KERALA UNIVERSITY FOR HEALTH SCIENCES
THRISSUR – 680 596, KERALA

REGULATIONS, SCHEME AND SYLLABUS

OF THE DEGREE OF

BACHELOR OF SCIENCE IN

MEDICAL RADIOLOGICAL TECHNOLOGY

B.Sc. (MRT)

CONTENT

1. **Title of the Course : The name of the course shall be "Bachelor of Science in Medical Radiological Technology"- B.Sc. (M.R.T)**

2. **Objectives/Goals of the Course**

To mould professionally competent Radiological Technologists
At the end of the course the successful candidate should be:

1. Able to do independently qualitatively good routine radiographic procedures.
2. Able to do special investigations under guidance of specialists in diagnostic radiology.
3. Able to execute all routine and state of the art radiotherapy programmes as per prescription and direction of radiation oncologists and physicists
4. Able to operate and maintain all equipments used in investigative and therapy procedures.
5. Able to exercise professional skill and optimization in all technological aspects of existing and emerging branches of radiological and radiotherapy practices
6. Able to use ionizing radiation observing all national and international guidelines on radiological safety and accepted protocols in individual cases of the different applications. The technologists will develop a high level of safety consciousness and learn to follow accepted work practices to achieve optimum use of radiation in varied applications.
7. Able to assist in the use of ionizing and non ionizing radiations for diagnosis and treatment of diseases.

3. **Course Outline**

Radiological Technology deals with the application of different types of radiations and allied tools for the diagnosis and treatment of diseases. Radiations of significance are all the ionizing and non ionizing radiations like the complete electromagnetic spectrum – radio waves to cosmic radiation, ultrasound waves and particle type atomic radiations. Besides, use of nuclear magnetic resonance and application of various radio nuclides in medicine also form significant components of this programme. Graduates in Radiological Technology are professionals who mostly work as technologists in medical institutions. They are in great demand both within India and abroad. Potential for employment abroad for such professionals is tremendous and continues to register a constant upward trend only. Besides, industry engaged in the design, manufacture, and sale of radiological systems of varied types need these graduates as application specialists. Thus, successful candidates who complete this course are sure to get useful employment in the public and private sectors in India as well as abroad. There is a great demand for these professionals in all the developed and developing countries and the present annual intake in such courses world wide is far short of the requirements. Hence, career opportunities for radiology technologists will continue to be bright and rewarding in the near and distant future.

REGULATIONS

4. Eligibility for Admission

The candidate shall pass higher secondary examination, 10+2 with Physics, Chemistry and Biology of Govt: of Kerala or equivalent course recognized by the **Kerala University of Health Sciences.**
A minimum of 50% marks in Physics, Chemistry and Biology taken together is essential.

5. Selection of Students

The selection of students for the B. Sc MRT course shall be made strictly on merit as decided by the Govt. of Kerala/Kerala University of Health Sciences.

6. Registration

A candidate on admission to the B Sc MRT course shall apply to the University for Registration

- By making a formal application in the prescribed format.
- Original mark lists of the qualifying examination.
- Transfer certificate from the previous institution.

- Allotment letter from the competent authority who conducted the admission process
    - Equivalency and migration certificate where ever needed.
    - Original SSLC/Equivalent Certificate.
    - The fees prescribed for the registration.

8. **Break of course / Re-admission**

The rules for Break of course / Re-admission shall fix by the Kerala University of Health Sciences from time to time.

9. **Duration of the course**

The duration of the course shall be four academic years - Approximately, 240 working days in a year, with a minimum of 6 hours per day - 1440 working hours per year. Maximum duration of the course is eight years. On completion of eight years the registration of the course will be cancelled and the candidate may re-register for the course.

10. **Medium of Instruction**

Medium of instruction and examinations shall be **English.**

11. **Branches of Study**

The course shall comprise of both theoretical and practical studies in different branches of Medical Radiological Technology and its related subjects such as:

1. Anatomy & physiology
2. Basic Mathematics, Physics & Electronics
3. Physics of radiology
4. Pathology
5. Radio diagnosis
6. Radiotherapy
7. Radiological protection
8. General topics - viz, Special English, computer Technology, Health education, Community Medicine & sociology

Teaching/Learning methods

- Lecture and practical classes
- Regular clinical posting to pick up practical skill and practice techniques on medical radiological technology.
- Students should present seminars in various clinical subjects in medical radiological technology to attain presentation skill.

12. **Title of Subjects & Hours of Study**

FIRST YEAR

PAPER	SUBJECT	THEORY Hrs	PRACTICAL Hrs	TUTORIALS Hrs	TOTAL Hrs
1	Anatomy	200		40	240
2	Physiology	200		40	240
3	General Physics & Electronics	200	80	40	320
4	Atomic & Nuclear Physics	160		40	200
5	Mathematics	120		40	160
6	Computer Science	30	40	10	80
7	General Papers: • Special English • Community Medicine, Sociology, Psychology, Health education	40 120		40	200
	TOTAL	1070	120	250	1440

SECOND YEAR

PAPER	SUBJECT	THEORY Hrs	PRACTICAL Hrs	TUTORIALS Hrs	TOTAL Hrs
1	Radiation Physics I	160	40	40	240
2	Radiotherapy I	180	360	40	580
3	Radio diagnosis I	180	360	40	580
4	Pathology	30		10	40
	TOTAL	550	760	130	1440

THIRD YEAR:

PAPER	SUBJECT	THEORY Hrs	PRACTICAL Hrs	TUTORIALS Hrs	TOTAL Hrs
1	Radio diagnosis II	180	310	40	530
2	Radiotherapy II	180	310	40	530
3	Radiation Physics II	180	40	40	260
4	Radiological Protection And statutory aspects	70	40	10	120
	TOTAL	610	700	130	1440

FOURTH YEAR: In the fourth year the students will be posted to work in approved hospitals and to carry out project work simultaneously. Hospital posting as well as project work must be substantiated with records duly signed by the Head of the Department of the Institution where the candidate is posted.

Regulation and scheme of examination

13. Eligibility for appearing Examination

a. Attendance and condonation option.

No candidates shall be admitted to any year of B.Sc (MRT) examination unless he/she has a minimum of 80% attendance with the provision for one time condonation up to 10% on medical grounds (condonable limit 70%). Condonation for shortage of attendance shall be vested with a committee constituted by the Principal/ Head of the respective college, with the Principal/ Head as the Chairman and five members (senior teachers) in the committee, and remittance of required fee to the University.

A candidate who has not attained 80% attendance and the shortage is beyond the condonable limit he/ she shall not be eligible to continue the course with the same batch of students. He/ She may obtain special sanction (Condonation of Break of Study) from the institution and the university to continue with the junior batch of students.

b. Internal Assessment marks.

The internal assessment marks in theory/Practical shall be restricted to a maximum of 50% of the University Examinations – in Theory/Practical separately. The internal assessment marks in theory/Practical shall be on the basis of the assessment made by the teachers from the candidate's performance in the: Three (3) sessional examinations (evenly placed) conducted by the department, Laboratory work and seminars during the course of study. The third sessional examination should be conducted as model examination. The best of first two sessional examinations marks and the third sessional model examination (compulsory) should be included for calculating internal assessment marks. The marks secured by the candidates in each paper/subject shall be forwarded to the university at the end of the course for university examinations. The class average of the sessional marks should not exceed 75%. The candidates who failed in the university examination will be allowed a separate internal assessment for both theory and practical including viva. The minimum requirement of internal assessment for appearing university examination shall be 35%. If a candidate not securing minimum internal assessment he / she should appear for next university examination (supplementary or regular) after securing minimum internal assessment. But student shall be promoted to the subsequent years. A regular record of theory and practical sessional marks shall be maintained for each student in the institution.

Criteria for Internal Assessment marks

Sl. No	Items	Max. Marks	Split up
1	Attendance	5	96% and above - 5 marks 92.1% – 95.9% - 4 marks 88.1% – 92% - 3marks 84.1% – 88% - 2marks 80% - 84% - 1marks
2	Assignments	20	Must be handwritten. Computer printouts are not allowed. Valuation based on Content, Presentation and Originality. Plagiarism will not be accepted and treated seriously and those assignments will be rejected.
4	Class tests	25	Average of two best class tests will be taken for calculation of internal assessment marks
TOTAL		50	

University Examinations

There shall be university regular examination at the end of each Academic year; in case of failed/not appeared candidates a supplementary examination will be conducted within six months after the previous regular examination result publication. Candidates who fail in one or more papers in an examination need appear for only those papers including theory, practical and viva, for securing complete pass in the examination. There will be no University examination for General Papers.

14. Scheme & Schedule of Examination

First year	
Paper-I	Anatomy
Paper-II	Physiology
Paper III	General Physics & Electronics
Paper IV	Atomic & Nuclear Physics
Paper V	Mathematics
Paper VI	Computer Science
Paper VII	General Papers: • Special English • Community Medicine, Sociology, Psychology, Health education
Only Internal examination will be conducted for Paper VII, no university examination. No Practical examination in Paper I, II, IV, V, VI & VII. Practical Examination in Paper III will be in one day.	
Second year	
Paper VIII	Radiation Physics I
Paper IX	Radiotherapy I
Paper X	Radio diagnosis I

Paper XI	Pathology
No Practical examination in Paper VIII, IX, X & XI	
Third year	
Paper X II	Radio diagnosis II
Paper XIII	Radiotherapy II
Paper XIV	Radiation Physics II
Paper XV	Radiological Protection And statutory aspects
No Practical examination in Paper XV. Practical examination in Paper X11, XIII & XIV will be in three consecutive days for each paper.	
Fourth year	
Paper XVI	Project (should be submitted for evaluation in the fourth year B.Sc MRT practical examination)
In the fourth year the students will be posted to work in approved hospitals and to carry out project work simultaneously. Hospital posting as well as project work must be substantiated with records duly signed by the Head of the Department of the Institution where the candidate is posted. Paper XVI shall be valued by the final year university examiners of concerned subject projects.	

15. Distribution of Marks

The following criteria shall be followed when distributing marks

Theory	Section A	50 marks
	Section B	50 marks
	Total	100 Marks
Internal Assessment marks		
Theory	Section A	50 marks
	Section B	50 marks
	Total	100 Marks
Practical	100 marks (10 marks for Record)	
Viva	50 marks	

FIRST YEAR EXAMINATION

Paper & Subjects	Theory						Practical						Grand Total	
	University		Internal		Total		University		Viva		Total			
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
Paper I Anatomy	100	50	50	25	150	75							150	75
Paper II Physiology	100	50	50	25	150	75							150	75
Paper III General Physics & Electronics	100	50	50	25	150	75	100	50	50	25	150	75	300	150
Paper IV Atomic & Nuclear Physics	100	50	50	25	150	75							150	75
Paper V Mathematics	100	50	50	25	150	75							150	75
Paper VI Computer Science	100	50	50	25	150	75							150	75
Paper VII General Papers:Only Internal examination will be conducted for General Papers and no university examination														
Special English			50	25	50	25							50	25
Community Medicine and Health education			50	25	50	25							50	25
Sociology, Psychology			50	25	50	25							50	25
Total Marks	**600**	**300**	**450**	**225**	**1050**	**525**	**100**	**50**	**50**	**25**	**150**	**75**	**1200**	**600**

SECOND YEAR EXAMINATION

Paper & Subjects	Theory						Practical						Grand Total	
	University		Internal		Total		University		Viva		Total			
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
Paper VIII Radiation Physics I	100	50	50	25	150	75							150	75
Paper IX Radiotherapy I	100	50	50	25	150	75							150	75
Paper X Radio diagnosis I	100	50	50	25	150	75							150	75
Paper XI Pathology	100	50	50	25	150	75							150	75
Total Marks	**400**	**200**	**200**	**100**	**600**	**300**	**0**	**0**	**0**	**0**	**0**	**0**	**600**	**300**

THIRD YEAR EXAMINATION

Paper & Subjects	Theory						Practical						Grand Total	
	University		Internal		Total		University		Viva		Total			
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
Paper XII Radio diagnosis II	100	50	50	25	150	75	100	50	50	25	150	75	300	150
Paper XIII Radiotherapy II	100	50	50	25	150	75	100	50	50	25	150	75	300	150

Paper XIV Radiation Physics II	100	50	50	25	150	75	100	50	50	25	150	75	300	150
Paper XV Radiological Protection And statutory aspects	100	50	50	25	150	75							150	75
Total Marks	**400**	**200**	**200**	**100**	**600**	**300**	**300**	**150**	**150**	**75**	**450**	**225**	**1050**	**525**

FOURTH YEAR EXAMINATION

PAPER	SUBJECT	External Posting and Project Work		Viva		Max	Min
		Max	Min	Max	Min		
XVI	Radio diagnosis & Radiotherapy	100	50	50	25	150	75
Total Marks for Fourth Year		**100**	**50**	**50**	**25**	**150**	**75**

Total Marks for the whole course: 3000

16. Question Paper pattern

All the question paper should be of standard type. Each theory paper will be of 3 hours duration and shall consist of ten questions with a maximum of 100 marks. Theory paper in all the subjects shall consist of two parts (Part A & Part B). Part A consists four essay type questions. Out of which two has to be answered. Each question carries 25 marks. Part B consists of eight brief answer type questions. Out of which five to be answered. Each question carries 10 marks each.

