AMRITA VISHWA VIDYAPEETHAM

A Multi Campus University with 'A' Grade Accreditation by NAAC

AMRITA SCHOOL OF MEDICINE

Centre for Allied Health Sciences

AIMS Ponekkara PO, Kochi – 682 041
Tel: 0484 – 2858131, 2858375, 2858845
Fax: 0484-2858382
Email: ahs@aims.amrita.edu
Web: www.amrita.edu

PROGRAM
BSc Medical Radiologic Technology

(Revised with effect from 2014-2015 onwards)

A Super Speciality Tertiary Care Hospital Accredited by ISO 9001-2008, NABL & NABH

Our Chancellor

SPIRITUAL PRINCIPLES IN EDUCATION

"In the gurukulas of ancient rishis, when the master spoke it was love that spoke; and at the receiving end disciple absorbed of nothing but love. Because of their love for their Master, the disciples' hearts were like a fertile field, ready to receive the knowledge imparted by the Master. Love given and love received. Love made them open to each other. True giving and receiving take place where love is present. Real listening and 'sraddha' is possible only where there is love, otherwise the listener will be closed. If you are closed you will be easily dominated by anger and resentment, and nothing can enter into you".

"Satguru Mata Amritanandamayi Devi"

Introducing AIMS

India is the second most populous nation on earth. This means that India's health problems are the world's health problems. And by the numbers, these problems are staggering 41 million cases of diabetes, nearly half the world's blind population, and 60% of the world's incidences of heart disease. But behind the numbers are human beings, and we believe that every human being has a right to high-quality healthcare.

Since opening its doors in 1998, AIMS, our 1,200 bed tertiary care hospital in Kochi, Kerala, has provided more than 4 billion rupees worth of charitable medical care; more than 3 million patients received completely free treatment. AIMS offers sophisticated and compassionate care in a serene and beautiful atmosphere, and is recognized as one of the premier hospitals in South Asia. Our commitment to serving the poor has attracted a dedicated team of highly qualified medical professionals from around the world.

The Amrita Institute of Medical Sciences is the adjunct to the term "New Universalism" coined by the World Health Organization. This massive healthcare infrastructure with over 3,330,000 sq. ft. of built-up area spread over 125 acres of land, supports a daily patient volume of about 3000 outpatients with 95 percent inpatient occupancy. Annual patient turnover touches an incredible figure of almost 800,000 outpatients and nearly 50,000 inpatients. There are 12 super specialty departments, 45 other departments, 4500 support staff and 670 faculty members.

With extensive facilities comprising 28 modern operating theatres, 230 equipped intensive-care beds, a fully computerized and networked Hospital Information System (HIS), a fully digital radiology department, 17 NABL accredited clinical laboratories and a 24/7 telemedicine service, AIMS offers a total and comprehensive healthcare solution comparable to the best hospitals in the world. The AIMS team comprises physicians, surgeons and other healthcare professionals of the highest caliber and experience.

AIMS features one of the most advanced hospital computer networks in India. The network supports more than 2000 computers and has computerized nearly every aspect of patient care including all patient information, lab testing and radiological imaging. A PET (Positron Emitting Tomography) CT scanner, the first of its kind in the state of Kerala and which is extremely useful for early detection of cancer, has been installed in AIMS and was inaugurated in July 2009 by Dr. A. P. J. Abdul Kalam, former President of India. The most recent addition is a 3 Tesla Silent MRI.

The educational institutions of Amrita Vishwa Vidya Peetham, a University established under section 3 of UGC Act 1956, has at its Health Sciences Campus in Kochi, the Amrita School of Medicine, the Amrita Centre for Nanosciences, the Amrita School of Dentistry, the Amrita College of Nursing, and the Amrita School of Pharmacy, committed to being centres of excellence providing value-based medical education, where the highest human qualities of compassion, dedication, purity and service are instilled in the youth. Amrita School of Ayurveda is located at Amritapuri, in the district of Kollam. Amrita University strives to help all students attain the competence and character to humbly serve humanity in accordance with the highest principles and standards of the healthcare profession.

