particle interactions with matter, linear accelerators, dosimetry, treatment planning basics, brachytherapy, and radiation protection. Emphasis is placed on clinical applications and problem-solving skills essential for medical physicists, dosimetrists, and radiation therapists.

Overall Learning Objectives

Upon successful completion of this course, students will be able to:

1. **Explain** the fundamental physics of atomic structure, radioactivity, and radiation production.
2. **Differentiate** the mechanisms of photon and charged-particle interactions with matter and predict their biological and clinical implications.
3. **Operate** basic dosimetry concepts, including dose calculation, beam calibration, and measurement techniques.
4. **Analyze** depth-dose distributions and beam data for both photon and electron beams.

5. **Apply** treatment planning principles for external beam radiotherapy (3D-CRT, IMRT, VMAT) and brachytherapy.
6. **Calculate** shielding requirements and evaluate radiation safety protocols in a clinical environment.
7. **Interpret** clinical dose-volume constraints and recognize the role of physics in quality assurance.
8. **Critically evaluate** published dosimetry data and treatment plans using standard reference sources.

Expectations (What You Will Be Able to Do After This course)

Area	Specific Outcomes
Clinical readiness	Communicate effectively with radiation oncologists and therapists about beam energies, field sizes, and dose prescriptions.
Problem-solving	Perform manual dose calculations for common clinical scenarios (SSD and SAD techniques).
Equipment knowledge	Identify components of a linear accelerator and explain their function during treatment delivery.
Safety competency	Apply ALARA principles and perform basic room shielding calculations.
Critical thinking	Assess the impact of tissue heterogeneities (bone, lung) on dose distributions.
Quality assurance	Understand routine QA procedures for linear accelerators and brachytherapy sources.
Research readiness	Read and interpret key graphs (PDD, TMR, OAR) from standard physics reports.

Weekly Course Schedule (15 Weeks + Exams

Week	Topic	Key Content
1	Introduction & Atomic Structure	Course overview, atom composition, atomic/mass numbers, electromagnetic spectrum basics
2	Radioactive Decay	Decay laws, half-life, activity calculations, alpha/beta/gamma decay modes
3	X-ray Production	Bremsstrahlung & characteristic radiation, x-ray tube components, KVp, filtration, output spectra
4	Photon Interactions with Matter	Photoelectric, Compton, pair production; attenuation coefficients, HVL, exponential attenuation
5	Charged-Particle Interactions	Elastic/inelastic processes, LET, stopping power, range; electron beam therapy basics
6	Treatment Machines (Part 1)	Cobalt-60 units, linear accelerator design & components, photon/electron production
7	Treatment Machines (Part 2)	Betatrons, cyclotrons, simulators, CT-simulation, collimators, wedges, bolus, compensators
8	**Midterm Exam**	Comprehensive review of weeks 1–7
9	Dosimetric Quantities	Exposure, Kerma, absorbed dose; beam output factors, beam quality, ion chamber measurements
10	Beam Calibration & Measurement	Ion chambers, diodes, calibration protocols (TRS-398), electron equilibrium, Bragg-Gray principle
11	Photon Dosimetry	PDD curves, TAR, TMR, tissue-phantom ratios; SSD vs SAD dose calculations
12	Electron Dosimetry	Depth-dose curves, practical range, energy selection, heterogeneity corrections
13	Treatment Planning Principles	Isodose curves, field combinations, 3D-CRT, IMRT, VMAT concepts, tissue inhomogeneity corrections

Week	Topic	Key Content
14	Brachytherapy	LDR vs HDR, common sources (Ir-192, I-125, Cs-137), source selection, planning principles
15	Radiation Protection & Health Physics	ALARA principles, shielding calculations (primary & secondary barriers), dose limits, regulations
16	**Final Exam**	Comprehensive coverage of all topics

Suggested Primary Textbook

- **Faiz M. Khan**, *The Physics of Radiation Therapy* (current edition) – standard reference used in most medical physics training programs.

Supplemental Resources

- IAEA – *Radiation Oncology Physics: A Handbook for Teachers and Students* (free online)
- Johns & Cunningham – *The Physics of Radiology*
- Cherry, Sorenson & Phelps – *Physics in Nuclear Medicine* (for brachytherapy & isotope sections)

Grading Breakdown (Proposed)

Component	Percentage
Attendance & Active Participation	5%

Component	Percentage
Weekly Problem Sets / Homework	15%
Weekly Quizzes (short, 10–15 min)	10%
Midterm Exam	30%
Final Exam	40%
Total	**100%**

Prerequisites (Recommended)

- Basic physics (mechanics, electricity, magnetism)
- Elementary calculus and algebra
- Introductory anatomy/physiology (helpful but not mandatory)

Teaching Methods

- **Lectures** with slide presentations and board work
- **Problem-solving sessions** during class
- **Case-based discussions** linking physics to clinical scenarios
- **Optional lab demonstrations** (if equipment available)

Final Takeaway

By the end of this course, you will not only master the theoretical foundations of radiation physics but also gain practical confidence to collaborate in a radiotherapy department, perform basic dose calculations, and understand the physical rationale behind modern treatment techniques.