17. Examiners

One set of Examiners will be sufficient (one external and one internal) to conduct the practical and viva examination in all the subjects.

18. Scheme of valuation

Double valuation of the answer papers will be conducted. If the variation in total marks obtained in two valuations is more than 15%, the paper should undergo a third valuation. No re- valuation should be permitted but only re-totaling is permitted. The average of marks obtained for double valuation is taken as the final mark of the student. In the case of answer papers going for third valuation the average of nearest two marks is taken as final mark.

19. Project

Synopsis

A project work based on medical radiological technology work on a current topic of relevance, consisting of about 30 pages (Times New Roman, Font size 14, line space 1.5), bound.

Submission

The project should be certified by the supervising staff and submitted to the Head of the Department one month prior to fourth year university practical examination and no need to submit to the University.

Valuation

The project report evaluation will be conducted by the internal and external examiners together in the concerned subject Fourth year B.Sc (MRT) University practical examination. If the project submitted by the candidate is rejected by examiners or the marks obtained is less than the pass mark, the candidate has to do a fresh project in parent institution under direct guidance and supervision of a senior faculty. The same has to be submitted for re-examination.

20. Criteria for pass and grace marks

Candidate who has secured a minimum of 50% marks in the University examination (theory and practical separately) and 50% marks in Total for theory block (University Theory & Internal assessment) and practical block (University Practical, Viva & Internal assessment) separately in any subject or subjects shall be declared to have passed in that subject / subjects. There will be no minimum marks for viva

examination. If a candidate fails in either theory or practical paper he/she has to reappear for both the papers (Theory and practical & viva). A candidate who fails in any subject in the university examination may appear for that subject in the subsequent supplementary or regular university examination.
Five marks (or as per university regulations) may be given as grace mark either in a subject alone or distribute it among subjects so as to make the candidate eligible for a pass.

21. Criteria for Promotion

Student shall be promoted up to third year irrespective of whether he/she has passed the first, or second year university examinations provided he/she has attained 80% attendance and appeared in all the sessional examinations for both theory and practical in the respective year. But a candidate before appearing the third year B.Sc (MRT) examination shall have passed in all the subjects of first and second year B.Sc (MRT) examinations. If the candidate fails in the first or second year or both, and third year examinations he/ she will be retained in the third year itself. Though the candidate fails in third year examination but he or she passed both first and second year shall be promoted to fourth year. The candidate before appearing the fourth year B.Sc (MRT) examination shall have passed in all the subjects of third year B.Sc (MRT).

22. Rules for Supplementary batch

No supplementary batch will be conducted for B.Sc (MRT) course but supplementary examination will be conducted after each regular examination.

23. a) Qualification of Teacher

Acquisition of MD or Masters Degree in the concerned subject, in any Institute or Medical College approved by the Kerala University of Health Sciences and Govt. of Kerala.

b) Qualification of Examiner

There shall be two examiners for practical and viva – one internal and one external. The external examiner shall be drawn from other institutions where a similar course is being conducted. Both internal and external examiners should have MD or Masters Degree in the concerned subject and those who are full time teachers of Masters Degree in the concerned speciality with at least two years teaching experience in concerned speciality after acquisition of MD or Masters Degree in the concerned subject. The theory papers should also be evaluated by teachers with above qualifications.

c) Qualification of Guide for Project

The supervising Teacher should have minimum 3 years full time teaching experience in the concerned subject.

24. Declaration of Class

Second class -Those who have secured 50% marks and less than 60% of the total marks shall be placed in the Second class

First class - Those who have secured 60% and above shall be placed in the First class

First class with Distinction- Those who have secured 75% or above shall be declared to have passed in First class with Distinction.

For awarding class in the final B.Sc (MRT) degree examination, the total marks obtained in the I, II, III&IV B.Sc (MRT) examination will be taken and the final B.Sc(MRT) mark list will contain the following details.

	Maximum marks	Minimum marks
Total marks awarded in the I B.Sc(MRT)		
Total marks awarded in the II B.Sc(MRT)		
Total marks awarded in the III B.Sc(MRT)		
Detailed mark list of IV B.Sc(MRT)		
Grand total of I, II, III & IV B.Sc(MRT) examination marks		

25. Awarding Rank

The First class/First class with Distinction/Rank will be declared based on the total marks obtained for the first, second, third and fourth B.Sc(MRT) examination provided the candidate has passed all the subjects in the first attempt in the prescribed duration of the course.

26. Eligibility for the award of Degree

A candidate who passes the entire subjects of the course for the specific period if any will be eligible for the award of degree.

27. Syllabus and Model Question Paper

B.Sc MRT **1440 hours**

1 YEAR

1. **ANATOMY**
2. **PHYSIOLOGY**
3. **GENERAL PHYSICS & ELECTRONICS**
4. **ATOMIC & NUCLEAR PHYSICS**
5. **MATHEMATICS**
6. **COMPUTER SCIENCE**
7. **GENERAL TOPICS**

- Special English and communication skills
- Community Medicine
- Sociology
- Health Education

I. ANATOMY 240 hours

Knowledge of the normal structure and function of the different parts of the body must be coupled with some idea of the way in which disease arises and extends, so that the technologist can assist in the various procedures used in diagnosis and treatment. The syllabus gives under the main headings the names of organs and systems to indicate the scope of teaching required. Both in diagnosis
and treatment.

Knowledge of the size and position of an organ is of paramount importance. The level to be aimed at here is difficult to define, but books on surface anatomy are available and only rarely will it be necessary to refer to major works on anatomy, such as Gray and Cunningham.

Under the repeating headings common terms used in connections with diseases of this system, no detailed list of diseases is required, but an explanation of those terms which the technologist may encounter in daily work is necessary

INTRODUCTION TO ANATOMY

Terms used in Anatomy

Regions of the body

Description of a typical animal cell: Cell mitosis; genes; sex cell; ova and spermatozoa. Fertilization of the ovum. Broad lines of embryonic development. Cell function and differentiation of tissues.

General Histology: Epithelium; simple and complex epithelial glands; skin. Connective tissue; fibrous tissue; cartilage; bone; Haversian systems; blood; numbers and types of cells in blood; clotting of blood. Muscle tissue; involuntary, voluntary and cardiac muscle. Nerve tissue.

MUSCULOSKELETAL SYSTEM

Classification of muscles

Anatomical relationships of muscles

Origin and insertion of muscles

General description of bones, their main processes and attachments, 'including the skull with emphasis on the skull as a whole. Development of bones, Primary and secondary oneenters;diaphysesandempiphyses. Position and function of main joints. Some common

Diseases and injuries of bones and joints

THORAX AND THORACIC CAVITY

Thoracic wall, pleura, lungs and its lobes and segments. Mediastinum and its contents, Heart and great vessels

RESPIRATORY SYSTEM

Nasal cavity, Paranasl sinuses, nasopharynx, Oropharynx, Larynx, Hypopharynx,trachea, Bronchi, Bronchial tree, Thoracic cavity, Mediastinum, Pleura. Lungs-Position, relation, Structure, Bronchopulmonary segments.

DIGESTIVE SYSTEM

Oral cavity, teeth, salivary glands, tongue, tonsil, oesopharynx, oesophagus, stomach, Duodenum, small intestine, caecum, appendix, large intestine, rectum, anal canal, mesentery, omentum, peritoneum,peritoneal cavity.

Liver- Position, relations, structure, gall bladder, cystic duct, common bile duct, gall stones, Portal circulation.

Pancreas- Position, structure, pancreatic duct.

Spleen- Position, relation, blood supply.

GENITO URINARY SYSTEM

The kidneys, collecting system, Urinary bladder and urethra in male and female. Testis, seminal vesicles, spermatic cord, prostate, penis, ovaries, fallopian tubes, uterus, vagina, vulva and clitoris.

NERVOUS SYSTEM

Brain- its coverings, different parts, cerebrum, cerebellum, midbrain, pons medulla oblangatta, Corpus calosum, cranial nerves and ventricles of brain. Spinal cord-its position and structure, coverings, spinal nerves and applied anatomy. Brief study of important peripheral nerves, sympathetic and parasympathetic system.

CARDIOVASCULAR SYSTEM

Heart, Pericardium, cardiac chambers, aorta, its paired and unpaired branches. Major blood vessels of extremities and brain.

LYMPHATIC SYSTEM

Structure of lymph node, different lymph node groups and its drainage areas, lymphatic vessels and thoracic duct.

ENDOCRINE SYSTEM

Gross anatomy of endocrine glands- Pituitary, Thyroid, Parathyroid, Pancreas, Adrenals, Pineal, Ovary, testes.

MISCELLANEOUS TOPICS

Gross and microscopic structure of skin and appendages. Orbit and Orbital structures. External, middle and internal ear, mastoid air cells.

REFERENCE BOOKS.

1. Radiographic anatomy – Messchan
2. Gray's anatomy
3. Anatomy and physiology for nurses including notes on their clinicalapplication- Evelun Pearce
4. Dean. Basic Anatomy and Physiology for Radiographers.
5. Hamilton et al, Surface and Radiological Anatomy

II. PHYSIOLOGY 240 hours

INTRODUCTION TO PHYSIOLOGY

RETICULO ENDOTHELIAL SYSTEM:

Composition of blood, gross structure of RBC,WBC, platelets, its production and functions. Anaemia, polycythemia,leucopenia, leucocytosis, thrombocytopenia, pancytopenia-defenition, common causes and clinical significance. Physiology of coagulation, coagulation factors, thrombus formation.

LYMPH:

Lymph formation, functions

URINARY SYSTEM:

General physiological functions of respiratory system, Mechanism of ventilation. Pulmonary circulation. Respiratory and non respiratory functions of lung. Diffusion of gases in lungs and factors influencing.

ENDOCRINE SYSTEM:

Brief description of endocrine organs, its hormones, functions of hormones, diseases produced by excess or deficiency of the hormones. Thyroid hormone production giving stress role of iodine in detail.

DIGESTIVE SYSTEM:

Physiology of deglutition, movement of food through oesophagus, stomach, small and large intestines and defecation. Brief study of different digestive juices, its functions, digestion and absorption.

REPRODUCTIVE SYSTEM

Functions of gonads. Male reproductive system, secondary sexual characters in male and onset of puberty. Physiology of the sperm, normal characteristics and composition of semen.

CRYPTOCHIDISM.

Female reproductive system, secondary sexual characters in female and onset of puberty. Physiology of formation of ovum and menstrual cycle. Pregnancy, infertility and menopause.

CARDIOVASCULAR SYSTEM:

General functions of cardiovascular system. Systemic and pulmonary circulation. Cardiac cycle, atrial systole and diastole, ventricular systole and diastole. Pulse, blood pressure, shock. Anaphylactic shock- detection and management.

NERVOUS SYSTEM

General introduction and structure.

Functions of central nervous system-motor, sensory and special senses.

CSF- Formation, properties, functions and absorption.

REFERENCE BOOKS;

1. Best & Taylor – The human body.
2. Dean, Basic anatomy and physiology for radiographers.
3. King and showers - Human anatomy and Physiology.

III. GENERAL PHYSICS AND ELECTRONICS 240 hours

Part 1: GENERAL PHYSICS

Basic knowledge at the level of Plus II syllabus in Kerala is a pre requisite.

1. **INTRODUCTORY GENERAL PHYSICS**

i. Matter and Energy, Basic forces of nature, Gravitational, Weak, Electromagnetic and Nuclear forces – basic characteristics and examples, Electromagnetic Radiations, Principles of quantum theory of radiations, Basic mechanisms of production and propagation of the whole range of EM waves, Fluorescence, Phosphorescence, specification of intensity and quality of radiations

ii. Particle type radiations and their characteristics, Atom and Nucleus, energy states, Transformations between energy states, emission, and absorption of radiation, Radioactivity, and radio nuclides and their different modes of decay.

