CURRICULUM FOR POST GRADUATE PROGRAM ON RADIATION PHYSICS

M.Sc., (Radiation Physics)

Rajiv Gandhi University of Health Sciences,
Bangalore

Section I:

Regulations Governing M.Sc. Radiation Physics course

1. Title of the course

Master of Science degree in Radiation Physics course.

2. Duration of study

The duration of the course shall be on full time basis for a period of two years from the commencement of the academic term.

3. Eligibility for Admission

Candidates who have passed final year of B.Sc., Science stream examination with **Physics as major subject** with 60% marks for general category and 55% for reserved category.

4. Selection Criteria

The short listed candidates will have to present themselves to a selection process, comprising written test. The marks obtained in the entrance test would solely be considered for selection to the course. Selected candidates would have to appear for student counseling to decide on the college of study.

5. Eligibility certificate

No candidate shall be admitted for the postgraduate degree course unless the candidate has obtained and produced the eligibility certificate issued by the university. The candidate has to make the application to the university with the following documents along with the prescribed fee.

Pass/Degree certificate issued by the parent university.
Marks card of all the university examinations passed.
Migration certificate.
Certificate of conduct.
Proof of SC/ST or category-I as the case may be.

Candidate should obtain the eligibility certificate before the last date of admission as notified by this university.

A candidate who has been admitted to post-graduate course should register his/her name in the university within a month of admission after paying the registration fee.

6. Medium of instruction

English shall be the medium of instruction for the subjects of study as well as for the examination.

7. Course of Study

The course shall be pursued on full time basis.

7.1. The training of this postgraduate degree shall be residency pattern with graded responsibilities in the management and treatment of cancer patients entrusted to his/her care. The course is mainly focused on practical aspects of **Radiological Physics**. Hence majority of the course pattern is dedicated towards all the practical aspects. The participation of the students in all facets of educational process is essential. Every candidate should take part in seminars, group discussions, case demonstrations, journal review meetings and clinics. Training should include involvement in laboratory and experimental work, and research studies.

7.2. The training also consists of posting the students in major cancer hospital across the country as **Field Training**, for a period of 3 weeks, before final year examination.

7.3. Every successful candidate is required to work also as Radiological Safety Officer (RSO) in addition to the responsibilities of a Medical Physicist. For this, every candidate needs to get **RSO certification** from Atomic Energy Regulatory Board (AERB), Mumbai, after successful completion of M.Sc. (Radiation Physics)

Subjects of study and teaching hours for first year and second year M.Sc, Radiation Physics course are shown in Table – I and Table – II respectively.

Table – I: Distribution of Teaching Hours in First Year M.Sc., Radiation Physics Subjects

Sl. No	Main Subjects	Theory No. of hours	Practical No. of hours	Training No. of hours	Total
1	Basic Radiation Physics	70	100	100	270
2	Principles of Imaging in Radiation Oncology	70	70	70	210
3	Introduction to Clinical Oncology	70	--	100	170
4	Quality Assurance, Calibration, Standardization in Clinical Dosimetry	80	120	120	320
	Subsidiary subjects				
	a. Bio Statistics & Numerical Methods in computation **b.** Surface Anatomy & Physiology	50 30			50 30
	TOTAL	370	290	390	1050

Table – II: Distribution of Teaching Hours in Second Year M.Sc., Radiation Physics Subjects

Sl. No	Main Subjects	Theory No. of hours	Practical No. of hours	Training No. of hours	Total
1	Advanced Radiation Physics	80	100	120	300
2	Radiological Safety & Protection	70	100	100	270
3	Radiation Biology	70	--	70	140
4	Advanced Clinical Radiation Oncology	70	100	120	290
	Subsidiary subjects				
	a. Management of Bio and Health Hazards **b.** Research Methodology	50 30			50 30
	TOTAL	370	300	410	1080

8. Attendance, Progress and Conduct:

8.1. A candidate pursuing this degree course should be associated with the concerned department for the full period as a full time student. No candidate is permitted to do any other course, running parallel, while studying this postgraduate course.

8.2. Each year shall be taken as a unit for the purpose of calculating attendance.

8.3. Every student shall attend symposia, seminars, conferences, journal review meetings, grand rounds, case presentations, clinics and lectures during each year as prescribed by the department and not absent himself/herself from work without valid reasons.

8.4. Every candidate is required to attend a minimum of 80% of the training during each academic year of the postgraduate course. Provided further, leave of any kind shall not be counted as part of academic term without prejudice to minimum of 80% attendance of training period each year.

8.5. Any student who fails to complete the course in the manner stated above shall not be permitted to appear for the University Examinations.

9. Monitoring Progress of studies

9.1. **Work diary / Log Book**: Each candidate shall maintain a work diary and record of his/her participation in the training programmes conducted by the department such as journal reviews, seminars, etc. (Please see the model checklists and logbook specimen copy, the details of which are given towards the end of this curriculum). The work diary shall be scrutinized and certified by the Head of the

Department and Head of the Institution, and presented in the university practical examination.

9.2. **Internal Assessment (IA):** Institutions running this course shall conduct three tests in First and Second year for internal assessment. The third test shall be conducted one month prior to the university examination so that it also serves as a preparatory examination. The marks obtained in these tests will be considered for internal assessment. Average of the best of two marks will be computed for internal assessment and shall be sent to the university as per the notification issued by Registrar (Evaluation) before each university examination. Records and marks obtained in tests will be maintained by the college and made available to the university. Marks of periodic tests shall be displayed on the notice board by the principal without fail.

If a candidate is absent from the test due to genuine and satisfactory reason, such a candidate may be given a re-test within a fortnight.

Table III. Distribution of Internal Assessment marks in first year M.Sc. Radiation Physics course

Sr. No	Subjects	Theory	Practical
1.	Basic Radiation Physics	25	25 Expt: 15 Record: 10
2.	Principles of Imaging in Radiation Oncology	25	25 Expt: 15 Record: 10
3.	Introduction to Clinical Oncology	25	--
4.	Quality Assurance, Calibration, Standardization in Clinical Dosimetry	25	25 Expt: 15 Record: 10

Table IV. Distribution of Internal Assessment marks in second year M.Sc. Radiation Physics course

Sr. No	Subjects	Theory	Practical
1.	Advanced Radiation Physics	25	25 Expt: 15 Record: 10
2.	Radiological Safety & Protection	25	25 Expt: 15 Record: 10
3.	Radiation Biology	25	--
4.	Advanced Clinical Radiation Oncology	25	25 Expt: 15 Record: 10

NOTE: A student must secure at least 50% of total marks fixed for internal assessment for a particular subject in order to be eligible to appear in university examination in that subject. The internal assessment marks **will not be added** to the marks obtained in the university examination for declaration of pass.

10.Dissertation:

10.1. Every candidate pursuing M.Sc. Radiation Physics course is required to carry out work on selected topics as project under the guidance of a recognized post graduate teacher for a period of one year after the submission of synopsis. The results of such a work shall be submitted in the form of a dissertation.

10.2. The dissertation is aimed to train a postgraduate student in methods and techniques of radiological physics. It includes identification of a problem, formulation of a hypothesis, search and review of literature, getting acquainted with recent advances, collection of data, critical analysis, comparison of results and drawing conclusions.