Table of Contents
Part I – Rules and Regulations

Part I
Rules and Regulations

Under Graduate Programmes (Bachelor of Sciences)

I.1. Details of Under Graduate Courses :			
Sl. No.	**Course**	**Duration**	**Conditions of Eligibility for admission to the course**
1	Medical Laboratory Technology (MLT)	4 years	Pass in plus Two with 50% marks with Physics, chemistry and Biology
2	Medical Radiologic Technology (MRT)	4 Years	First class in plus two with Mathematics, Physics, Chemistry, and Biology
3	Emergency Medical Technology	3 Years + One year internship	Pass in plus two with 50% marks in Physics, Chemistry and Biology.
4	Anaesthesia Technology	3 Years + One year internship	Pass in plus two with 50% marks in Physics, Chemistry and Biology
5	Respiratory Therapy (RT)	3 Years + one year Internship	Pass in plus two with 50% marks in Physics, Chemistry and Biology
6	Dialysis Therapy	3 Years + One year internship	Pass in plus two with 50% marks in Physics, Chemistry and Biology
7	Physician Assistant	3 years + one year internship	Pass in plus two with 50% marks in Physics, Chemistry and Biology.
8	Cardio Vascular Technology (CVT)	3 Years + One year internship	Pass in plus two with 50% marks in Physics, Chemistry and Biology.
9	Echocardiography Technology	3 Years + One year internship	Pass in plus two with 50% marks in Physics, Chemistry and Biology.
10	Cardiac Perfusion Technology (CPT)	3 Years + One year internship	Pass in plus two with 50% marks in Physics, Chemistry and Biology.
11	Diabetes Sciences	3 years + One year internship	Pass in plus two with 50% marks in Physics, Chemistry and Biology.
12	Optometry	3 Years + One year Internship	Pass in plus two with 50% marks in Physics, Chemistry and Biology.
13	Optometry (Lateral Entry)	2 Years + One year Internship	Pass in two year Diploma in Optometry
14	Bachelor of Audiology & Speech Language Pathology (BASLP)	3 years + One year internship	Pass in plus two with 50% marks in Physics, Chemistry and Biology.
15	Neuroelectrophysiology	3 years + One year internship	Pass in plus two with 50% marks in Physics, Chemistry and Biology.

I.2. Medium of Instruction:

English shall be the medium of instruction for all subjects of study and for examinations.

I.3. Eligibility:

Generally Science Graduates with Physics, Chemistry, and Biology are eligible for admission to the Under Graduate Courses except in respect of certain specialties for which other qualification or subjects are specifically called for. Essential qualifications for eligibility are mentioned under clause I.1

II. General Rules:

Admissions to the courses will be governed by the conditions laid down by the University from time to time and as published in the Regulations for admissions each year.

II.1. Duration of the Course

Duration details are mentioned under clause No.I of this booklet.

Duration of the course : 4 Years (3 years + 1 year Internship except for courses at serial number 1 and 2 in clause I.1)
Weeks available per year : 52 weeks
Vacation / holidays : 5 weeks (2 weeks vacation + 3 weeks calendar holidays)
Examination (including preparatory) : 6 weeks
Extra curricular activities : 2 weeks
Weeks available : 39 weeks
Hours per week : 40 hours
Hours available per academic year : 1560 (39 weeks x 40 hours)

Internship wherever specified are integral part of the course and needs to be done in Amrita Institute of Medical Sciences, Kochi itself.

II.2. Discontinuation of studies

Rules for discontinuation of studies during the course period will be those decided by the Chairman /Admissions, Amrita School of Medicine, and Published in the "Rules and Regulations" every year.

II.3. Educational Methodology

Learning occurs by attending didactic lectures, as part of regular work, from co-workers and senior faculty, through training offered in the workplace, through reading or other forms of self-study, using materials available through work, using materials obtained through a

professional association or union, using materials obtained on students own initiative, during working hours at no cost to the student.

II.4. Academic Calendar

Course will follow and annual scheme as per details mentioned under:

FIRST YEAR

Commencement of classes	– August
First sessional exam	– November
Second sessional exam	– February
Model Exam (with practical)	– May - June (one week study leave)
University exam (with practical)	– June - July (10 days study leave)
Annual Vacation	– 3 weeks after the University examination.

SECOND YEAR

Commencement of classes	– August
First sessional exam	– November
Second sessional exam	– February
Model Exam (with practical)	– May - June (one week study leave)
University exam (with practical)	– June - July (10 days study leave)
Annual Vacation	– 2 weeks after the University examination

THIRD YEAR

Commencement of classes	– August
First sessional exam	– November
Second sessional exam	– February
Model Exam (with practical)	– May (one week study leave)
University exam (with practical)	– June (10 days study leave)
Annual Vacation	– 1 week after the University examination.
Date of completion of third academic year	– 31st July

III. Examination Regulations:

III.1. Attendance:

75% of attendance (physical presence) is mandatory. Medical leave or other types of sanctioned leaves will not be counted as physical presence. Attendance will be counted from the date of commencement of the session to the last day of the final examination in each subject.