2. **OPTICS:**

i. Interference- Principle of superposition, coherent sources, conditions of brightness and darkness expression for bandwidth.

ii. Diffraction: General ideas, types of diffraction- Fresnel and Fraunhofer diffraction, plane transmission grating determination of wave length.

iii. Polarization- Polarization by reflection and refraction, Brewster's law, Double refraction: Ordinary and extra ordinary rays, Quarter and half wave plates.

iv. Scattering of light: Rayleigh scattering, Raman effect: Explanation based on quantum theory. Relative intensities of stokes and antistokes lines.

v. Production and properties of Lasers. Fiber optics: Principle and applications.

3. **MAGNETISM AND ELECTRICITY**

i. Static and current electricity, Role of C, R ,L in direct and alternating currents, conductors, insulators and semiconductors, Basic semiconductor devices like diodes, Transistors and their characteristics with emphasis on applications in electronic circuits. Alternating currents: peak and r.m.s values of current and voltage, circuit containing LR, CR and LCR- Power factor, wattles current, the J operator, series and parallel LCR circuits, resonance and Q factor, Acceptor and rejector circuits. Single phase and three phase circuits, Star and Delta connections

ii. Magnetism and electricity, Basic concepts of induction, Intensity of magnetization- Magnetic susceptibility, BH curve, magnetic hysteresis, Dia para and ferromagnetism.

iii. Construction of magnets, Electromagnets, High strength magnets using super conductors and their applications.

iv. Varying currents- Growth and decay of LR circuit, time constant, charge and discharge of a capacitor through a resistance and inductance, Oscillations in an LC circuit. Rectification – half wave and full wave rectifiers, rectification in three phase systems, basic circuits and applications. RMS and peak values of current and voltage in rectified circuits. Transformers of different types,Electricity and heat production, Eddy currents and hysteresis loss etc

v. Units of measurement in electricity, Measuring instruments for measurement of Current, Voltage, Resistance, power, Energy consumed, inductance and capacitance. Construction and maintenance of the meters.

4. **OSCILLATIONS:**

i. Differential equations and solutions of S.H.M, expressions for period, velocity and acceleration, phase, initial phase, forced oscillations, resonance.

ii. Doppler effect: General expression for apparent frequency. Applications

iii. Ultrasonics- production-magnetostriction and peizo electric methods, properties and uses.

Part II: ELECTRONICS

1. Semiconductors: Conduction in crystals, Energy bands (qualitative). Intrinsic and extrinsic semiconductors, n-type and p-type semiconductors, majority and minority carriers.
2. Semiconductor diodes: p-n junction- properties, forward and reverse bias, characteristics of p-n junction, Rectifiers- Half wave and fullwave, ripple factor, Efficiency of HW and FW rectifiers, filter circuits, zenor diode, regulated power supply.
3. Transistors- Symbols, Transistor connections and characteristics, Transistor as an amplifier in CE arrangement, load line analysis, operating point, types of amplifiers, feed back- negative feed back in amplifiers.
4. Transistor oscillators- Hartley, Colpits and phases light oscillators.
5. Transistor as a switch- multivibrators- Astable, monostable, bistable multivibrators- simple.
6. Special devices- SCR, Diac, UJT, Fet, Mosfet, simple ideas on OPAMP, Microwave generators like Magnetron and Klystron , Wave guides.
7. Micro chips, Integrated circuits, Measuring systems
8. Radiofrequency waves, generation and detection and measurement.

List of Practicals

1. Spectrometer- Refractive index of the prism
2. Spectrometer- Dispersive power
3. Spectrometer- i-d curve
4. Spectrometer-Grating-Normal incidence
5. Full wave rectifier
6. Full wave bridge rectifier
7. Semiconductor diode -Characteristics
8. Zener diode – Characteristics
9. Op-Amp inverting amplifier
10. Digital gates-(OR,AND,NOT) verification
11. Op-Amp differentiator
12. Conversion of galvanometer into ammeter

IV: ATOMIC AND NUCLEAR PHYSICS 200 hours

1. Discovery of cathode rays, nature and properties, e/m- Thomson's method, charge on electron, Milliken's experiment.
2. Positive rays, isotopic constitution of matter, Aston's mass spectrograph.
3. Structure of atom- Thomson's model, Rutherford Nuclear atom model, Bohr's theory of hydrogen atom, critical potential, Excitation potential, limitations of Bohr's theory, Ritz combination principle, Somerfield's modification- elliptical orbits- relativistic correction.

   Vector atom model- Quantum numbers, coupling schemes, Pauli's Exclusion principle, Bohr magneton, Stern Gerlach experiment, Electronic configuration- periodic classification, Larmour precession, Zeemen effect (qualitative).
4. Quantum Physics- photo electric effect, Laws of photo electric emission, Einsteins theory, Millikan's verification of Einstein's equation.
5. Matter waves- De-Broglie's theory (qualitative), phase and group velocities, uncertainty principle.
6. Atomic Nucleus- general properties, binding energy, , nuclear forces, general ideas on meson theory, reasons for instability in nuclei.
7. Radioactivity- Natural and artificial radioactivity, nature of radioactivity, Law of radioactive disintegration, half life and mean life, radioactive series, law of successive disintegration, radioactive equilibrium,Various modes of radioactive decay with common examples, units of radioactive strength.

Range of alpha particles, Theory of alpha decay(qualitative), Beta and Gamma decay with examples. finite range of beta rays, Neutrino hypothesis, other sub atomic particles.

Gamma ray spectra absorption by matter, pair production, conversion electrons, electron capture, Auger electrons.

Nuclear reactions-(α,p),(α,n) and common nuclear reactions, proton bombardment, Fission, Fusion, Q values, Nuclear reactors, production of short lived and long lived isotopes, nuclear isomerism.

8. Qualitative ideas on elementary particles and cosmic rays.

V. MATHEMATICS 160 hours

1. ALGEBRA

Laws of indices, logarithm, Exponential, Logarithm series, progression, permutation and combination, matrices- sum, product and transpose of matrices, 2x2 &3x3 determinants, Use of theorems in evaluation, Cramer's rules, Partial fractions.

Mathematical induction, Binomial expansion (1+x) & (1-x) for all n

2. TRIGNOMETRY

Measurement of angles, Trigonometric ratios, Relations connecting complementary and supplementary angles, Ratios of compound angles Product formula, Multiple and sub multiple angles, Area of triangle, Relations between sides and angles of a triangle, Trigonometric equations, inverse trigonometric functions.

3. CALCULUS

Functions and Limits, Differentiation, Rules of differentiation, sum, difference, product and quotient formulae, function of a function rule, Differentiations of inverse trigonometric functions, parametric functions, Implicit functions, Logarithmic differentiation. Higher order derivatives and partial differentiation, Integration: Methods of integration, Integration by substitution, integration by parts, Definite integral and its properties.

4. VECTORS

Definition, Product of vectors, scalar and vector products, scalar and vector triple products, vector differentiation, Gradient, Divergence and curl.

5. COMPLEX NUMBERS

Definition, Modulus, Amplitude and properties, De Moiveres theorem, Extraction of roots of a complex number.

6. STATISTICS

Basic ideas of statistical evaluation, mean, standard deviation etc Calculation of mean, median, mode, standard deviation, mean deviation, variance, coefficient of variation, calculation of correlation coefficient and regression analysis, concept of probability. Calculation of probability in a discrete sample space, Binomial, Poisson and normal distribution, Simple problems.

7. GENERAL IDEAS

Fourier transforms, laplace transform, Sievert integral, Differential equations, Numerical methods of integration

VI. COMPUTER SCIENCE 80 hours

Paper: Introduction to IT and Programming

Module – I: Introduction to PC

Functional Units of Digital Computer-Basic Operation Concepts-Hardware and Software- I/O devices, CPU, Memory-Primary and Secondary, RAM, ROM, Storage Devices - Hard Disk, Floppy, Optical Disk, etc.-Overview of Parts of a PC- Cabinet, Motherboard, Video card, Sound cards, Modems, Hard Drive, Zip Drive, CD ROM Drive, Network card, CPU, Main Memory, Power Supply-Computer Generations, Multiprocessors and Multicomputers

Types of Computers: Analog, Digital and Hybrid Type- Micro, mini, main frame & super computers

Programming Languages: Machine language, Assembly language, High level language

Algorithm- Flowchart and coding- Computer Software: System Software and Application Software

Introduction to Database: Database System concepts- DBMS and RDBMS

Introduction to computer Networks: Advantages of networking -Types of computer networks- LAN, MAN, WAN, Internet, Public networks, intranet & extranet, wireless network

Module-II : Introduction to Operating System

Introduction to Operating Systems: Basic concepts - Types of OS: batch processing, multiprogramming, time sharing, real time system

Components of an operating system - OS structure - Multiprocessor system-Distributed system-Operating system services.

Different Operating Systems- DOS: Introduction, Loading and Quitting the Operating Systems, Important DOS Commands (Internal and External), File and Directory System Concepts in DOS- MS Windows: Introduction, Desktop icons, Creating Folder, creating, copying and cutting files, Renaming, introduction to MS-office package-Word, Excel, Power point- Linux: Introduction, basic commands, Introduction to open office -Writer, Calc, Impress

Module-III: Introduction to C Programming

Introduction to C Language- History of C, Characteristics of C Language, C Program Structure, Preprocessor and the #include and #define Directives, Data Types:

Variables and Constants, Operators: Arithmetic, Logical, Relational, Bitwise, Unary and Ternary Operators

Conditional Statements, Looping and Iteration, Arrays: Single and Multi

Dimensional array, Pointers and Strings, Dynamic Allocation of Memory

Module-IV: Preparing and running a C program

Structures and Union, Enum Data Type, Functions-Types of functions, Pass by value, Pass by reference- Class Storage: Auto, Extern, Static and Global Variable, File Handling, C Program to Swap two Numbers, Generate Fibonacci series and add two arrays.

Module-V: Introduction to Health IT

IT application in different fields : Internet and the World Wide Web, Basics of Internet - – Getting connected – Addresses and Names - web objects - sites, E-mail, setting up E-mail, Web server, Proxy server, Web Browsers, Firewalls, Search Engines, Web TV, Internet Telephone, E-commerce, E-Publishing, IT as an educational management tool, online learning, multimedia - IPR and implication – Viruses, different types of viruses- Cyber Laws – Social, Economical, Political, and Ethical Perspective of IT.

Health Information Technology: definition, common HIT applications- Hospital Information Systems, practice management systems, Electronic Medical records and Electronic health records, e prescribing, Personal Health records, Patient registries, patient portals, e health and telemedicine, Mobile health, PACS, Use of HIT- Advantages and challenges.

Reference Books:

1. Fundamentals of Computing, J. B. Dixit, Laxmi Publications
2. Database System Concepts, Korth,Silberschatz, and Sudarsan --- Tata McGraw Hill
3. Computer Networks-Andrew S. Tannenbaum-PH
4. Internet for Everyone - Alexis Leon and Mathews Leon -- Vikas Publishing House Pvt. Ltd., New Delhi
5. Operating System Concepts, SilberSchatz, Galvin,Gange(6th Edition)
6. Open Office Basic: An Introduction, Prof. James Steinberg, Gold Turtle Publishing, December 2012, ISBN 978-1481270939
7. C – Programming, E.Balagurusamy, Tata McGray Hill
8. C The Complete Reference - H.Sohildt, Tata McGraw Hill
9. Let us C - Y.Kanetkar, BPB Publications
10. The C programming language : Kerninghan and Ritchie
11. Information Systems For Healthcare Management, C.J. Austin, S.B. Boxerman, 6th Edn, ISBN 81-8014-093-8, Standard Publishers Distributors, New Delhi
12. Health Informatics in the Cloud, Mark L. Braunstein,Springer-Verlag New York Inc.(2012)

VII. GENERAL TOPICS 200 hours

1. **PSYCHOLOGY**

A sound knowledge of psychology is essential to help the students understand themselves and other people, and how to develop inter personal relationships. This knowledge would then be applied in working with any patient and as a member of the treatment team.

1. What is psychology? Fields of application of psychology
2. Respective influences of heredity and environment on the individual.
3. Development and growth of behavior in infancy and childhood.
4. Intelligence and intelligence testing.
5. Aptitudes and interests, motivation.
6. Emotions and emotional development.
7. Personality and assessment thereof.
8. Memory- remembering, forgetting, thinking.
9. Learning theories, methods of learning.
10. Sensation, Preception
11. Social Psychology, influence of individuals and groups of behaviour of others. Leaderships; Group Psychology.