10.3. Every candidate shall submit to the Registrar (Academic) of the university in the prescribed proforma, two hard copies of synopsis containing particulars of proposed dissertation work within six months from the date of commencement of the course on or before the date notified by the university. The synopsis shall be sent through proper channel.

10.4. The university shall arrange for review of synopsis and if found suitable, shall register the dissertation topic. No change in the dissertation topic or guide shall be made without prior approval of the university.

10.5. The dissertation should be written under the following headings:

i) Introduction
ii) Aims or Objectives of study
iii) Review of Literature
iv) Material and Methods
v) Results
vi) Discussion
vii) Conclusion
viii) Summary
ix) Reference
x) Tables
xi) Annexure

10.6. The written text of dissertation shall not be less than 50 pages and shall not exceed 100 pages. It should be neatly typed in double line spacing on one side of the A4 size paper and bound properly. Spiral binding should not be done. A declaration by the candidate that the work was done by him/her shall be included. The guide, head of the department and head of the institution shall certify the dissertation.

10.7. Four copies of dissertation along with a soft copy on a CD shall be submitted to the Registrar (Evaluation), before the declaration of final examination. It shall be assessed by two examiners appointed by the university, one internal and one

external. No marks shall be awarded for dissertation. Acceptance of the dissertation is a pre-requisite for a candidate to be eligible to appear in the final examination.

11. Guide

The academic qualification and teaching experience required for recognition as Guides by the RGUHS are:

a) Eligibility to be a guide:

Shall be a full time teacher in the college or institute where he or she is working.

b) Academic qualification and teaching/professional experience:

M.Sc in Physics/Bio-Physics with one-year Postgraduate diploma in Radiological Physics from Bhabha Atomic Research Centre and minimum of **four** years of experience in the field of medical physics in a hospital environment.

Or

M.Sc in Medical Physics from a recognized university with **five** years experience in the field of medical physics in a hospital environment.

c) Age:

The age of guide shall not exceed 65 years.

d) Student-Guide Ratio: 3:1

A recognized guide shall supervise dissertation work for note more than four students per academic year. In any given college the maximum number of seats shall not exceed 6.

12. Schedule of Examination:

12.1 The university conducts two examinations in a year at an interval of not less than four to six months.
12.2 The number of examiners for practical and viva-voce shall be two, comprising of one internal and one external examiner appointed by the university.
12.3 A candidate shall not be admitted to the practical examinations for the first time unless he/she produces the class record book certified by the Head of the Department.
12.4 A failed candidate needs to appear for both theory and practical examination in the failed subject/s only in the subsequent examination.

13. Scheme of Examination:

There shall be two university examinations, one at the end of the first year and the other at the end of second year, respectively.

A candidate shall be eligible to appear for the first year M.Sc., Radiation Physics examination at the end of one year from the commencement of the course. He/She should have satisfactorily completed the prescribed course and fulfilled the prescribed attendance.

Written Examination: Shall consist of theory papers each of three hours duration. Each paper shall carry 100 marks.

Practical Examination: There shall be one practical examination at the end of each year in each of the designated subject. Each examination carries 75 marks. The duration of practical is three hours.

Records to be assessed by the external examiners during university practical examination.

Viva Voce: This shall aim at assessing: depth of knowledge, logical reasoning, confidence and oral communication skills. Each viva carries 25 marks. Presentation of dissertation and discussion on it shall be done during viva voce. However, no marks shall be awarded to the presentation of dissertation.

Both internal and external examiners shall conduct the practical and viva-voce examination.

The particulars of subjects for examination and distribution of marks are shown in the table V and VI.

Table V. Main subjects for examination and distribution of marks for first year

Sr. No	Subjects	Theory	Practical			Grand Total
			Expt	Viva	Total	
1.	Basic Radiation Physics	100	75	25	100	200
2.	Principles of Imaging in Radiation Oncology	100	75	25	100	200
3.	Introduction to Clinical Oncology	100	--	--	--	100
4.	Quality Assurance, Calibration, Standardization in Clinical Dosimetry	100	75	25	100	200

Table VI. Main subjects for examination and distribution of marks for first year

Sr. No	Subjects	Theory	Practical			Grand Total
			Expt	Viva	Total	
1.	Advanced Radiation Physics	100	75	25	100	200
2.	Radiological Safety & Protection	100	75	25	100	200
3.	Radiation Biology	100	--	--	--	100
4.	Advanced Clinical Radiation Oncology	100	75	25	100	200

14. Criteria for Pass.

For declaration of pass in any subject in the university examination, a candidate shall pass both in theory and practical components separately as stipulated below:

Theory component consists of marks obtained in university written paper. For a pass in the theory subject, a candidate shall secure not less than 50% of maximum marks in each paper and an aggregate of 50% marks per subject prescribed for the university examination separately. For pass in practical examination, the candidate has to secure 50% marks in aggregate, i.e. marks obtained in the practical and viva-voce examination added together provided the candidate has secured 40% marks in practical experiment. A failed candidate is required to appear for both theory and practical in the subsequent examination in that subject.

To consider as pass in first or second year, a candidate has to appear in all the papers prescribed for each subject and has to pass in all the prescribed subjects of the university examination for the concerned year.

15. Carry over

A candidate who has appeared in all subjects of first year in the university examination is eligible to go to second year provided he/she has passed in any two subjects. However, failed candidate has to pass in all the prescribed subjects of the university examination for the concerned year.

16. Declaration of Distinction:

A candidate securing total aggregate marks of 75% or more in the first attempt shall be declared as passed with distinction. Distinction will not be awarded for candidates passing the examination in more than one attempt.

17. Number of attempts

A candidate is permitted not more than **three** attempts (actual appearance) to pass the first year examination or within two academic years from the year of admission, whichever is earlier. No candidate would be allowed to continue the course if this stipulation is not complied with.

18. Maximum duration for completion of course

A candidate shall complete the course within three years from the date of admission. Failing which the candidate would be discharged.

19. Eligibility for award of degree

A candidate shall have passed in all the subjects of first and second year to be eligible for the award to degree.

20. Field training

Before final year examination, every student will be posted, as observer, in leading cancer hospitals across the country, for a period of 3 weeks. Successful completion of this field training is a pre-requisite to appear in the final year examination.

21. RSO certification

Every student who have successfully completed M.Sc. Radiation Physics program has to undergo RSO certification program, to be arranged by Atomic Energy Regulatory Board, Mumbai.

Chapter II

GOALS AND GENERAL OBJECTIVES OF POSTGRADUATE PROGRAM

The aims of this course are:

- To induce life long learning skills, attitudes for social & personal development.
- To provide trained manpower.
- To provide leadership qualities.
- To create awareness of health hazards due to carcinogenic materials.
- To associate in development of new methods & techniques for the radiotherapy treatment of various cancer diseases and to have correct diagnosis of the diseases and subsequent proper implementation of radiotherapy to have cure of patient.
- To develop radiotherapy treatment managerial skills and trained Radiation Physicists.

General Objectives:

In recent decades, radiation therapy has come to play an increasingly vital role in the treatment of cancer. High quality patient care in radiation therapy depends upon the teamwork. The radiation oncologist or the radiation therapist, the engineers, the medical physicist specializing in radiation therapy, the radiation technologist, the dosimetrist and the nurse are all important members of the team.

The quality of patient care provided by the radiation oncologist is dependent upon, among other factors, precisely administered treatments. Without such precision, it is not possible to optimally balance maximum probability of cure or palliation and acceptable levels of complications. Quality assurance related to the whole treatment process is essential if such results are to be obtained.