III.2. Internal Assessment:

1. **Regular periodic assessment shall be conducted throughout the course. At least three sessional examinations in theory and preferably one practical examination should be conducted in each subject. The model examination should be of the same pattern of the University Examination. Average of the best of two examinations and the marks obtained in assignments / viva / practical also shall be taken to calculate the internal assessment.**
2. **A candidate should secure a minimum of 35% marks in the internal assessment in each subject (separately in theory and practical) to be eligible to appear for the University examination.**
3. **The internal assessment will be done by the department thrice during the course period in a gap of not more than three months and model exam will be the same pattern of university examination. The period for sessional examinations of academic year are as follows :**

    8. **First Sessional Exam : November**
    9. **Second Sessional Exam : February**
    10. **Model Exam : May /June**

4. Each student should maintain a logbook and record the procedures they do and the work patterns they are undergoing. It shall be based on periodical assessment, evaluation of student assignment, preparation for seminar, clinical case presentation, assessment of candidate's performance in the sessional examinations, routine clinical works, logbook and record keeping etc.
5. Day to day assessment will be given importance during internal assessment, Weightage for internal assessment shall be 20% of the total marks in each subject.
6. Third sessional examinations (model exam) shall be held three to four weeks prior to the University Examination and the report shall be made available to the Principal ten days prior to the commencement of the university examination.

III.3. University Examinations:

- University Examination shall be conducted at the end of every academic year.
  A candidate who satisfies the requirement of attendance and internal assessment marks, as stipulated by the University shall be eligible to appear for the University Examination.
- One academic year will be twelve months including the days of the University Examination. Year will be counted from the date of commencement of classes which will include the inauguration day.
- The minimum pass marks for internal assessment is 35% and for the University Examination is 45%. However the student should score a total of 50% (adding the internal and external examination) to pass in each subject (separately for theory and practical)
- If a candidate fails in either theory or practical paper, he/she has to re-appear for both the papers (theory and practical)
- Maximum number of attempts permitted for each paper is five (5) including the first attempt.
- The maximum period to complete the course shall not exceed 6 years.
- All practical examinations will be conducted in the respective clinical areas.
- Number of candidates for practical examination should be maximum 12 to 15 per day
- One internal and external examiner will jointly conduct the theory evaluation and practical examination for each student during the final year.

III.4. Eligibility to appear university Examination:

A student who has secured 35% marks for Internal Assessment is qualified to appear for University Examination provided he/she satisfies percentage of attendance requirement as already mentioned at the III (1).

III.5. Valuation of Theory – Revaluation Papers:

1. Valuation work will be undertaken by the examiners in the premises of the Examination Control Division in the Health Sciences Campus.
2. There will be **Re-Valuation** for all the University examinations. Fees for revaluation will be decided by the Principal from time to time.
3. Application for revaluation should be submitted within 5 days from date of result of examination declared and it should be submitted to the office with payment of fees as decided by the Principal.

III.6. Supplementary Examinations:

Every main University examination will be followed by a supplementary examination which will normally be held within four to six months from the date of completion of the main examination.

As stipulated under clause No. III.2 under Internal Assessment, HOD will hold an internal examination three to four weeks prior to the date of the University Examination. Marks secured in the said examination or the ones secured in the internal examination held prior to the earlier University Examination whichever is more only will be taken for the purpose of internal assessment. HODs will send such details to the Principal ten days prior to the date of commencement of University examination.

Same attendance and internal marks of the main examination will be considered for the supplementary examination, unless the HOD furnishes fresh internal marks and attendance after conducting fresh examination.

Students who have not passed / cleared all or any subjects in the first University examination will be permitted to attend the second year classes and also eligible to appear for second year university examination along with first year supplementary examination. However, he / she can appear for the third (final) year university examination, only if he / she clear all the subjects in the first as well as in the second year examinations.

Students of supplementary batches are expected to prepare themselves for the University Examinations. No extra coaching is expected to be provided by the Institution. In case at any time the Institution has to provide extra coaching, students will be required to pay fees as fixed by the Principal for the said coaching.