II. SOCIOLOGY

1. Introduction: What is sociology? Importance of the study of sociology. Its relation with other social sciences. Application of Sociology: Formulating policies & laws of Govt. Development of agriculture, Industry, Harijan& Tribal welfare.Labour welfare. Education, family welfare etc.
2. Individual and society: Socialization: The individual as an isolate unit. The socialized individual: Importance of society n the development of individual personality.
3. social group: Primary and secondary groups:
4. Family : Family as a basic unit of society. Importance of family in the community. Social institutions.
5. Culture: Meaning of culture. Culture traits: cultural similarity and diversity.
6. Social change: Factors of social change. Nature of social change and meaning of social progress; social changes in urban and rural areas.
7. Community development and rural reconstruction programme.
8. Social and case study methods.
9. Social problems:
    a. Migration of population from rural to urban areas overcrowding.
    b. Problem of housing; government housing schemes; slums and slum clearance.
    c. Problem of poverty: Social security scheme.
    d. Prostitution: Venereal diseases and control.
    e. Unemployment causes and remedies.
    f. Juvenile delinquency
    g. Alcoholism: Various aspects of prohibition drug addiction.

h. Population explosion: Maltusian theory. Family welfare and birth control.
i. Problem of beggary.
j. Malnutrition.

10. The Indian ideals of womanhood: working women. Problems at home and unemployment.
11. Medical social work.

III. COMMUNITY MEDICINE.

[Recommended Text Book: Preventive and social medicine by J.E park]

- General concepts of Health and diseases with reference to natural history of disease with pre pathogenic and pathogenic phase. The role of socio-economic and cultural environment in health and disease. Epidemiology and scope.
- Public Health Administration- overall view of the health. Administration setup at Central and State levels.
- The national Health progammme: Highlighting the role of socio economic and cultural factors in the implementation of the national programmes.
- Health problems of vulnerable groups- pregnant and lactating women, infants and pre-school children. Occupational groups; geriatrics.

- Occupational health. Definition; Scope: occupational disease; prevention of occupational disease and hazards.
- Social security and other measures for the protection of occupational hazards, accidents and diseases. Details of compensation acts.
- Family planning, Objectives of National family planning programme and family planning methods. A general idea of advantages and disadvantages of methods.
- Mental health- Community aspects of mental health; role of physiotherapists. Therapists in Mental Health problems such as mental retardation.
- Communicable diseases- An overall view of communicable diseases classified according to mode of transmission. Role of insects and other vectors.
- International Health Agencies.

IV.HEALTH EDUCATION

1. Health education- Philosophy, main principles and objectives, health education versus health legislation: education versus propaganda.
2. Review of beliefs, values, norms, habits and taboos among practices. Mores in human groups and their importance in learning and change process.

3. Review of concepts of perception, attitudes, socialization process, learning and theories of learning, social change and change process, Motivation, needs and drives.
4. Principles and process of communication.
5. Methods and tools of health education: Individual and group methods, A critical evaluation of the theories and tools of health education.
6. The role of professional health education; role of other personnel in health education, co-ordination and co-operation in health education with other members of health team.
7. Elements of planning, implementation and evaluation of a health education programme.

V. SPECIAL ENGLISH- English for special Purpose (English for Medical Sciences)

Students of professional courses have a tendency to neglect the language content. The paper "English for Special Purposes" is introduced with a view to developing the communication skills of the participants in written and spoken English. The emphasis will be fully on the practical aspects of language use, and not on literature. The course content may also help the students to take up overseas examinations in English proficiency like the IELTS or TOEFL.

- Writing skills (15 hours)

Composition:

Writing effective paragraphs, ability to describe objects, people, process and ideas and narrating incidents- note taking/ making summaries. Writing telegrams, advertisements, preparing laboratory reports.

Letter writing:

Business letters-applying for a job, for higher studies- preparing curriculum vitae- subscribing to a journal- requesting for information- ordering equipments- Letters to the editor.

- Foundation English(10 hours)

Revision of basic grammar: common errors in English, Language functions in medical writing- use of passive voice particularly in scientific and official writing, expressing obligation- use of must, should, ought: expressions of possibility, likelihood, certainty, degrees of comparison, expression of necessity: must, have to, need to, expression of generalizations and emphasis.

- 111. Vocabulary: (5 hrs)

The language of doctor and patient. Medical terminology- roots, prefixes and suffixes, medical abbreviations.

- IV. Spoken English (10 hrs)

A course in speech and conversation with focus not on phonetics and grammar, but on developing their ability to talk about objects and expressions around them.

Fixing appointments- Getting information- Managing medical representatives- Telephoning in a hospital: The objective is to provide practice in fluent conversation. Focus is on specific expressions typical of familiar situations in a medical practice. Techniques of discussion at medical meetings, making presentation at workshop or conference.

Recommended reading:

John Cristopher Maher, International Medical communication in English(London, Edinburg, University press) 1990.
Jones L. Functions of English (Cambridge University Press) Tickoo Subramaniam.

B.Sc. MRT - II YEAR **200 hours**

I. RADIATION PHYSICS I

SECTION I:

Cathode Rays:-

Conduction of electricity through rarefied gases, Production and properties of cathode rays- Thermionic emission- variation of anode current with voltage- Voltage and filament temperature- Thermionic gas diode- photoelectric emission-Laws, Quantum theory.

SECTION II:

Spectra:

Emission spectra- continuous, Line and band spectra- Spontaneous and stimulated emission-Laser action.

He-Ne Laser- Absorption Spectra.

Luminance, Fluorescence and Phosphorescence with examples and uses.

SECTION III:

Physics of X-ray production

Production and properties of X-rays, Continuous and characteristic x-rays, X-ray spectra, intensity and quality of X-rays and factors controlling them, Various types of X-ray tubes, Associates electrical and electronic circuits, High Tension Transformer, Filament Transformer, Auto transformer, KV, mA, mAs and exposure time measuring systems, Heel effect. Dissipation of Heat in X-ray production, X-ray tube and housing rating charts and their evaluation, comparison of different X-ray systems like self rectified, half wave rectified, full wave rectified, multi pulse and constant voltage systems. Measures to protect X-ray units from over heating, preventive measures. Comparison of diagnostic and therapy X-ray tubes, CT tubes, Mammography tubes, High energy systems – MV generators, Linear accelerators (brief features)

SECTION IV:

X-ray production continued, Intensity distribution around the focal spot, Quality and quantity analysis, dependence on KV, mA, exposure time, distance, filtration,

characteristic component – its removal and special applications, calibration techniques for exposure factors, use of spinning top,KVp meter, mA(S) meter, KVP cassettes etc.

SECTION V:

Interaction of ionizing radiation with matter:Absorption and Transfer of energy- Attenuation- Attenuation coefficients-HVL-Narrow and Broad beams- Attenuation processes- photoelectric effect- Thomson scattering- Rayleigh scattering- Compton scattering- pair production- Total attenuation coefficient- importance of these interactions in medical imaging and radiation oncology.

SECTION VI:

Units and Measurement of ionizing radiation quantities, Energy, Intensity, Exposure, Kerma, Energy absorbed, dependence on relevant factors like nature of the absorber, type and energy of the radiation-Roentgen- Free Air ionization chamber- Other measuring systems(qualitative)- Absorbed dose, Rad, Gray, Kerma, Electronic equilibrium, Exposure rate constant.

Description and working of common measuring systems, Ion chambers, GM detectors, proportional chambers, scintillation detectors, TLD, chemical detectors, photographic detectors etc.

Section VII:

X-Ray Technology-1

X-ray tubes: Diagnostic and Therapy tubes, Gas tubes, Coolidge tube, Rotating anode tube, Line focus tube, Dual focus tube, Hooded anode tube, other therapy tubes(qualitative study), X-ray generator circuits, auto transformer, Filament transformer, Rectification of anode voltage, self rectifier circuit, Half wave and full wave rectification.

3 Phase generators, Phase transformers- 6 pulse 6 rectifier, 6 pulse 12 rectifier, Power storage generators(Qualitative), capacitor, Units for diagnosis- Villard circuit, Grenacher circuit, MA stabilizer, KV stabilizer, Mains compensator, Main stabilizer, measurement of KV, sphere gap method, series resistance volt meters, electrostatic volt meters, KV meter, crystal spectrometer.

SECTION VIII:

X-Ray Technology 2

Timers:Synchronous, Electronic, ionization, Photo, MAS timers.- pulse counting - Rating factors controlling rating - Use of rating charts -Accelerators.

SECTION VIII

Principles of Diagnostic Radiology:

Physical principles, Physics and chemistry of image formation, latent image and its processing, automatic and manual processing techniques, flat panel detectors and filmless imaging filters and filtration, inherent and added filtration, heavy metal filter, Effect of filtration on low and high energy beams.

Characteristics of radiographic images, contrast, sharpness, definition, distortion and factors affecting them to be discussed in detail, methods to improve the quality of images

Collimators, grids, grid characteristics, Types of grids, evaluation of grid performance, stroboscopic effect.. Exposure factors in imaging. QA of diagnostic X-ray units-necessity and procedures.

SECTION IX:

Effects of X-rays.

Fluorescence, Phosphorescence, Luminescence and their applications.

SECTION X:

X-ray films and other image receptors:

Film construction, image production, Development, Fixation and hardening, Processing, Properties of x-ray films, H&D curve, film gamma, speed or sensitivity, latitude, contrast.

Screens:

Intensifying and fluorescent screens, Actions, intensifying factors, screen thickness, materials used, quantum mottle (Brief), Modulation Transfer Function (Brief)

Solid state detectors and image receptors, Amorphous silicon flat panel detectors.

SECTION XI:

Image details:

Primary radiological images, image intensifier, Cine radiography, Video tape recording, TV technique, image quality, geometric factors influencing the image, Magnification and distortion, Unsharpness, Penumbra, Radiographic exposure, Quality assurance in X-Ray radiology.

SECTION XI:

Special procedures.

Fluoroscopy, Tomography, Stereoscopy, Myelography, Mammography, Pelvimetry, Xero radiography.

SECTION X :

Modern systems of imaging.

Computed Tomography:

Principles and operations, Different generations of CT units, spiral CT machines, Special features of X-ray generators and detectors.

Digital subtraction Angiography, Dental radiography and imaging techniques, spectial features of dental units.

II. RADIOTHERAPY- PART 1 — 220 hours

1. The student should have a knowledge of various diseases which come within the encompass of radiotherapy. This knowledge includes pathology and epidemiology. A general knowledge of the disease process, including knowledge of normal cell structure and life cycle, is necessary basis for an understanding of the abnormality. In the disease below basic pathology, etiopathogeneis, basic epidemiology, patterns of spread, treatment options for various stages and role off radiotherapy should be known. Common diseases to consider are:

1. Brain tumors
2. Head Neck Cancers
3. Lung Cancers
4. Breast Cancer
5. Esophageal Cancer
6. Rectal Cancer
7. Cervical Cancer
8. Endometrial Cancer
9. Vulva and Vagina
10. Soft Tissue Sarcomas
11. Testis
12. Penis
13. Prostate
14. Kidney, Ureter and Bladder
15. Pancreas Liver Stomach
16. Lymphomas
17. Pediatric tumors: Retinoblastoma, Wilms Tumor and Rhabdomyosarcoma

2. Effect of radiation on tissues including acute and late effects of radiotherapy.: Skin, Mucosa, GI tract, Genitourinary system, respiratory system, CNS.
3. Stochastic and nonstochastic effects
4. Effect of radiation on the body including effects of total and hemi body radiation.
5. Linear energy transfer and relative biological effectiveness;
6. Radiosensitizers and Radioprotectors : Examples and principles of action. Oxygen effect.
7. The student should have an understanding of principles underlying the choice of treatment and the relative place of radiotherapy with surgery, chemotherapy and hormone therapy in treatment of malignant diseases. This understanding should includes sound knowledge of principles of radiation dosage, effect of fractionation, sensitivity and relative biological effectiveness of the radiation used.
8. Patterns of spread. Basic tests done for cancer patients workup including biopsy and staging workup.
9. TNM, FIGO and Ann Arbor Staging systems.

III. RADIODIAGNOSIS PART-I 220 hours

PAPER-I

1.

1. Preliminary steps in Radiography
2. Radiation hazards, genetic and somatic effects.
3. General anatomy and radiographic positioning terminology.
4. Practical safety measures in diagnostic radiography

5. Physical principles of x-ray diagnosis.
6. Radiological images, intensifying screens, fluoroscopic screens, grids, Moving grid, radiographic cones.

1. Radiographic films, single coated, double coated films.
2. Various stages of film processing
3. X-Ray developer, fixer, replenisher
4. Dark room construction, dark room safe light, pass box
5. Fog in X-ray films.
6. Automatic X-ray film processing.
7. Practical aspects in radiography of children.
8. Bed side radiography, High KV Radiography, soft tissue radiography.

II (a) UPPER EXTREMITY:

Basic alternative and additional projections for special conditions of the bones and joints of the upper extremity.

Shoulder girdle: Basic and alternative techniques for the shoulder joint and scapula, clavicle, ACJ and SCJ.