Radiation Physicist, often called as Medical Physicist, plays very vital and important role in this team work interms of ensuring complete quality assurance of radiation generating equipments which include, among other aspects, Physics Dosimetry of radiation beams, performing the aid to arrive at accurate treatment planning and guiding radiation oncologists in precise treatment delivery, pre and post treatment quality checks on treatment plans.

There are tremendous increases in the technological advancement of the radiation therapy equipments, which is used for cancer care. The technological advancements ranging from: superficial & deep x-ray, tale-cesium, cobalt-cobalt, low energy linear accelerators, multi leaf collimators, high energy linear accelerators, Intensity Modulated Radiation Therapy (IMRT) and Image Guided Radiation Therapy (IGRT).

These advances, IGRT and IMRT, have revolutionized the treatment outcome of the cancer since these treatments precisely target the cancer cells and associated clinical

target volume. These treatment modalities are delivered with stringent quality assurance procedures of the treatment machine and patient. Radiation Physicist play vital role in these high quality treatments, amongst his other responsibilities.

In radiation oncology, physicists have the primary responsibility for the following, except where the responsibility is noted as shared:

Planning for resource allocation with radiation oncologists, administrators, and technologists, including:

- Equipment usage, selection and replacement,
- Staff requirements, assignments, and recruitment,
- Budget preparation,
- Program operation, and
- Continuing review of the program's policies and procedures.

Physical aspects of all radiation sources (radioactive materials and radiation producing machines) used in a radiation oncology program, including:

- Performance specification, acceptance testing and commissioning of new equipment
- Calibration of the sources and maintenance of all information necessary for their appropriate use
- Development and maintenance of a quality assurance program for all treatment modalities, localization procedures, and computational equipment and programs to assure that patients receive:
    - Prescribed doses and dose distributions, within acceptable degrees of accuracy,
    - Maintenance of all instrumentation required for calibration of sources, measurement of radiation, and calculation of doses, and
    - First-order maintenance of treatment units (in conjunction with any in-house electronic technician).
    - The radiation safety program (possibly shared with an institution's radiation safety officer, including:
    - Development and administration of the radiation safety program, including compliance with all regulating and certifying agencies (e.g., the Nuclear Regulatory Commission, the Joint Commission on Accreditation of Health Care Organizations, the Occupational Safety and Health Administration, and appropriate state and local agencies),
    - Administration of a personnel radiation monitoring program,
    - Supervision of source preparation and handling during brachytherapy, and the continual maintenance of the brachytherapy source inventory,
    - Participation on the institutional Radiation Safety Committee, and other committees (e.g., General Safety) as needed, and Calculation of shielding required for new or renovated treatment rooms, radioactive-source storage and handling facilities, and brachytherapy patient rooms.

The physical aspects of patients' treatments, including:

- Consultations with radiation oncologists on the physical and radiobiological aspects of patients' treatments, and the development of treatment plans.
- Acquisition and storage of data for treatment plans
- Calculation of dose distributions and machine settings for patient treatments,
- Design and fabrication of treatment aids and treatment-beam modifiers.
- Assurance of the accuracy of treatment unit parameters and settings used for a patient's treatment, including correct transfer of parameters between the simulator, treatment plan and the treatment unit, and periodic review of each patient's chart.
- *In-vivo* measurement to verify the dose delivered to a patient.
- Assisting the radiation oncologists in statistical analysis for evaluation of treatment efficacy, and participation in clinical trials,
- Development of techniques (hardware, software, or procedural) to improve the delivery of radiation treatments,
- Participation at patient-discussion conferences, and
- Continuing education of the radiation oncology staff.

Interaction with the medical physics community, including:

- Participation at radiation oncology physics or related medical meetings to receive and disseminate state-of-the-art information, and
- Participation in peer review.

Over the years, the number of radiation oncology centers has increased many folds and a great deal of demand for quality Radiation Physicist professionals in radiation oncology. Currently very few centers in the country are offering the Medical Physics program and number of qualified personnel is no way nearer to the need. Hence the need to have this course which would help the oncology community in acquiring the right staff.

Chapter III

COURSE CONTENT

M.Sc. (Radiation Physics) FIRST YEAR

Paper 1: Basic Radiation Physics
(Class room: 70 hours + hands on training)

THEORY:

Elements of Atomic & Nuclear Physics, Atomic & Nuclear structure, General introduction to the properties of radiation and matter, Atom, Nucleus, AMU, Nuclear forces, Electro magnetic Radiation, Nuclear Transformation: Radioactivity, General properties & production of radioactive Materials, Radioactive decay, Half-life, Mean-life, Transient & Secular equilibrium, Isotopes used in medicine. Nuclear reaction.

Interaction of Ionizing radiation with matter: Photoelectric Compton effects & pair production, Processes & their clinical importance. Attenuation & absorption coefficients Exponential law, Half value layer & simple calculations. Basic Teletherapy machines: Superficial & deep X-ray machines. Different types of isotope-isotope unit. Installation properties. Machine properties. Penumbra, its properties and practical applications. Quality Assurance & Calibration of cobalt-cobalt units. Mould room techniques.

Radiological Units: Curie, Roentgen, Gray, RAD & Sievert; Measurements and applications of above radiological units and their application in radiological safety. Air kerma, Exposure rate, Dose rate, Principles of Radiation Dosimetry: Basic concept % depth dose (PDD). Tissue air ratio (TAR), Peak scatter factor (PSF/BSF) & tissue maximum ratio (TMR) and their use in treatment time calculation. Isodose curves. Manual addition of isodose curves. Equivalent square calculations for simple and complex fields.

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. Record Keeping, Treatment chart, notes, and computerization. Hospital network.

PRACTICAL: (To carry out any at least 5 based on the infrastructure)

1. Manual addition of isodose charts for simple field arrangements and manual calculation of simple treatment fields.
2. Performance of Quality Assurance for a teletherapy machine.
3. Study of immobilization and patient positioning devices used for external beam therapy
4. Determination of half-life and verification of inverse square law for brachytherapy source.
5. Determination of PDD & TMR for photon beam energies
6. Determination of PDD for electron beam energies
7. Computerized treatment planning for static plain fields

Textbook for reference:

Author	Title	Edition	Year of Publication
F.M. Khan	Physics of Radiation Therapy	3rd	2005
W.J. Meredith, J.B. Massey	Fundamental Physics of Radiology	2nd	
Hence, William	Radiation therapy physics	-	1996
Cherry, Pam	Practical radiotherapy physics & equipment	-	1998

Paper 2: Principles of Imaging in Radiation Oncology (Class room: 70 hours + hands on training)

THEORY:

X-ray: Discovery, Production and properties of X-rays. (Characteristic & continuous X-ray spectrum). Anode, Cathode, Basic X-ray circuit, Rotating Anode type, Hooded anode tubes, Industrial x-ray tubes, X-ray tube for crystallography, tube ratings, Safety devices in x-ray tubes, Rayproof and shockproof tubes, Anode cooling, insulation and cooling of x-ray tubes, mobile and dental units, Faults in x-ray tubes, limitation in loading.

Voltage rectification, Physics of X-ray Production, X-ray spectra, Characteristic X-rays, Factors affecting quality of X -ray emission. Angular distribution of X-rays around the target. Different types of X- ray machines (Diagnostic & Therapeutic) Generators & X-ray tubes. Mammography unit- C-Arm machine -CT- scanner. 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. Simulator: Simulator including technology -machine parameters, Mechanism, Image receptor, Lasers and Image Intensifier, Various simulation techniques for different sites

CT Scanner: CT gantry, table configuration, role of lasers, table indexing, three dimensional reconstruction, Contrast study, Magnetic resonance imaging (MRI): contrast study, T1, T2 weighted images, planar view, Ultra Sonography (USG), Positron Emission Tomography (PET), PET-CT and Angiography

Role of these diagnostics in RT planning.

PRACTICAL: (To carry out any at least 5 based on the infrastructure)

1. Evaluation of Quality Assurance for diagnostic X-ray machine
2. Evaluation of Quality Assurance for therapy simulator
3. Performance evaluation of CT Scanner
4. Performance evaluation of mammography unit.
5. Simulation technique for the treatment of Head & Neck cancers
6. Simulation technique for the treatment of Breast cancer.
7. Simulation technique for the treatment of Brain tumors

Textbook for reference:

Author	Title	Edition	Year of Publication
H.E.Jones, J.R.Cunnigham	The Physics of Radiology		1980
RF Farr	Physics of Medical Imaging	1	2006
W.J. Meredith, J.B. Massey	Fundamental Physics of Radiology	2nd	
Carlton, Richar R.	Principles of Radiographic imaging: An art and a science	-	2000
Henwood, Suzanne	Clinical C T : techniques and practice	-	1999

Paper 3: Introduction to Clinical Oncology
(Class room: 70 hours)

THEORY:

What is Oncology? Detection, Diagnosis and Extent of Disease, Basic Anatomy, Physiology and Pathology Anatomic Staging of the Disease, Histopathologic Classification, Treatment of Cancer, Principles of Radiation Oncology and Cancer Radiotherapy. Counseling of cancer patients. Parameters to be considered for particular treatment choice. Overview of inter-departmental coordination in tackling cancer.

Teletherapy Unit, Telecobalt Unit, Telecaesium Unit, Linear Accelerator, Heavy Particle Accelerators, Brachytherapy: Intracavitory Insertions, Interstitial Implants, Surface Applicators, Curative or Radical Intent, Palliative Intent. Patient positioners, Immobilization devices.

General Aspect of Radiotherapy: Forms of treatment, Radio sensitive tumors, "Radio sensitivity" Radio resistant tumors, Tumors of limited sensitivity, Curability of Cancer, General Principles – Radiation Factors, Tumor lethal dose –TLD, Normal Tissue Tolerance, Therapeutic Ratio, Methods of Increasing Therapeutic Ratio.

Units of quality of Radiation – RT dose, Given dose, Incident Dose, Skin Dose, Model Dose, Integral dose, Quality or wave length of radiation, Beam flattening, Beam Wedging, Time factors, Fractionation. Importance of Beam directed X-ray therapy. Beam modifiers, Patient preparation for radiation treatment. Combination therapy.

Radiation dose tolerance of various organs. Lethal and sub lethal dose levels. Use of these in RT planning. Dose size and its effect on radiation tolerance.

PRACTICAL: NIL

Textbook for reference:

Author	Title	Edition	Year of Publication
Devita	Cancer Principle and Practice of oncology	7	2000
Choa K. S., Clifford	Radiation oncology – management decisions	-	1998
Perez et.al.	Principles of radiation oncology	4th	
J.Dobbs et.al.	Practical Radiotherapy Planning	3rd	1999
Rath GK et.al.	Text book of radiation oncology	1st	2000

Paper 4: Quality Assurance, Calibration, and Standardization in Clinical Dosimetry
(Class room: 80 hours + hands on training)

THEORY:

Teletherapy Machines & Accessories: Telecobalt machines, Medical linear accelerator. Machine properties. Quality Assurance & Calibration. Beam directing, modifying and defining devices. Radiation Detection: Basic principles of radiation detection, Ionization chambers and G.M. counters, Photographic film Dosimeters Thermoluminisence dosimeter, Film badges, Semiconductor detectors, Clinical Dosimeter such as secondary standard Dosimeters. HVT & Linear attenuation coefficient Quality Assurance & Calibration of Telecobalt Unit Radiological Protection Survey

Instruments used in Clinical Radiation Dosimetry, construction, principles of working, calibration and quality assurance and control. Ionisation chamber type, GM type, scintillation type detectors used in radiation measurements. Commercially available dosimetry systems, water phantom, RFA, isodose plotters, multi channel dosimeters, Q.A tests systems

Isodose charts – Computation of combination isodose charts and methods of evaluation of dose within and outside the target volume. Modern computerized treatment planning systems, principles and use of the same. Methods of tumor localization – Radiotherapy simulator, Q.A of simulator, portal films and identification of target volume. QA on Treatment Planning System.

Dosimetry for Brachytherapy, conventional ICI, ICA, linear sources, LDR, MDR, HDR, PDR, calculations based on radiographs, manual and computer systems. Dosimetry for permanent implants. Source Calibration Procedure, Timer error estimation, Decay calculations and its verification. Application of inverse square law in the practice of brachytherapy

Dosimetry for large field irradiation, whole body irradiation and in irregular fields Use of Electronic Portal Imaging in clinical dosimetry, film and ion chamber dosimetry Principles of fractionated radiotherapy and methods of evaluation of radiobiological equivalence, NSD, CRE, TDF, linear quadratic model and other developments in evaluation of radiotherapy regimes.

PRACTICAL: (To carry out any at least 5 based on the infrastructure)

1. Determination of Beam quality for photon and electron beam energies
2. Dose calibration of photon beam energies using IAEA protocol
3. Dose calibration of electron beam energies using IAEA protocol
4. Setup and QA on Radiation Field Analyzer
5. Determination of virtual source position for electron beam energy
6. Dose calibration and Quality Assurance of HDR Brachytherapy unit
7. Determination of timer error/end MU error for a teletherapy unit and timer error for a brachytherapy unit.

Textbook for reference:

Author	Title	Edition	Year of Publication
K. Govinda Rajan	Advanced Medical Radiation Dosimetry	1	2002
IAEA	TRS-398 protocol	1	2003
H.E.Jones, J.R.Cunnigham	The Physics of Radiology	2	1980
F.M. Khan	Physics of Radiation Therapy	3	1994

Subsidiary Subjects:

a. Bio Statistics & Numerical Methods in computation
(Class room: 50 hours)

Introduction to statistics, Basic Mathematics, Population, variates, collection, tabulation and graphical representation of data, Basic ideas of statistical distributions, frequency and frequency distribution, measures of central tendency, dispersion, skewness and kurtosis.