(b) LOWER EXTREMITY

Basic alternative projections of the lower extremity, Toes, foot, fingers, calcaneus, subtalar joint, ankle joint leg, knee intercondylar notch, patella femur.

(c) PELVIC GIRDLE AND HIP REGION.

Basic and alternative techniques for the whole pelvis and upper femora, Pelvis and hip joints, femoral necks, acetabulum, anterior pelvic bones, special technique for congenital dislocation of the hip.

(d) VERTEBRAL COLUMN

Basic and alternative techniques for the occipito cervical articulations, Atlas and axis (Open mouth) Odontoid process cervical vertebrae, cervical intervertebral foramina, cervicothoracic region: thoracic vertebrae, lumbo sacral junction and sacro iliac joints, sacroiliac joints and coccyx.

(e) BONY THORAX: Techniques for Sternum, sternoclavicular joints, Ribs, upper and lower.

(f) THORACIC VISCERA: Techniques for Trachea, Trachea and pulmonary apex, chest(lungs and heart)

(g) ANTERIOR JOINT OF NECK: Techniques for pharynx and larynx.

(h) DIGESTIVE SYSTEM: Abdomen, gall bladder, spleen and liver.

(i) SKULL: Techniques applicable to the whole skull cranial bone, sellaturcica, orbit, optic foramen, superior and inferior orbital fissure.

(j) FACIAL BONES:

Radiographic positioning of Face bone, Nasal bone, Zygomatic arches, maxilla, mandible, mandibular symphysis, TMJ, Panoramic tomography of the mandible.

(k) PNS: Radiography and positioning of paranasal sinuses.

(l) TEMPORAL BONE : Radiography and techniques for the mastoid process and mastoid and petrous positions, jugular foramina.

(m) Dental radiography.

(n)X-ray imaging of ladies, children, precautions during pregnancy etc..

a. .

b. Progress in cancer treatment.

IV. PATHOLOGY 40 hours

1. Disorders of circulation
    a. Thrombosis
    b. Embolism
    c. Infarction
    d. Oedema
2. Mechanism and changes in inflammation
3. Detailed study of tumors
    a. Characteristics
    b. Classification
    c. Etiology & pathogenesis
    d. All the common benign and malignant tumors
4. Common infection
    a. Common acute bacterial infection
    b. Detailed study of tuberculosis, Leprosy, Syphilis
    c. Commonest fungal infection with a short account of opportunistic fungal infection
    d. Brief account of all viral infections including AIDS
    e. Common protozoa and helminthes
5. Detailed study of biological effects of radiation
6. Regenerative changes
    a. Fatty change
    b. Necrosis
    c. Gangrene
    d. Pathogenic calcification
7. Genetic diseases
    Down's syndrome
    Haemophilia
8. Immunology
    Auto immune diseases
    Rheumatoid arthritis
    SLE
    Immuno deficiency-AIDS
9. Brief study of nutritional diseases

DISEASES OF INDIVIDUAL ORGAN SYSTEMS (Basic Outline only is required about the pathology and important radiological features as well as areas where radiological imaging is useful in the management)

1. CVS
   - -I H D
   - -R HD
   - -Infective endocarditis
   - -Hypertension
   - -Valvular diseases

2. Lung
   - - Pneumonias
   - -TB
   - -Asthma
   - -Tumors

3. G I T
   - -Oral cavity
   - - Oesophageal Ca
   - -Peptic ulcer
   - -Ca stomach
   - -Malabsorption
   - -Inflammatory Bowel diseases
   - -Dysentry
   - -Appendicitis
   - -Peritonitis

4. Gall bladder
   - -Stones
   - -Cholecystitis

5. Pancreas
   - -Pancreatitis
   - -Stones
   - -Diabetis mellitus

6. Male Reproductive system
   - -Hydrocoele
   - - Orchitis & Epididynitis
   - -Benign prostate hypertrophy

7. Female reproductive system
   - - Cervicitis
   - -Ca Cervix
   - -Ca Endometrium
   - -Disorders of Menstruation
   - -Lyomyoma
   - -Brief account of ovarian tumors
   - -Disease of pregnancy- PHT- Ectopic

1. Breast - Fibro adenoma
   - Ca Breast
2. Blood - Anaemias
   - Leukaemia
   - Bleeding disorders
3. Lymphoreticular systems
   - Lymphadinitis
   - Lymphomas
4. Bones - Congenital
   - Osteomylitis
   - Rickets osteomalacia
   - Bone tumors
   - Arthritis
5. Endocrine - Thyroid
   - Pituitary
   - Adrenal
   - Parathyroid
6. Brief account of eye and ear infection
7. Skin - Psoriasis
   - Eczema
   - Skin tumors (Basal, squamous, Malignant Melanoma)
8. Kidney - Stones
   - Glomerulonephritis
   - Pyelonephritis
   - Renal failure
   - Nephrotie syndrome
   - Tumors

B.Sc. (MRT) III YEAR 1440 hours

RADIO DIAGNOSIS PART II 220 hours

SPECIAL RADIOGRAPHY AND IMAGING

CONTRAST MEDIA

Type of contrast agents, Strength and quantities and methods of introduction to be taught along side the appropriate subject in association with the radiographic technique

(a) CNS:

Radiological Anatomy, Cerebral angeography, Patient preparation. Examination procedure and radiography technique. Myelography Ventriculography and Encephalography Discography Stereotactic surgery

(b) Digestive system:

Radiological anatomy, preparations of the patient for contrast examinations. Ba swallow, Ba meal, Ba FT, Ba enema, Examination procedures and radiographic techniques.

(c) Biliary system:

Radiological anatomy and radiological procedures, Oral cholecystography, Intra venous chole cystangiography, cholangiography, operative, postoperative, percutaneous and ERCP.

(d) Urinary system:

Radiological anatomy, contraqst media used in urography, Excreting urography, Retrograde urography, Retrograde cystography, Female cysto urethrography, male cysto urethrography.

(e) Reproductive system:

Radiological anatomy, contrast media used in HS.., Hysterosalpingiography, Radiographic pelvimetry and cephalometry; vesiculography, localization of IUCD.

(f) Circulatory system:

Diagnostic visceral and peripheral angiography

(g) Cardiovascular system:

Cardiographic angiography, catheterization methods and techniques, catheterization studies and procerdures.

(h) Parotid, sub maxillary and sub liqual

Sialography-

(i) Oral and Crico-thyroid

Bronchography-

(j) Lacrimal ducts

Dacto cystography-.

Mamography: Film- mammography, film- screen mammography, Xero mammography, Techniques.

Computer fundamentals and applications in Radiology

Computed tomography- Equipment and methodology

Reconstructive image parameters

Digital radiography- Digital angiography- Digital subtraction angiography

Diagnostic ultra sound:

Physical principles, clinical applications, Ultrasound colour Doppler techniques.

Magnetic Resonance Imaging Equipment, positioning, comparison of MR to conventional radiology, physical principles, Biomedical effects of MR, clinical applications

Nuclear medicine-Clinical nuclear medicine

Positron emission tomography-principles, clinical studies

Macro radiography

Steroradiography

MMR or flurography

Cine radiography
Fluroscopy
Image intensifier
Kymography
Subtraction radiography
Indirect Radiography
Pulsed radiography.
Computed Radiography, Direct & Indirect Digital Radiography – Principles in detail about all the current systems.

Nuclear Medicine

Radio isotopes used measurement of sample activity, Detection of radioactivity in the body, simple collimating system, whole body counting, scanners, and Gamma cameras.

Radiopharmaceuticals, Radionuclide, Types of radiation used, Biological, physical and effective half lives, specific activity, Thyroid uptake, Plasma volume, elusion.

RADIOTHERAPY PART II 220 hours

1. Basic Tumor location and simulation: Tumor localization principles and procedures. Use of Imaging techniques for tumor localization. Use of Xray, CT, MRI, PET in tumor localization. Use of Image registration.
2. Treatment planning: Principles of beam modifying devices. Beam directed radiotherapy principles and practice. Steps involved in beam directed radiotherapy.
3. Xray and CT based treatment planning of common malignancies given in Radiotherapy Part I. Bony landmarks for field placement. Mantle field planning.
4. ICRU guidelines for target volume delineation and concept of GTV / CTV / PTV and ITV.
5. Practical experience with care of radiotherapy machines. Care of machine-Set up single, multiple fields-Use of wedges, shields and tissue compensators-Use of beam directional devices, methods of patient immobilization-Knowledge of technique involving electron beam therapy-moving beam therapy-conformal therapy-stereo tactic radio surgery and radiotherapy-Handling emergencies inTeletherapy
6. Principle of brachytherapy;intestritial-intracavitory-surface mould-intra luminal- Safe handling of small sealed radioactive sources. Preparation, -Storage Brachytherapy

Source-Check x-rays -Record keeping in relation to brachytherapy sources patient data

7. Mould room techniques: Construction of casts, shields and electron applicators.
8. General welfare of the patient during and after the treatment including the care of any

intercurrent disease (diabetic, tuberculosis, arthritis). Diet and fluid intake. The observation and reporting any change in the signs and symptoms of patients receiving treatment.

9. The use of blood count in the control of certain treatment. The care of local and systemic reaction. Local reaction should include those in the ear, nose, throat and eye and those arising from treatments given to the pelvis. Care of cancer patients.
10. Organization of radiotherapy, department practice, appointment organization in the planning room, treatment area. Management of waiting patients.
11. Special techniques in Radiation Therapy, Stereo tactic 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.
12. 3DCRT / IMRT / VMAT / Helical Tomotherapy/Total Body Radiation / Total Skin Electron therapy

I. RADIATION PHYSICS II 220 hours

SECTION I

Radiotherapy

Principles of Radiotherapy-High energy Machines- Co 60, Cs 137, –Betatron, Cyclotron, Microtron LINAC, source choice and design- treatment head – shutter mechanism- beam collimation and Penumbra Beam shaping devices – beam modification – shielding – beam flattening - Bolus - compensating filters- wedge filters- MLC -beam direction devices – front and back pointer. Radiotherapy with Protons, Neutrons and heavy charged particles.

SECTION II

Phantoms – functions used in dose calculation – TAR,TMR,TPR, PSF- PDD- Isodose curves, Beam profile– characteristics – comparison of charts for beams of various energies. Tumor dose calculations using various techniques-

Patient data acquisition – body contours- patient immobilization radiotherapy simulator, CT Simulator – Computerized treatment planning system –Volume definition –Gross tumor volume (GTV) - Clinical target volume (CTV) - Planning target volume (PTV) –Organ at risk (OAR) - Dose volume histograms - treatment simulation –Virtual simulation - treatment verification – Electronic portal imaging devices - contour irregularities- correction for field shaping – geometric separation of adjacent fields.

SECTION III

Treatment planning – SSD set up- isocentric set up- integral dose- direct beam therapy- calculations- opposing beam therapy- 3 field technique (qualitative) – rotation therapy – whole body radiation.

SECTION IV

Electron Beams – Interaction with absorbing medium – depth dose curve –Virtual source position –Range (csda) –Therapeutic range R_{90} - isodose curves – Field shaping – Electron arc therapy

SECTION V

Brachytherapy

Radioactive sources used:- Ra, Co, Cs, I, Ir, Au,Pd – source construction and care – activity- exposure rate constant- effective Ra eq- Mg hr- treatment planning- surface moulds- line source – interstitial treatment- single plane implant- 2 plane implant- volume implant- permanent implants - treatment of cancer of cervix Paterson- Parker and Paris technique (qualitative) – Stepping source dosimetry systems -after loading applications – manual –remote – Intravascular brachytherapy

SECTION VI

Special Procedures and Techniques in Radiotherapy

Steriotactic irradiation – Total body irradiation (TBI) – Total skin electron irradiation (TSEI) – Intra operative radiotherapy (IORT) – Conformal radiotherapy – Intensity Modulated Radiation Therapy (IMRT) –Image Guided Radiation Therapy (IGRT) – recent advances in radiotherapy.

SECTION VII

Nuclear Medicine

Radioisotopes used- measurement of sample activity- detection of radioactivity in the body- simple collimator system- whole body counting – scanners- gamma cameras.

Radiopharmaceuticals- Radionuclides- Types of radiations used- Biological, Physical and effective half lifes- specific activity- Thyroid uptake – plasma volume- elusion.

Radio isotopes in therapy

LIST OF PRACTICALS

·Radiation protection survey of Teletherapy Unit (Cobalt 60)
·Radiation protection survey around Brachytherapy Installation (HDR)
·Shutter timer error
·Timer error in HDR
·Radiation protection survey of linac
·Parallel opposed technique with dose to one critical organ measurement
·Four field technique with dose to one critical organ measurement
·Planning of multiple technique (3 field) with measurement of dose to one critical organ
·Characteristics of G.M.Counter
· Transport of radioactive package
· Output measurement of Linear Accelerator
· Output measurement of HDR

· Output measurement of cobalt 60
· Congruence between light field and radiation field

IV **RADIOLOGICAL PROTECTION AND STATUTORY ASPECTS:** 80 **hours**

SECTION I

INTRODUCTION

Radiation units- Roentgen-Kerma-Absorbed dose-Rad-Gray-Exposure rate constant-RHM and RMM-Equivalent dose-Effective dose-committed dose-collective dose-Genetically significant dose- ALARA- Sources of radiation- Natural, terrestrial, artificial and occupational

Radiation exposure control- critical organs and tissues- quantities used in Radiological protection- Radiation weighing factors- equivalent dose- Tissue weighing factors-effective dose

Section II

Biological effects of radiation

Cell- interaction of radiation with cells- target theory (brief) – cell survival curve-Dose response curve - response to radiation – lethal dose- LD 50- oxygen effect- oxygen Enhancement Ratio- RBE-LET- QF-Effects of radiation on DNA- radiation risk-effects of radiation in utero-ten day rule.

Section III

Radiation Detection Instruments

Ionization chamber- proportional counter –GM counter- scintillation counter-thermoluminiscent Dosimeter- film- solid state detectors- chemical dosimeters - calorimetry

Radiation monitoring instruments- Pocket dosimeters film badges, TLD, area monitoring instruments, survey monitors.

Section IV

Principles of radiation protection

Time, distance and shielding calculations, HVL and TVL primary and secondary protective barriers, radiological protection survey-leakage levels-protective barriers used in X-rays

Patient exposures in diagnostic radiology including CT,Nuclear medicine, dental radiology

Section V

Planning of radiological facility

General guidelines- x-ray facility-fluoroscopy installation- mammography-CT

Radiotherapy facility-cobalt rooms-linac rooms-brachy installations

Nuclear medicine – in vivo and invitro – gamma camera rooms- nuclear medicine therapy rooms

Section VI

Radiation monitoring –Personnel monitoring- Film badge-TLD badge-pocket dosimeters – Area monitoring – protection survey – diagnostic – therapy and nuclear medicine installations- protection of patients and staff-record keeping

Radiation protection measures in the departments of Radiology, Radiotherapy and Nuclear Medicine. Radiation hazards in brachytherapy and teletherapy departments. Handling of patients, radiation safety during source transfer operation, special safety consideration for LINAC installations,- minimizing radiation exposures by adopting different techniques.

Radiation protection: ; principle, history& development-National & international agencies; AERB, BARC,ICRP,WHO,IAEA and their role. Equivalent dose-effective dose-sievert-rem. Sources of radiation-natural-man made & internal exposures. Biological effects of radiation ; effects on cell-stochastic & deterministic effects-radiation risk-tissues at risk -genetic, somatic & fetus risk-risk at other industries. Dose equivalent limits-philosophy-ICRP(60) concepts-AERB guidelines.

Section VII

Quality assurance – introduction- Quality assurance – diagnostic X-ray- fluoroscopy-mammography-CT-gamma camera – therapy units cobalt-linac – brachy therapy-PET –CT

Section VIII

Transport and Waste disposal

Type of package-transport index- package requirements- placards-consignors declaration- tremcard-information to carriers

Waste management-sources and nature of waste- type of waste- classification of waste-disposal of low active waste-disposal of radio active effluent into ground-disposal of P^{32} and I^{131} waste-decontamination procedures

Section IX

Radiation emergencies

Type of radiation emergencies- accidents-injuries in diagnostic X-rays- radiation accidents in nuclear medicine- radiotherapy-brachy therapy-emergency action plan-medical management of personnel exposures

Section X

Regulations and dose limits

ICRP Recommendations (Brief) – operational units- current codes of practice for protection of radiation workers and public against ionizing radiation arising from medical and dental use. AERB safety codes- National regulatory requirements.

B.Sc M.R.T
IV YEAR

1. EXTERNAL POSTING in RADIO DIAGNOSIS and RADIOTHERAPY

2. PROJECT WORK

Project

In fourth year the students will be posted to work in approved hospitals and to carry out project work simultaneously. Hospital posting as well as project work must be substantiated with bonafide records duly signed by the designated senior staff

members concerned.Submission of a Project work is a compulsory requirement for the B. Sc (MRT) –course. Each student can choose a topic for the project in any one of the subjects related to – Radio diagnosis and radiotherapy.

The supervising Teacher should have minimum 3 years full time teaching experience in the concerned subject. The student should be under the guidance of the supervising staff, carry out the work on the topic selected and prepare a project report including results and references. The project report duly certified by the supervising staff and head of the department of one month prior to fourth year university practical examination should be submitted to the fourth year B. Sc (MRT) University practical examination of concerned subject.

The project report evaluation will be conducted by the concerned subject internal and external examiners together in the Fourth year B. Sc (MRT) University practical examination.

MODEL QUESTION PAPERS

CODE NO **Reg. No……**

Name……

FIRST YEAR B.Sc (MRT) DEGREE EXAMINATION……20

Paper I ANATOMY

Time 3 hrs Max Marks: 100

Part A

(Answer any 2 questions, each questions carry 25 marks)

1. Describe the gross anatomy of r lung. Mention the various segments at the right hylum and their relationships.
2. Name the paranasal sinuses. Describe the anatomy of maxillary sinus
3. What is colis cystitis? Describe the anatomy of gall bladder and mention its lymphatic drainage.
4. Describe the anatomy of thyroid gland. Mention various strap muscles in relation to thyroid gland.

Part B

(Answer any 5 questions, each questions carry 10 marks)

5. a. What are the different parts of uterus?
   b. Briefly describe the embryology of ovaries.
   c. Briefly describe the gross anatomy of ovaries.
   d. Briefly describe the lymphatic drainage of uterus
6. a. Mention the coverings of brain
   b. Circulation of CSF may be described in short.
   c. What is corpus calosum?
   d. How is circle of Willis form?
7. a. Briefly describe the microscopic anatomy of skin
   b. Differences between keratinized and non keratinized epithelium

c. Describe the areas where the areas where keratinized epithelium seen.
d. What are the functions of skin?

8. a. Describe the surface anatomy of pancreas.
   b. Briefly describe the embryology of pancreas.
   c. Mention the relationships of pancreas
   d. What is ampulla of Vater?
9. a. Describe the radiological anatomy of kidney.
   b. Describe the surface anatomy of right ureter
   c. Mention the blood supply of kidney.
   d. Mention the lymphatic drainage of right kidney.
10. a. What are the lobes of liver?
    b. Briefly describe porta hepatis
    c. What is bare area of liver?
    d. Mention the surface anatomy of liver.
11. a. Describe the parts of fallopian tube
    b. Describe the blood supply of fallopian tube
    c. Describe the location of ovary and its blood supply
    d. Describe the ligaments attached to ovary and fallopian tube
12. a. Describe the parts, location and peritoneal covering of gall bladder
    b. Describe the cystic duct, common bile duct
    c. What is surface marking of gall bladder
    d. Give the clinical importance of gall bladder and the ducts. Mention the radiological technique by which it can be visualized.

CODE NO **Reg. No……**
Name……

FIRST YEAR B.Sc (MRT) DEGREE EXAMINATION……20
Paper II PHYSIOLOGY

Time 3 hrs Max Marks: 100 marks

PART A

(Answer any 2 questions, each questions carry 25 marks)

1. What are the important constituents of bile? Describe its main features. What is entero hepatic circulation?
2. Describe the salient features of coronary circulation – Write a note on arterial pulse.
3. Explain briefly the metabolism of Iron in the body. Write a note on the structure and types of hemoglobin
4. Explain the production, morphology and functions of platelets.

PART B

(Answer any 5 questions carry 10 marks)

5. a. Describe the flow of cerebrospinal fluids (CSF)
   b. What are the functions of CSF
   c. Briefly mention the techniques of collection of CSF
   d. What are the normal constituents of CSF
6. a. Enumerate various normal constituents of blood
   b. Enumerate various type of WBC
   c. Briefly describe structure and function of platelets
   d. Enumerate various components of blood involved in clotting/coagulation
7. a. Define exocrine and endocrine organs
   b. Enumerate major exocrine organs
   c. What are the different organs involved in digestion of food.
   d. Briefly describe digestion and absorption of proteins.
8. a. Draw a nephron and mark its parts
   b. What is juxtaglomerular apparatus
   c. Briefly describe rennin-anjiotorsin system
   d. Enumerate hormones involved in maintenance of blood pressure.
9. a. What is systolic and diastolic blood pressure and write its normal value
   b. Briefly describe coronary circulator
   c. Draw and label various stages of cardiac cycle.
   d. Briefly describe conduction system of heart.

10. a. Compare and contrast systemic and pulmonary circulation
    b. Briefly describe various lung volume with the help of diagram
    c. Define central Venous pressure (CVP) how is it measured
    d. Briefly describe regulation of respiration.
11. a. What are the actions of thyroxine
    b. What are the features of hypothyroidism
    c. Mention the actions of aldosterone
    d. What is Cushings Syndrome
12. a. What are the features of coronary circulation
    b. Describe Jugular Venous pressure
    c. Enumerate factors regulating cardiac output
    d. What is myocardial infarction.

CODE NO **Reg. No……**

Name……

FIRST YEAR B.Sc (MRT) DEGREE EXAMINATION……20

Paper III General Physics and Electronics

Time 3 hrs Max Marks: 100

Part A

(Answer any 2 questions, each questions carry 25 marks)

1. a) Discuss Bohr atom model and obtain the expression for Bohr radius.
   b) Explain the different decay modes that may occur from a radioactive nucleus
   c) How many different wave lengths would appear in the spectrum of hydrogen atoms initially in the n=5 state? Show the possible transitions in a diagram.
2. a) What is Raman effect? Give the quantum mechanical explanation for it.
   b) What is quarter wave plate? Deduce its thickness for a given wavelength in terms of its refractive index
   c) If the plane of vibration of the incident beam makes an angle of 30 degree with the optic axis, compare the intensities of the extraordinary and ordinary rays.
3. a) Analyse a series L-C-R circuit and obtain the condition of resonance.
   b) Explain the construction and working an instrument for measuring high resistance in a circuit.
   c) An alternating voltage of 10 V and f= 100 cycles per second is applied to an choke having inductance 5H and resistance 200 ohms. Find the power factor of the choke coil.
4. a) Explain the rectifying action of a PN Junction diode.
   b) With the help of a diagram explain the working of a full wave rectifier using two diodes.
   c) A Hartley oscillator has a capacitor of 0.1 micro farad and inductance of each coil is 20 milli Hertz. Determine the frequency of oscillation, if there is no mutual inductance between the coils.

Part B

(Answer any 5 questions, each questions carry 10 marks)

5. a. Explain the mechanism of production of X-rays
   b. State and explain the displacement law of radioactive disintegration
   c. Distinguish between Fraunhoffer and Frensel Diffraction
   d. What is the difference between ordinary and extraordinary rays?
6. a. what are ultrasonic waves? Give one application
   b. Explain the piezoelectric method for the production of ultrasonic waves
   c. What is Barkhausen criterion for oscillations.

d. Draw the circuit diagram of a phase shift oscillator and briefly explain the action.

7. a. What is the principle of transmission of light through an optical fibre
   b. State and explain Gauss's law for magnetism
   c. What are acceptor and rejector circuits?
   d. What is peak inverse value of a diode? Explain its significance.
8. a. what is the principle of a superconducting magnet
   b. What is eddy current? What are the methods to reduce eddy current in a transformer?
   c. What is magnetic hysteresis? Draw the B-H curve for a material to be used as a permanent magnet.
   d. Compare the properties of step-up and step-down transformer. Write the power conservation equation for a transformer
9. a. Define simple harmonic motion.
   b. Obtain an expression for the velocity of a body executing simple harmonic motion.
   c. What is forced oscillation? When will resonance occur in forced oscillations?
   d. Explain Doppler effect and red shift.

10. a. Distinguish between negative and positive feedback
    b. Plot the frequency versus gain graph of a common emitter amplifier for the cases of(1) with negative feedback (2) Without negative feedback
    c. Explain the action of a monostable multi vibrator
    d. What are the important properties of operational amplifier
11. a. State and explain Brewster's law.
    b. Explain polarization by reflection
    c. Give the applications of fiber optics
    d. Distinguish between Rayleigh scattering and Raman scattering
12. a. Explain star and delta connections
    b. Obtain Resonance and Q-factor in an LCR circuit.
    c. Give a brief note on FET
    d. Explain i) Wattless current and ii) rms value of current and voltage

CODE NO **Reg. No……**

Name……

FIRST YEAR B.Sc (MRT) DEGREE EXAMINATION……20

Paper IV ATOMIC AND NUCLEAR PHYSICS

Time 3 hrs Max Marks: 100

Part A

(Answer any 2 questions, each questions carry 25 marks)

1.a) Briefly describe the nature of cathode rays.
   b) Describe with adequate theoretical Backing Thomson's method for the experimental determination of e/m for these rays.

c) In Millikan's oil drop method, a drop of oil (p=900 kg/m3) of radius r=2.5 micro meter has three units of excess negative charge on it. What is the direction and magnitude of the electric field required to keep the drop stationary.