Probability; Addition and multiplication laws of probability, conditional probability, stochastic independence, Baye's theorm, Discrete probability distribution, Binomial and Poisson distribution, Gaussian distribution, Bivariate distribution, Correlation and regression, curve fitting, least square methods, sampling distributions, testing statistical hypothesis, errors, cancer registry, signal to noise ratio, systematic and random sampling

Errors in numerical computation, solution of non linear equations, graphical method, bisection method, iterative procedure for roots, regula falsi, newton's method; interpolating polynomials; finite and divided difference operators, various interpolation formulae, numerical differentiation, numerical quadrature,

Various quadrature schemes such as trapezoidal, simpson's methods. Initial value problems, Picard's, Taylor's, Euler's (initial and modified),Runge-Kutta methods. The linear equation of order one, Bernoulli's equation, equations with coefficients linear in two variables. Linear differential equations.
Ordinary differential equations, Numerical solution of system of linear equations, iterative determination of eigen values,

Computer Algorithms, Dose calculation algorithms; Monte Carlo Simulation

Textbook for reference:

Author	Title	Edition	Year of Publication	Publisher & Address
J. Medhi	Statistical Methods – An introductory text	1992	1992	New Age International publishers
N.P. Bali & Dr. N.Ch. Srimannaray ana Iyergar	A text book of Engineering Mathematics	2001	2001	Laxmi publications
S.D. Joglekar	Mathematical Physics – THE BASICS	1	2007	Universities Press
S. Chandra	A text book of Mathematical Physics			Narosa Publishing House

b. Surface Anatomy & Physiology

General anatomical terms, structure of tissues, skeleton, arthrology, muscular, cardiovascular and respiratory systems, Alimentary system, Urinary system, Eye and ear, Lymphatic and reticulo endothelian systems, reproductive system, mammary gland, endocrine glands.

Cell Biology: Cell physiology and biochemistry, Structure of cell, types of cells and tissue, their structures and functions, organic constituents of cells, carbohydrates, facts, proteins and nucleic acids, enzymes, and their functions, functions of mitochondria, ribosomes, golgi bodies and lysosomes, cell metabolism, kerbs cycle, DNA as concepts of gene and gene action, Mitotic and meiotic cell division, Semi conservative DNA synthesis, Genetic variation crossing over, mutation, chromosome segregation, heredity and its mechanisms.

Textbook for reference:

Author	Title	Edition	Year of Publication	Publisher & Address
Tortora, Gerard	Principles of anatomy and physiology	-	2000	John Wiley & Sons Inc., Newyork
Ross and Wilson	Anatomy and Physiology	9Rev -	2005	Churchill Livingstone;
Perez et.al.	Principles of radiation oncology	4th		Lippincott – Raven Pub., Philadelfia

Chapter III

COURSE CONTENT

M.Sc. (Radiation Physics) SECOND YEAR

THEORY

Paper 1: Advanced Radiation Physics
(Class room: 80 hours + hands on training)

Physical Aspects and properties of Three Dimensional Conformal Radiation Therapy; MLC properties. Role of Multi Leaf Collimator (MLC) in conformal therapy and its comparison with conformal block Principles of Photon and Electron Dosimetry and dose calculations. Electron Arc Therapy, Total Skin Electron Therapy, Concept of static wedge, wedge angle, hinge angle. Comparison its properties with Dynamic wedge. Quality Assurance aspects of teletherapy machines and its implication on treatment planning.

Detailed treatment time calculations and its verification with planning computer output. Three-dimensional compensation. Physics of high precision radiation therapy. Physics dosimetry for 3D-CRT, IMRT and IGRT. IMRT plan evaluation and Physics QA of treatment plans using film dosimetry, 2D array and thermo luminescence in radiation dose estimation. International Commission on Radiation Units and measurements (ICRU-50/62) recommendations and its applications. Use of Electronic Portal Imaging Devices.

Physics of Brachytherapy for all types of applications. Source calibration, Timmer error for ICRU-38 recommendations, System of dosimetry for Intracavitory, Intersitial, Intraluminal and surface mould applications. Physics of calibration procedures: Well type chamber and air kerma estimation.

PRACTICAL: (To carry out any at least 5 based on the infrastructure)

1. Quality Assurance and dosimetry of Multi Leaf Collimator
2. Quality Assurance for OBI-CBCT
3. Quality Assurance of Enhanced Dynamic Wedge
4. Quality Assurance for Treatment planning system
5. Estimation of surface dose for photon beam energies
6. Performance evaluation of Electronic Portal Imaging Device (EPID)
7. Quality Assurance tests for IMRT.

Textbook for reference:

Author	Title	Edition	Year of Publication	Publisher & Address
F.M. Khan	Physics of Radiation Therapy	2	1994	Willams & Wilkins
H.E.Johns, J.R.Cunnigham	The Physics of Radiology	1	1980	Charles C.Thomas, NY
Jacob Van Dyk	Modern Technology of Radiation Oncology Vol. 1 & 2	1	1999	
AERB	Methodology of QA manuals	-	1994	Atomic Energy Regulatory Board, Mumbai

Paper 2: Radiological Safety & Protection
(Class room: 70 hours + hands on training)

THEORY:

Maximum permissible levels for radiation workers and general public, ALARA principle, ICRP recommendations. Shielding calculations for Tele-therapy and Brachy-therapy installations. Role of National regulatory body in radiological safety. Principles of Time, Distance, Shielding. Personnel Monitoring. National/International agencies associated in Radiation safety; Source Disposal, source transportation,

Planning of radiotherapy department. Radioactive waste management. Half Value Thickness (HVT) & Tenth Value Thickness (TVT) and its relevance in shielding calculations. Protection aspects in diagnostic radiology and nuclear medicine departments.

Details of regulatory forms for specific purposes and its utilities in various procedural aspects of Radiotherapy.

Biological Effects of Radiation: Somatic - general effects, Effects on cellular levels, Effects on organs. Stochastic and non-stochastic effects Biological Models: Treatment fractionation NSD (Nominal Standard Dose) CRE (Cumulative Radiation Effect) TDF (Time Dose Fractionation) LQM (Linear Quadratic Models) and their practical applications

PRACTICAL: (To carry out any at least 5 based on the infrastructure)

1. Installation planning and Radiation Survey for diagnostic X-ray and CT Scanner
2. Installation planning and Radiation Survey for Therapy simulator
3. Installation planning and Radiation Survey for Telecobalt machine
4. Installation planning and Radiation Survey for High Energy Linear Acclerator
5. Installation planning and Radiation Survey for LDR and/or HDR brachytherapy
6. Procedural aspects of transport of Radioactive Material used for Teletherpay and/or Brachytherapy
7. Determination of Dose equivalence for treatment with altered fractionation scheme for tele- and brachytherapy treatments.

Text Book Reference:

Author	Title	Edition	Year of Publication	Publisher & Address
F.M. Khan	Physics of Radiation Therapy	-	1994	Willams & Wilkins
AERB	Safety code for medical diagnostic X-ray equipment and installations AERB Code No. SC/ MED-2	-	1986	Atomic Energy Regulatory Board, Mumbai
AERB	Transport of radioactive materials AERB Code No. SC/TR-1	-	1986	Atomic Energy Regulatory Board, Mumbai

Paper 3: Radiation Biology
(Class room: 70 hours)

Biological Effect of Radiation, Basic Structure of a Cell, and Effect of Radiation on Cells: Radio sensitizing Agents; Radio protectors. Immediate Cell Death, Effects on Cancer Cells: Direct, Indirect Effects of Radiation on Normal Tissues: Introduction, Pathogenesis of Early and Late Radiation Effects, Normal Tissue and Organ. Single and double strand brake.

Effects of Irradiation on Normal tissues, Skin, Oral Cavity, Oropharynx and Salivary Glands, Orbit, Lung, Gastrointestinal Tract:, Haemopoietic Tissues, Bone and Cartilage, Kidney, Testicle, Ovary, Nervous System, Systemic Effects of Irradiation, Carcinogenic Effects.