2. a) Outline the major limitations of Bohr's theory.
   b) Explain how sommerfield modified the theory. What success was obtained?
   c) Calculate the value of the fine structure constant alpha using the known values of the fundamental constants e and c.

3) a) Distinguish between natural and artificial radio activities.
   b) Give a theoretical explanation for the alpha decay process
   c) A given specimen of radioactive nucleus initially contains 10^{23} nuclei. After the lapse of 20 days, it contains only 10% of the initial number of radioactive nuclei. Calculate the mean life time of the nuclei.

4. a) Explain fusion and fission reactions.
   b) Define Q value of a nuclear reaction. Explain threshold energy.
   c) Given the following masses: (All in amu)
   ^{27}Al : 26.981539, Si : 29.973764, H: 1.007825, He: 4.002603
   Calculate the Q Value of the nuclear raction AL+ He giving Si+ H Is there a threshold for this reaction.

Part B

(Answer any 5 questions, each questions carry 10 marks)

5. a. Define the nuclear atom model proposed by Rutherford
   b. Give the experimental basis for the above.
   c. Which are the quantum numbers in the vector atom model? Explain each.
   d. What is Pauli's exclusion principle? Give one example.

6. a. Explain Einstein's theory of the photoelectric effect.
   b. Distinguish between phase velocity and group velocity.
   c. Explain the concept of binding energy of a nucleus.
   d. Give the essential ideas of meson theory of nuclear forces.

7. a. State and explain the law of radioactive disintegration
   b. Explain the meaning of the terms half life and mean life time.
   c. Describe what happens to a radioactive nucleus in beta decay. Give one example.
   d. What are neutrinos? How are they produced? Give four of their important properties.

8. a. briefly describe what happens to a narrow beam of gamma rays when it travels through and absorbing medium.
   b. Explain the process of pair production by gamma rays.
   c. Explain nuclear isomerism. Give one example.
   d. What basic processes take place inside a nuclear reactor.

9. a. What are the main characteristics of nuclear forces
   b. Explain the main reasons for instability of nucleus.
   c. Define critical potential and excitation potential
   d. Explain Larmor precession

10. a. What are Leptones? Give their important properties. Give two examples
b. What are cosmic rays? Describe briefly their interaction in earth's atmosphere.
c. Describe how radioactive isotopes are produced artificially.
d. What are nucleons? List the two types of nucleons. Bring out the major differences between them.

11. a. How will you find the isotopic mass using a mass spectrograph?
b. How did Rutherford's atom model fail to explain the emission of light?
c. State and explain Geiger- Nuttal relation
d. Explain Zeeman effect?

12. a. What is meant by nuclear isomerism?
b. Derive an expression of De Broglie wavelength.
c. Write a note on β particles.
d. Give importance of practical applications of photoelectric effect.

CODE NO **Reg. No……**
Name……

FIRST YEAR B.Sc (MRT) DEGREE EXAMINATION……20
Paper V MATHEMATICS

Time 3 hrs Max Marks: 100

Part A

(Answer any 2 questions, each questions carry 25 marks)

1. a) If A+B+C =π show that
$\sin^2 A + \sin^2 B + \sin^2 C = 2 + 2 \cos A \cos B \cos C$

b) Find the area of triangle ABC when
i) a = 13, b=14, c=15
ii) a=22, b=28, c=36

c) Prove that $\sin 10^0 \sin 50^0 \sin 70^0 = 1/8$

2. a) Show that $\sum_{n=1}^{\infty} \frac{2n+3}{(2n-1)!} = \frac{5}{2}e - \frac{3}{2e}$

b) Prove by mathematical induction that
$1^2+2^2+3^2+\text{----------}n^2 = \frac{1}{6} n(n+1)(2n+1)\ \forall n \in N$

c) if $A = \begin{pmatrix} 2 & 1 \\ 3 & 4 \end{pmatrix}$ $B = \begin{pmatrix} 0 & 3 & 7 \\ 1 & 8 & 9 \end{pmatrix}$ and $c = \begin{pmatrix} 3 & 7 & 1 \\ 2 & 6 & 1 \\ 1 & 4 & 0 \end{pmatrix}$
verify that (AB)C+ a(BC)

3. Differentiate i) $\frac{Secx-1}{Secx+1}$ ii) $\frac{\sqrt{X}(2x+3)}{\sqrt{X}+1}$ 2

iii) Find $\frac{dy}{dx}$, when $x=\sin^{-1}\frac{2t}{1+t}$;
$y= \tan^{-1}\frac{2t}{1+t}$

b) If Y= $e^{mcos-1x}$, prove that

(1-x^2) $\frac{d2y}{dx2}$ - x$\frac{dy}{dx}$ - m^2y = 0

c) If u = log (x^3+y^3+Z^3-3xyz) prove that

$\frac{\partial u}{\partial x}+\frac{\partial u}{\partial y}+\frac{\partial u}{\partial z}=\frac{3}{x+y+z}$

4. a). If X follows the binomial distribution with parameters n=6 and p. If 9 p(x=4) = P(x=2). Find P?

b) Find the standard deviation from the following frequency distribution

Weight (Kg)	No. of Persons
44-46	3
46-48	24
48-50	27
50-52	21
52-54	5

c) The life of a light bulb is normally distributed with an average (mean) life of 100 hours and variance of 36

i) What percent will last more than 110 hours?

ii) What percent will last between 85 & 95 hours?

Part B

(Answer any 5 questions, each questions carry 10 marks)

5. a. show that $\begin{vmatrix} a+b+2C & a & b \\ c & b+c+2a & b \\ c & a & c+a+2b \end{vmatrix}$ = 2 $(a+b+c)^3$

b. resolve into partial fractions $\frac{x-2}{(x+2)(x-1)}$2

c. use crame's rule to solve that following system of equations

3x-5z= -1, 2x+7y=6, x+y+z=5

d. Find n, if 3np_4 = n-1 p_5

6. a. evaluate $\int \frac{dx}{4x2+4x+5}$

b. show that $\int_0^{\pi/4} \log(1+tanx)\ dx = \pi/8 \quad \log 2$

c. evaluate $\int$ x^2log (1+x) dx

d. Evaluate $\int \frac{1}{2+sinx+cosx}$ dx

7. a. Simplify

$$\frac{(\cos 2\theta - i\sin 2\theta)^4(\cos 4\theta - i\sin 4\theta)^{-5}}{(\cos 3\theta + i\sin 3\theta)^2(\cos 5\theta - i\sin 5\theta)^{-3}}$$

b. If $1, w, w^2$ are thre cube roots of unity and $x=a+b$, $y=aw+bW^2$, $z = aW^2+bw$, then prove that $x^2+y^2+Z^2= 6ab$

c. find the constant λ such that the vectors are coplanar

i) $2i-j+k$, $i+2j-3k$, $3i+\lambda j+5k$

ii) $2i+j+\lambda K$, $4i+5j$, $2i+4j+k$

d. if $F = x^2zi+2y^3z^2j+xy^2k$ at (1,-1,1)

Find $\nabla.\overline{F}$ and $\nabla x .\overline{F}$

8.a. Calculate Karl Pearson's lo efficient of correlation between the marks in English and mathematics obtained by ten students

Marks in English	**Marls in Mathematics**
20	17
13	12
18	23
21	25
11	14
12	8
17	19
14	21
19	22
15	19

b. Obtain the line of regression of Yon X for the following data

X	**Y**
1	1
3	2
4	4
8	5
9	6
11	8
13	9

c) One bag contains 5 white and 4 black balls. Another bag contains 7 white and 9 black balls. A ball is transferred from the first bag to the second and then a ball is draw from the second. Find the probability that the ball drawn is white

d) The probability that a student entering the PUC course with statistics and mathematics as a optional subjects and mathematics as optional subjects will complete the course is 0.37. Determine the probability that out of 6 six students (a) none (b) one and (c) at least one will complete the course.

9. a. show that $\begin{vmatrix} a+b+2C & a & b \\ c & b+c+2a & b \\ c & a & c+a+2b \end{vmatrix}$ = 2 $(a+b+c)^3$

b. resolve into partial fractions $\frac{x-2}{(x+2)(x-1)}2$

e. use crame's rule to solve that following system of equations

3x-5z= -1, 2x+7y=6, x+y+z=5

f. Find n, if $3np_4 = n\text{-}1\ p_5$

10 a. evaluate $\int \frac{dx}{4x2+4x+5}$

b. show that $\int_0^{\pi/4} \log(1+tanx)\ dx = \pi/8 \quad \log 2$

c. evaluate $\int x^2 \log(1+x)\ dx$

d. Evaluate $\int \frac{1}{2+sinx+cosx}\ dx$

11 a. evaluate $\int \frac{dx}{4x2+4x+5}$

b. show that $\int_0^{\pi/4} \log(1+tanx)\ dx = \pi/8 \quad \log 2$

c. evaluate $\int x^2 \log(1+x)\ dx$

d. Evaluate $\int \frac{1}{2+sinx+cosx}\ dx$

12 . a. show that $\begin{vmatrix} a+b+2C & a & b \\ c & b+c+2a & b \\ c & a & c+a+2b \end{vmatrix}$ = 2 $(a+b+c)^3$

b. resolve into partial fractions $\frac{x-2}{(x+2)(x-1)}2$

g. use crame's rule to solve that following system of equations

3x-5z= -1, 2x+7y=6, x+y+z=5

h. Find n, if $3np_4 = n\text{-}1\ p_5$

CODE NO **Reg. No……**

Name……

FIRST YEAR B.Sc (MRT) DEGREE EXAMINATION……20

Paper VI COMPUTER SCIENCE

Time 3 hrs Max Marks: 100

Part A

(Answer any 2 questions, each questions carry 25 marks)

1. Describe different generations of computers. Explain Advantages and disadvantages of each generation.
2. What is an operating system? Write 3 examples. Explain different components of an operating system.
3. Explain conditional statements in C Language
4. Define Health Information Technology? Explain common health IT applications?

Part B

(Answer any 5 questions, each questions carry 10 marks)

5. a. Explain the functional units of a digital computer?
   b. Differentiate Machine language, Assembly language and High level language?
   c. Draw a flow chart to find the smallest of three different numbers
   d. Explain different type of computer networks?
6. a. Differentiate batch processing and multi programming OS?
   b. Explain the file and directory system concepts in MS-DOS?
   c. Write a short note on i) Ms-Office, ii) Linux, iii) Distributed system, iv): Impress
   d. Explain any four MS-DOS commands with syntax?
7. a. Explain Preprocessor directives in C language?
   b. Explain different operators used in C language?
   c. Explain different types of Arrays in C language?
   d. Describe pointers in C language?
8. a. What are the difference between structures and union?
   b. Explain different storage classes used in C language?
   c. Explain the file handling techniques used in C language?
   d. Explain functions? Differentiate Pass by value and pass by reference
9. a. Write a program to swap two numbers in C language.
   b. Write a program to add two 3x3 arrays in C language.
   c. Write a program to find a number is positive or not?
   d. Write program to find Fibonacci series?
10. a. Write a short note about E-Commerce and E-Publishing
    b. What are the advantages and challenges of using Health IT?

c. What is the difference between web server and proxy server?
d. Explain Internet and World Wide Web?

11. a. Explain the functional units of a digital computer?
b. Differentiate Machine language, Assembly language and High level language?
c. Draw a flow chart to find the smallest of three different numbers
d. Explain different type of computer networks?

12. a. What are the difference between structures and union?
b. Explain different storage classes used in C language?
c. Explain the file handling techniques used in C language?
d. Explain functions? Differentiate Pass by value and pass by reference

CODE NO **Reg. No……**
Name……

SECOND YEAR B.Sc (MRT) DEGREE EXAMINATION……20
Paper VIII RADIATION PHYSICS I

Time 3 hrs Max Marks: 150

PART A

Answer any 2 questions (each question carries 25 marks)

1. (a) Describe the cross section of an x-ray film (various layers in the section) and explain the function of each layer.
(b) Describe the different constituents of the x-ray developer and their functions.
2. (a) Discuss factor affecting image quality in medical diagnostic radiology.
(b) (i) explain the features of the characteristic curve of medical x-ray film.
(ii) What is the correct region of exposure in the curve? Why?
3. Explain the total attenuation coefficient for photons. Explain each process involved and its variation with energy and atomic number.
4. List the various effects of radiation that lead to its detection. Explain the working of a GM counter.

PART B

Answer any 5 questions (each question carries 10 marks)

5. Short notes on
a) Spontaneous and stimulated emission
b) Grid cut off and its reason
c) X-ray image intensifier tube
d) Filters
6. Short notes on

a) Breaking radiation

b) Cooling mechanism in x-ray tubes
c) Charge particle equilibrium
d) Medium frequency generators

7. Write short notes on
   a) Line focus principle
   b) Heel effect
   c) Thermionic emission
   d) Saturation Voltage
8. Write in detail the material and method required for
   a) Focal spot size and resolution test
   b) Beam alignment test
   c) Timer Linearity test
   d) Optical and radiation field congruence test.
9. Describe in detail the production, properties and process of x-ray generation.
10. Describe in detail the basic interactions between x-rays and matter.
11. Describe in detail autotransformer.
12. Write the various generations of CT scanner.

CODE NO **Reg. No……**
Name……

SECOND YEAR B.Sc (MRT) DEGREE EXAMINATION……20
Paper IX RADIOTHERAPY I

Time 3 hrs Max Marks: 150

PART A

Answer any 2 questions (each question carries 25 marks)

1. Discuss the biological factors influencing radio sensitivity of cells and their importance in radiation therapy.
2. Describe the advantages of hyper fractionation over conventional radiotherapy treatment.
3. Discuss the 5 Rs of Fractionated Radiotherapy.
4. What are the effects of radiation on normal tissues.

PART B

Answer any 5 questions (each question carries 10 marks)

5. Write short notes on
   a. Cell survival curve
   b. Relative Biological Effectiveness

c. Oxygen Enhancement Ratio
d. LET

6. Write short notes on
    a. Oestrogen receptors
    b. Linear accelerator
    c. Hypofractionation
    d. Hematological syndrome
7. Short notes on
    a. Differentiate between palliative and radical treatment
    b. Nuclear fission
    c. HVL
    d. Simulator
8. Write short notes on
    a) Immobilization techniques
    b) Beam modifiers
    c) ALARA Principles
    d) Linear quadratic equation.

9. Describe in detail new trends in Radiotherapy.
10. Describe classification of cytotoxic drugs.
11. Explain the factors influencing the choice of radical or palliative treatment.
12. What is fractionation in radiotherapy? Explain. Explain about altered fractionation.

CODE NO **Reg. No……**
Name……

SECOND YEAR B.Sc (MRT) DEGREE EXAMINATION……20
Paper X RADIO DIAGNOSIS I

Time 3 hrs Max Marks: 150

PART A

(Answer any 2 questions, each question carry 25 marks).

1. Describe in detail the dark room chemistry.
2. What are paranasal sinuses? Describe the radiographic anatomy of paranasal sinuses. Describe the various projections to demonstrate paranasal sinuses?
3. Describe automatic processor with suitable diagram?
4. What are the parts of temporal bone? Write briefly about radiography of petrous part of temporal bone.

PART B

(Answer any 5 questions, each question carry 10 marks).

5. Write short notes on:
    a) Radiographic technique of Zygomatic arch.
    b) Radiographic technique of sacro-iliac joints.
    c) Intensifying screen.
    d) Bed side radiography.
6. Describe
    a) Various dental radiographic techniques.
    b) Basic views of skull.
7. Short notes on
    a) Macro radiography
    b) Fog in X-ray film
    c) Film storage
    d) Safe light
8. Write short notes on:
    a) mastoid process
    b) Jugular foramina.
    c) Maxilla
    d) Mandible
9. Write short notes on:
    a) Radiological images
    b) fluoroscopic screens
    c) Moving grid
    d) Radiographic cones.
10. Write short notes on:
    a) Radiographic films- single coated
    b) Double coated films.
    c) X-Ray developer
    d) Fixer
11. Write short notes on:
    e) Latent image
    f) Pass box
    g) Fluorography
    h) Dental fim.

12. Write short notes on:
    i) Multiple radiography
    j) Caldwell view
    k) Photographic density
    l) Film storage.

CODE NO **Reg. No……**

Name……

SECOND YEAR B.Sc (MRT) DEGREE EXAMINATION……20

Paper XI PATHOLOGY

Time 3 hrs Max Marks: 100

PART A

(Answer any 2 questions, each question carry 25 marks).

1. Define Repair. Describe the process of healing by second intention. Mention the factors which influence the healing of wounds.
2. Mention the causative organisms of Malaria. Explain the pathogenesis of the two commonly occurring malarial infection in our region.
3. Describe the etiology, gross and microscopic appearance of Carcinoma cervix.
4. What are renal calculi? Describe the aetiology, pathogenesis, types and effects of renal calculi.

PART B

(Answer any 5 questions, each question carry 10 marks).

5. Write short notes on
a) Chemical carcinogens
b) Amniotic fluid embolism
c) Wet gangrene
d) Hemophilia

6. Write Short notes on
    a) Thrombosis
    b) Embolism
    c) Infarction
    d) Oedema

7. Write short notes on
    a) Pneumonia
    b) Megaloblastic anaemia
    c) Fatty liver
    d) Cholecystitis
8. Write short notes on
    a) Necrosis
    b) Gangrene
    c) Peptic Ulcer

d) Psoriasis

9. Write short notes on
   a) Leprosy
   b) Carcinoma of stomach
   c) Gall bladder stones
   d) Radiation injury

10. Write short notes on
   a) Malaria
   b) Microcytic hypochromic anemia
   c) Hydatid cyst
   d) Infective endocarditis

11. Describe the pathogenesis of Diabetes Mellitus. Explain the difference between benign and malignant tumors
12. Discuss the vascular reaction in acute inflammation. Explain the effects of radiation on cells.

CODE NO **Reg. No……**

Name……

THIRD YEAR B.Sc (MRT) DEGREE EXAMINATION……20

Paper XII RADIODIAGNOSIS- PART- II

Time 3 hrs Max Marks: 100

Part A

(Answer any 2 questions, each questions carry 25 marks)

1. Enumerate the various investigations of digestive system. Discuss in detail about Barium swallow.
2. Enumerate various investigations of genitourinary system. Discuss in detail about IVP.
3. Enumerate various investigations reproductive system. Discuss in detail about Hysterosalpingiography.
4. Enumerate the various investigations of central nervous system. Discuss in detail about Myelography and encephalography.

Part B

Answer any 5 questions (each question carries 10 marks)

5. Short notes on
   a) Contrast agents and preparation of the patient for contrast examinations.
   b) Barium meal
   c) Digital subtraction angiography
   d) A mode and B mode scan
6. Short notes on

a) Fluroscopy
b) Pelvimetry and cephalometry
c) ERCP
d) Sialography

7. Write short notes on
a) contraqst media used in urography,
b) Excreting urography
c) Female cysto urethrography
d) male cysto urethrography.

8. Computer fundamentals and applications in Radiology.
9. Briefly describe ultrasound colour Doppler techniques.
10. Clinical applications of Magnetic Resonance imaging.
11. What is the principle of Computed Tomography? Explain with neat diagram, the different generations of CT scanner.
12. Briefly describe the reconstructive image parameters in Computed Tomography.

CODE NO **Reg. No……**

Name……

THIRD YEAR B.Sc (MRT) DEGREE EXAMINATION……20

Paper XIII RADIOTHERAPY- PART- II

Time 3 hrs Max Marks: 100

Part A

(Answer any 2 questions, each questions carry 25 marks)

1. Describe the staging of Nasopharynx. Discuss in detail the steps of radiotherapy planning, portals with special emphasis on newer modalities.
2. Describe the management of Stage III B carcinoma of cervix. What are the methods to improve the results of treatment? Describe the radiation portals.
3. Describe the radiotherapy techniques in the treatment of medulloblastoma.
4. What are the different types of brachytherapy and explain brachytherapy in the case of carcinoma cervix.

Part B

Answer any 5 questions (each question carries 10 marks)

5. Short notes on
   a) Role of radiation in Hodgkin's lymphoma and technique of mantle field irradiation.
   b) IMRT
   c) Role of computers in Radiotherapy
   d) Total skin electron treatment

6. Short notes on
a) IGRT
b) Radiotherapy technique on the treatment of soft tissue sarcomas.
c) Carcinoma of maxillary antrum – radical plan
d) Tumour lysis syndrome

7. Short notes on
   a) Conventional radiation treatment planning of carcinoma cervix stage IIB.
   b) IMRT in Ca Breast
   c) Stereotactic radiotherapy and surgery
   d) Craniospinal irradiation.

8. Treatmet of Ca breast stage IIIB with explaining Radiotherapy planning and newer trends.
9. Describe in detail Simulation in Radiotherapy.
10. Indication and techniques of craniospinal irradiation
11. Role, techniques and side effects of radiation in carcinoma of esophagus.
12. A carcinoma of esophagus to be treated with 3 oblique 6 MV beam (F1,F2,F3) using field size 7*15 in SAD technique to a dose of 60 Gy in 30 fractions. Two of the beams (F2, F3) use 30 degree wedges of wedge factor 0.636. Depths of the tumour for each of the field F1, F2, F3 are 8 cm, 12 cm and 13 cm respectively. Calculate the MU required from the following given data.
    Out put of the machine for 10*10 cm at dmax = 1.05 cGy/MU
    PDD/TMR for 10*10 cm at 7 cm depth = 78.33/0.863
    PDD/TMR for 10*10 cm at 10 cm depth = 66.97/0.7757
    PDD/TMR for 10*10 cm at 15 cm depth = 50.91/0.635

CODE NO **Reg. No……**

Name……

THIRD YEAR B.Sc (MRT) DEGREE EXAMINATION……20

Paper XIV RADIATION PHYSICS - PART- II

Time 3 hrs Max Marks: 100

Part A

(Answer any 2 questions, each questions carry 25 marks)

1. Compare various characteristics of Ion chamber, Proportional counter and GM counter.
2. Explain angular distribution of X-ray in thin and thick target. What is a transmission target and what are the materials used for the same. How do we obtain a useful electron beam from a Linac?
3. Explain SSD and SAD type of treatments in radiotherapy with advantages and disadvantages if any. What is the role of PDD and TMR in SSD/SAD dosimetry?
4. Explain effective SSD for an electron beam and its clinical applications.

Part B

Answer any 5 questions (each question carries 10 marks)

5. Short notes on
a) Wedge filters.
b) Role of TPR in dosimetry.
c) Define wedge angle and Hinge angle with suitable equations.
d) What is compensator, Explain the design of compensator

6. Short notes on
a) Penumbra and different types.
b) Derive Meynord factor
c) Define Point A and Point B
d) Define what is phantom and what the different types of phantoms used in Radiotherapy are?
7. What is isodose charts. How do you measure isodose curves. What is the difference between an SSD chart and SAD chart.
8. Explain with neat diagram the construction and working of medical linear accelerator.
9. Briefly describe Electronic portal imaging devices.
10. Briefly describe what is MLC, its composition and its properties.
11. What are the factors that affect PDD? Briefly explain.
12. Explain the difference between 3DCRT, IMRT, IGRT.

CODE NO **Reg. No……**

Name……

THIRD YEAR B.Sc (MRT) DEGREE EXAMINATION……20

Paper XV RADIOLOGICAL PROTECTION AND STATUTORY ASPECTS

Time 3 hrs Max Marks: 100

Part A

(Answer any 2 questions, each questions carry 25 marks)

1. Define HVL and TVL and derive the relation between them.
2. What are the different types of Collimators used in Gamma camera? Explain in detail with diagram.
3. Explain the fundamental principles of radiological protection?
4. What are the various radiation monitoring instruments? Explain each with the detectors used in it. Explain the principle of TLDs. How does it help in personnel monitoring?

Part B

Answer any 5 questions (each question carries 10 marks)

5. short notes on
a) Biological monitoring

b) Glove boxes
c) Principles of radioactive waste disposal
d) What are the different types of packages of radionuclides?

6. Short notes on

a) Explain the principle of SPECT
b) What is RIA
c) Explain the principle of emission tomography
d) What is Renogram

7. Write short notes on
   a) Pocket dosimeters
   b) Area monitors
   c) TLD
   d) Film badges
8. Distinguish between tissue weighting factors and radiation weighting factors.
9. Draw a LINAC room layout and label it.
10. Discuss various methods for reducing patient exposures in Diagnostic Radiology?
11. What are the requirements of radionuclides used in Nuclear Medicine?
12. Quality assurance of Teletherapy units – Cobalt and Linac

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