Radiation Modifiers: Radio Sensitizer, Radio protectors, Hyperthermia. Irradiation, Side Effects - Early and Late complications.

The biological hazards of irradiation; effects on the whole body; effects on the embryo and the fetus; like shortening, leukarmogenesis and carcinogenesis, genetic and somatic hazards for exposed individuals and populations. Genetic and cytological effects.

4Rs of Radiotherapy. Effects of these on dose fractionation.

Text Book Reference:

Author	Title	Edition	Year of Publication	Publisher & Address
Hall Eric J.	Radiobiology for the radiologist	-	1994	Lippincott Williams & Wikins, Philadelfia
Bushong, Stewart C.	Radiological Science for technologists – physics, biology and protection	-	1997	Mosby, St. Louis

Paper 4: Advanced Clinical Radiation Oncology (Class room: 70 hours + hands on training)

THEORY:

Philosophy in cancer therapy. Socio economic status of cancer patients and their adaptability to cancer therapy and financial management. Treatment strategies and symptoms of Brain and Head & Neck Tumors; Treatment strategies and symptoms of cancer in Thorax region (male and female); Treatment strategies and symptoms of blood disorders in oncology;

Treatment strategies and symptoms of Pediatric Tumors; Treatment strategies and symptoms of Abdominal tumors; Treatment strategies and symptoms of Pelvic malignancies (male and female); Treatment strategies and symptoms Soft tissue tumors; Treatment strategies and symptoms of Metastasis Lesions - Lung, Brain, Bone and Liver; Radiation Syndromes, Radiotherapy Emergencies; Therapeutic Nuclear Medicine (I131, P32, Sr89).

Practical applications of Three Dimentional Conformal Radiation therapy, Intensity Modulated Radiation Therapy, Total skin electron therapy, Total body photon therapy, Electron Arc, Stereo Radiosurgery, Stereo Radiotherapy, Image Guided Radiation Therapy.

Practical applications of Various Brachytherapy techniques: Intracavitory, Interstitial, surface mould and intra luminal. Relevance of ICRU recommendations in modern radiotherapy.

PRACTICAL: (To carry out any at least 5 based on the infrastructure)

1. Computerized treatment planning for Gated IGRT
2. Computerized treatment planning for IMRT
3. Dosimetry of IMRT fields.
4. Computerized treatment planning for 3D-CRT (co-planar and non-co-planar fields)
5. Computerized treatment planning for surface mould interstitial brachytherapy
6. Computerized treatment planning for intracavitory and intraluminal brachytherapy.
7. Performance evaluation of Electronic Portal Imaging Device (EPID)

Text Book for Reference:

Author	Title	Edition	Year of Publication	Publisher & Address
Perez et.al.	Principles of radiation oncology	4th		Lippincott – Raven Pub., Philadelfia
Rath GK et.al.	Text book of radiation oncology	1st	2000	B.I Churchill Livingstone
Journals	International Journal of Radiation Oncol Biology Physics	-	-	-
Journals	Radiotherapy Oncology	-	-	-

Subsidiary subjects

a. Management of Bio and Health Hazards
(Class room: 50 hours)

Historical perspective of bio hazards, impact of environmental factors on health, trends in occupational health, health and environment, patterns of illness due to health hazards, basic toxicology, epidemiology, control of work space health hazard, aerosols, biological and biological-effect monitoring, the effects of inhaled material in lung, airborne contaminations, nature and properties of work place, environmental law, risk assessment and management, occupational hygiene, personal hygiene, electromagnetic radiation, Waste management (Solid and liquid), Injury control, carcinogenicity, biological exposure indices, infections (manifestations, management and control), nature of health hazards, Managing patients have high degree of infections such as HIV, HBSAG, etc. Health and nutrition, action to protect health and environment.

Text Book for Reference:

Author	Title	Edition	Year of Publication	Publisher & Address
Cherilyn Tillman (Editor)	Principles of Occupational Health & Hygiene: An introduction		2007	Allen & Unwin
Kerry Gardiner, J. Malcolm Harrington	Occupational Hygiene	3rd	2005	Blackwell Publishing
Annalee Yassi, Tord Kjellstrom, Theo de Kok, Tee L. Guidotti	Basic Environmental Health		2001	Oxford University Press US
Dade W. Moeller	Environmental Health	3rd	2005	Harvard University Press

b. Research Methodology
(Class room: 30 hours)

Aim: The aim of this module is to provide the student with experience of research methods and techniques while working alongside research laboratory staff on a designated research project.

Objectives: By the end of this study module, students should be able to:
i) design, carryout, write up and critically appraise a selected research topic
ii) demostrate knowledge of skills in appropriate research laboratory practices
iii) carryout a range of laboratory techniques using appropriate methodologies.

Constituency
This module is intended for students who wish to learn research methods and techniques and perhaps do a PhD in the future. Some experience of laboratory practice would help the student to take full advantage of this module, although in most instances students will be fully trained in all necessary techniques.

Conceptual outline
This is purely practical module designed to introduce students to a variety of research techniques and to give them the opportunity of using these techniques in conducting a novel a research project. Each student will choose an individual research project and will be directly supervised by an expert in the field. This module will necessitate long working hours in some cases and may involve some studying in institutions other than the parent institution.

Teaching strategy
This module is entirely laboratory based, with no formal teaching or lectures. Teaching is on a one-to-one basis with a designated supervisor. Students must be highly motivated and be prepared to work long hours in order to make a success of this module.

Reviewing the literature

Aim

This study module aims to describe and illustrate the methods available for identifying and reviewing quantitative and qualitative literature.

Objectives

By the end of the study module, students should be able to:

i) carry out an appropriate, rigorous review of literature; and
ii) understand the strengths and weaknesses of different methods of identifying, assessing and synthesizing literature.

Conceptual outline

This module will cover all stages in carrying out an appropriate and rigorous review.

i) Planning the review: the role of the literature review and specification of the task
ii) Identification of relevant literature, both published and unpublished: developing a search strategy and using bibliographic databases.
iii) Appraising the literature: methods for assessing the quality of quantitative and qualitative research.
iv) Synthesising the evidence: integration of the evidence using both quantitative and qualitative methods; principles of meta-analysis.
v) Formulating recommendations and writing the review.

Teaching strategy:

The technical aspects of literature reviewing will be presented in lectures and computer practicals, using some of the databases available through the RGUHS's HELINET network. The format of the seminars will encourage both a practical application and critical appraisal of methods. Each student can choose his or her own topic and question for their assessed literature review. Students should consider possible topics and questions in preparation for the study module. There will be three sessions during the study module for general advice on the assessment.

The ongoing Seminars, Journal club in the department for the students would provide a part of technical expertise towards achieving the goal of this subject.

TOPICS FOR SEMINARS:

First Year

1. Radiation Sources available for radiotherapy
2. Radiation units and measurements used in radiotherapy
3. Use of isodoses in radiotherapy
4. Mould room procedures
5. Interaction of radiation with matter and radiation detection
6. Effect of inverse square law in radiation therapy
7. Effect of shutter timer error/end MU error in external radiation therapy
8. Effect of timer error in brachy therapy
9. Gap correction in radiation oncology
10. Description of Teletherapy unit
11. Description of Brachytherapy unit
12. System of implant dosimetry
13. Photon dosimetry using TRS 277
14. Photon dosimetry using TRS 398
15. Electron dosimetry using TRS 277
16. Electron dosimetry using TRS 398
17. Use of Portal vision in radiation oncology
18. Comparison of MLC and Blocks in conformal radiation therapy
19. The relevance of ICRU recommendations in modern radiation therapy
20. The effect of tissue heterogeneities in radiation treatment planning

Second Year

1. Transport of Radioactive material
2. 2D, 3D and 4D treatment planning in radiotherapy
3. Radiation emergencies
4. Dosimetry of treatments with extended SSD.
5. Principles of Radiation Protection
6. Medical emergencies in Radiation oncology
7. Teletherapy techniques
8. Brachyherapy techniques
9. Respiratory Gating in Radiation therapy
10. Image guidance in radiation therapy

11. Image based brachytherapy
12. Use of RFA in radiation dosimetry
13. Total Skin Electron Therapy
14. Total Body Photon therapy
15. Electron Arc therapy
16. Photon arc therapy
17. Use of personnel monitoring in radiation oncology
18. Radiation Installation planning
19. The effect of leaf thickness of MLC in radiation treatment planning
20. Beams Eye view and Dose Volume histograms in treatment planning

Journal Club:

The choice of topic is from the recent publication of relevant topic during the time of presentation.

SHCEME OF EXAMINATION

THEORY

Duration: 3 hours Max. marks: 100

Type of questions	No. of questions	No. of question and marks for each question	Total marks
Brief	10 out of 12 questions	10 x 2 marks each	20
Descriptive	6 out of 8 questions	6 x 4 marks each	24
Short essay	4 out of 6 questions	4 x 8 marks each	32
Long essay	2 either/or questions	2 x 12 marks each	24

PRACTICAL

Experiment: Duration: 3 hours Max. marks: 75

Viva voce: Duration: as stipulated Max. marks: 25

SECTION-IV

MONITORING LEARNING PROGRESS

It is essential to monitor the learning progress of each candidate through continuous appraisal and regular assessment. It not only helps teachers to evaluate students, but also students to evaluate themselves. The monitoring be done by the staff of the department based on participation of students in various teaching/learning activities. It may be structured and assessment shall be done using checklists that assess various aspects. Model checklists are given in this chapter, which may be copied and used.

The learning out comes to be assessed should include:

i) Acquisition of knowledge: The methods used comprise of 'Log Book' which records participation in various teaching/learning activities by the students. The number of activities attended and the number in which presentations are made are to be recorded. The log book should periodically be validated by the supervisors. Some of the activities are listed. The list is not complete. Institutions may include additional activities, if so desired.

   Journal Review Meeting (Journal Club): The ability to do literature search, in depth study, presentation skills, and use of audio- visual aids are to be assessed. The assessment is made by faculty members and peers attending the meeting using a checklist (see Model Cheklist I, Section IV)

   Seminars/symposia: The topics should be assigned to the student well in advance to facilitate in depth study. The ability to do literature search, in depth study, presentation skills and use of audio- visual aids are to be assessed using a check list (see Model Checklist II, Section IV)

ii) Teaching Skills: Candidates should be encouraged to teach undergraduate paramedical students, if any. This performance should be based on assessment by

the faculty members of the department and from feedback from the undergraduate students (See Model Checklist III, Section IV)

iii) Dissertation: Please see Checklist IV in Section IV.

iv) Work diary / Log Book – Every candidate shall maintain a work diary and record his/her presentation in the training programmes conducted by the department such as journal reviews, seminar, etc. Special mention may be made of the presentations by the candidate as well as details of experiments or laboratory procedures, if any conducted by the candidate.

v) Records: Records, log books and marks obtained in tests will be maintained by the Head of the Department and will be made available to the university.

Log Book

The log book is a record of the important activities of the candidates during his training, internal assessment should be based on the evaluation of the log book. Collectively, log books are a tool for the evaluation of the training program of the institution by external agencies. The record includes academic activities as well as the presentations and procedures carried out by the candidate.

Format of the log book for the different activities is given in Tables 1 and 2 of Section IV. Copies may be made and used by the Institutions.

Procedure for defaulters: Every department should have a committee to review such situations. The defaulting candidate is counseled by the guide and head of the department. In extreme cases of default the departmental committee may recommend that defaulting candidate be withheld from appearing the examination, if she/he fails to fulfill the requirements in spite of being given adequate chances to set himself or herself right.

Format of Model Checklists

Checklist-I: MODEL CHECKLIST FOR EVALUATION OF JOURNAL REVIEW PRESENTATIONS

Name of the student: Date:

Title of the topic:

Name of the faculty/observer:

Sl. No	Items for observation during presentation	Poor 0	Below Average 1	Average 2	Good 3	Very Good 4
1.	Article chosen was					
2.	Extent of understanding of scope & objectives of the paper by the candidate					
3.	Whether cross- references have been consulted					
4.	Whether other relevant references have been consulted					
5.	Ability to respond to questions on the paper/subject					
6.	Audio visuals aids used					
7.	Ability to defend the paper					
8.	Clarity of presentation					
9.	Any other observation					
	Total Score					

Checklist-II: MODEL CHECKLIST FOR EVALUATION OF SEMINAR PRESENTATIONS

Name of the student: Date:

Title of the topic:

Name of the faculty/observer:

Sl. No	Items for observation during presentation	Poor 0	Below Average 1	Average 2	Good 3	Very Good 4
1.	Article chosen was					
2.	Extent of understanding of scope & objectives of the paper by the candidate					
3.	Whether cross- references have been consulted					
4.	Whether other relevant references have been consulted					
5.	Ability to respond to questions on the paper/subject					
6.	Audio visuals aids used					
7.	Ability to defend the paper					
8.	Clarity of presentation					
9.	Any other observation					
	Total Score					

Checklist-III: MODEL CHECKLIST FOR EVALUATION OF TEACHING SKILLS

Name of the student: Date:

Title of the topic:

Name of the faculty/observer:

Sl. No		Strong Point	Weak Point
1.	Communication of the purpose of the talk		
2.	Evokes audience interest in the subject		
3.	The introduction		
4.	The sequences of ideas		
5.	The use of practical examples and/or illustrations		
6.	Speaking style (enjoyable, monotonous, etc. specify)		
7.	Summary of the main points at the end		
8.	Ask questions		
9.	Answer questions asked by the audience		
10.	Rapport of speaker with his audience		
11.	Effectiveness of speaker with his audience		
12.	Uses of AV kids appropriately		

Checklist-IV: MODEL CHECKLIST FOR EVALUATION OF THE SEMINAR PRESENTATIONS

Name of the student: Date:

Title of the topic:

Name of the faculty/observer:

Sl. No	Points to be considered during presentation	Poor 0	Below Average 1	Average 2	Good 3	Very Good 4
1.	Interest shown in selecting topic					
2.	Appropriate review					
3.	Discussion with guide and other faculty					
4.	Quality of protocol					
5.	Preparation of proforma					
	Total Score					

Checklist-V: MODEL CHECKLIST FOR CONTINUOUS EVALUATION OF DISSERTATION/PROJECT WORK BY GUIDE/CO-GUIDE

Name of the student: Date:

Title of the topic:

Name of the faculty/observer:

Sl. No	Items for observation during presentation	Poor 0	Below Average 1	Average 2	Good 3	Very Good 4
1.	Periodic consultation with guide/co-guide					
2.	Depth of Analysis/ discussion					
3.	Department presentation of findings					
4.	Quality of final output					
5.	Others					
	Total Score					

OVERALL ASSESSMENT SHEET

Date:

Check List No.	Name of the Students			
	A	B	C	D
1				
2				
3				

Signature of HOD Signature of the Principal

The above overall assessment sheet used along with logbook should form the basis for certifying satisfactory completion of course of study, in addition to the attendance requirement.

KEY:
Main Score: Is the sum of all the scores of checklists 1 to 5
A, B, C: Name of the students.

LOG BOOK

Table 1: Academic activities attended

Name:
Admission Year:
College:

Date	Type of activity, specific seminar, journal club, presentation, UG teaching	Particulars

Table 2: Academic activities attended

Name:
Admission Year:
College:

Date	Topic	Type of activity, specific seminar, journal club, presentation, UG teaching

MANAGEMENT INFORMATION SYSTEM REPORT

1. Name of the college imparting M.Sc. Radiation Physics PG Program:
2. Details of M.Sc. Radiation Physics program

Sl. No	Name of the Branch & Teaching faculty	Sanctioned strength	Admitted	Name of the subjects to be studied at 1st year

3. No. of experiments/assignments conducted for 1st year M.Sc. Radiation Physics students

Sl. No	Branch		Subject	Assigned by RGUHS	Conducted	%	Remarks
1		No	Name				

4. No. of theory classes conducted for 1st year M.Sc. Radiation Physics students

Sl. No	Branch		Subject	RGUHS Norms (25)	Conducted	%	Remarks
1		No	Name				

5. Number of theory and practical classes taken by 2nd year M.Sc. Radiation Physics students for under graduate program (Optional)
6. No. of Journal clubs (department wise) for the 1st and 2nd year M.Sc. Radiation Physics students

Total No. of students year wise	Norms for half yearly report	Achieved Number	% Achievement	Remarks
1st year No=	2 per candidate per year			
2nd year No=	2 per candidate per year			

7. Number of seminars for the 1st and 2nd year M.Sc. Radiation Physics students

Total No. of students year wise	Norms for half yearly report	Achieved Number	% Achievement	Remarks
1st year No=	2 per candidate per year			
2nd year No=	2 per candidate per year			

8. Number of interdepartmental meetings

Norms for half yearly report	Achieved Number	% Achievements	Remarks
1	2	200%	Interactive and productive

9. Number of visits to other hospital and related institutes for the 1st and 2nd year M.Sc. Radiation Physics students

Norms for half yearly report	Achieved Number	% Achievements	Remarks
1	2	200%	Educative & informative

10. Number of guest lectures for postgraduate program

Norms for half yearly report	Achieved Number	% Achievements	Remarks
2	3	150%	Need focused and educative

11. Number of research papers published in the year in the college
12. Any other additional information such as consultancy/collaboration/conducing seminars & workshops or attending seminar & workshops or conference.

Section V
ETHICS OF M.Sc. Radiation Physics

Introduction: With the advances in science and technology and the increasing needs of the patient, theirs families and community, there is a concern for the health of the community as a whole. There is a shift to greater accountability to the society. It is therefore absolutely necessary for each and every one involved in the health care delivery to prepare them to deal with these problems. Physicists like the other professionals are confronted with many ethical problems.

Standards of professional conduct for Physicists are necessary in the public interest to ensure an efficient Radiation Oncology Service. Every Physicist should, not only be willing to play his part in giving such a service, also avoid any act or omission which would prejudice the giving of the services or impair confidence, in respect, for Physicist as a body.

To accomplish this and develop human values, it is desired that all the students undergo ethical sensitization by lectures or discussion on ethical issues.

Introduction to Ethics
What is ethics?
General introduction to code of laboratory ethics
How to form a value system in one's personal and professional life?
International code of ethics.

Ethics of the individual-
Physicist relation to the job
Physicist in relation to his trade
Physicist in relation to medical profession
Physicist in relation to his profession

Professional ethics-
Code of conduct
Confidentiality
Fair trade practice
Handling of prescription
Mal Practice and Negligence
Professional vigilance

Research ethics-
Experimental research
Human experimentation
Human volunteer research – informed consent
Clinical trials
Gathering all scientific factors
Gathering all value factors
Identifying areas of value conflict, setting proiorities
Working out criteria towards decision

Recommended reading: Francis C.M, Medical Ethics, I Edition, 1993, Jay Pee, Delhi.

Section VI

MINIMUM REQUIREMENT OF INFRASTRUCTURE, LABORATORY FACILITIES AND STAFF FOR M.Sc, RADIATION PHYSICS COURSE

Institute should have its own hospital with full-fledged Department of Radiation Oncology with facilities mentioned hereunder.

1. Teletherapy machine (atleast one unit of the below)
   Essential: Linear Accelerator with Multi Leaf Collimator (MLC)
   IMRT capabilities
   Desirable: Linac with IGRT capabilities
   Tele cobalt machine
2. Brachytherapy machine (atleast one unit of the below)
   Essential: High Dose Rate machine
   Desirable: Manual after loader
3. Independent Diagnostic Department
   a. Essential: X-ray, CT Scan, MRI, Mammography, Ultrasonography
   b. Desirable: PET and/or PET-CT, angiogram, Nuclear Medicine facilities
4. Treatment Planning system capable of performing:
   Essential: CT Scan based treatment planning
   Associated contouring workspace
   Teletherapy plans including 3D-CRT and IMRT
   Brachytherapy planning (HDR)

   Desirable: IGRT planning; Virtual simulation
5. Beam verification devices (atleast any two of the below)
   a. Electronic Portal Imaging Device
   b. Film dosimetry with appropriate phantom
   c. 2D array
   d. TL Dosimetric system
6. Physics Dosimetry equipments
   a. Radiation Field Analyzer
   b. Ion chambers (cylindrical and parallel plate)
   c. Well type chamber
   d. Jig and associated gadgets.
   e. Electrometers
   f. Water Phantoms
   g. Survey Meter
   h. Zone Monitor
7. Immobization devices
8. Mould Room facilities
9. Library with Internet facility for educational purpose

Laboratory space: 800 sq.ft

Seminar room: 250 sq.ft

Class room: 250 sq.ft (2 numbers)

Audio-Visual aids: LCD projector, Slide projector, Over Head Projector and associated computers

Principals room, student's common room, staff room, office room store room.

Staff Requirement:

Teaching Staff (minimum requirement)

Head the Department (Chief Medical Physicist): One

Should have atleast 12 years of experience in the field of Medical Physics after qualifying degree/diploma in the field of Medical Physics/Radiation Physics/Biophysics

Senior Medical Physicist: One

Should have atleast 5 years of experience in the field of Medical Physics after qualifying degree/diploma in the field of Medical Physics/Radiation Physics/Biophysics

Junior Medical Physicist: One

Should have atleast 2 years of experience in the field of Medical Physics after qualifying degree/diploma in the field of Medical Physics/Radiation Physics/Biophysics

Radiation Oncologist: One

Should have atleast 3 years of experience in the field of Radiation oncology after qualifying degree in the field of Radiation Oncology

Non-Teaching Staff:

RT Technologist: Two

Should have atleast 3 years experience in the field of Radiotherapy Technology after qualifying degree/diploma in the field of Radiotherapy Technology

Physicist: One (optional)

Should have upto two years of experience in the field of Medical Physics after qualifying degree/diploma in the field of medical physics/radiation physics/Biophysics.