III.7. Rules regarding carryover subjects:

A candidate will be permitted to continue the second and third year respectively of the course even if he/she has failed in the first or second year university examinations.

A candidate must have passed in all subjects to become eligible to undergo compulsory internship of one year. For the candidates who have not passed all the subjects the duration of the third year shall be extended until they become eligible to undergo compulsory internship.

IV. Criteria for Pass in University Examination - Regulations:

IV.1. <u>Eligibility criteria for pass in University Examination</u>:

In each of the subjects, a candidate must obtain 50% in aggregate for a pass and the details are as follows:

- A separate minimum of 35% for Internal Assessment.
- 45% in Theory & 35% in Viva.
- A separate minimum of 50% in aggregate for Practicals / Clinics (University Examinations).

- Overall 50% is the minimum pass in subject aggregate (University Theory + Viva + Practicals + Internal Assessment).

IV.2. Evaluation and Grade:

Minimum mark for pass shall be 50% in each of the theory and practical papers separately (including internal assessment) in all subjects except English. Only a minimum of 40% is required to pass in English

A candidate who passes the examination in all subjects with an aggregate of 50% marks and above but less than 65% shall be declared to have passed the examination in the second class.

A candidate who passes the examination in all subjects in the first attempt obtaining not less than 65% of the aggregate marks for all the three years shall be declared to have passed the examination with First Class.

A candidate who secures an aggregate of 75% or above marks is awarded distinction. A candidate who secures not less than 75% marks in any subject will be deemed to have passed the subject with distinction in that subject provided he / she passes the whole examination in the first attempt.

A candidate who takes more than one attempt in any subject and pass subsequently shall be ranked only in pass class.

A Candidate passing the entire course is placed in Second class / First class / Distinction based on the cumulative percentage of the aggregate marks of all the subjects in the I, II and III (Final) university examinations

Rank in the examination: - Aggregate marks of all three year regular examinations will be considered for awarding rank for the B.Sc Graduate Examination. For the courses where the number of students are more than 15 only, rank will be calculated as under :

5. Topmost score will be declared as First Rank.
6. Second to the topmost will be declared as Second Rank.
7. Third to the topmost will be declared as Third Rank.
8. There will be no ranking if the number of candidates is less than 15.

V. Internship:

V.1. Eligibility for Internship - Regulations:

Wherever internship is a part of the curriculum, students will have to do the internship in Amrita Institute of Medical Sciences itself. A candidate must have passed in all subjects to become eligible to undergo compulsory internship of one year or a period fixed in the curriculum.

"Internship has to be done continuously for a period provided in the syllabus except in extra ordinary circumstances where subject to the approval of the Principal the same may be done in not more than two parts with an interruption not exceeding six months. In any case Internship shall be completed within 18 months from the date of acquiring eligibility to do the internship.

V.2. Attendance and leave details during Internship:

For 30 days of duty an intern will be eligible for casual leave and one weekly off. A Student will become eligible to receive his/her degree only after completion of internship to the complete satisfaction of the Principal.

VI. General considerations and teaching / learning approach:

There must be enough opportunities to be provided for self learning. The methods and techniques that would ensure this must become a part of teaching-learning process.

Proper records of the work should be maintained which will form the basis for the students assessment and should be available to any agency that is required to do statutory inspection of the school of the course.

VII. Project:

Each student should submit a project in consultation with HOD and guidance under Project Guide, 3 months prior to their final year university exam. The student will be eligible to appear for the final year examination only after submission of the project.

VIII. Maintenance of Log Book

- Every graduate student shall maintain a record of skills he/she has acquired during the training period certified by the various Heads of Departments/Program Coordinator under whom he/she has undergone training.

- In addition, the Head of the Department shall involve their graduate students in Seminars, Journal Club, Group Discussions and participation in Clinical, Clinical-Pathological meetings.

- The Head of the Departments/Program coordinator shall scrutinize the logbook in every month.

- At the end of the course, the student should summarize the contents and get the log book certified by the Head of the Department.

The log book should be submitted at the time of practical examination for the scrutiny of the Board of Examiners.

Part II
Syllabus

INTRODUCTION AND ADVANCEMENT

The branch of allied health field known as Radiological Technology deals with the use of sophisticated technology in medical imaging and cancer treatment. It has various sub specialties such as Radiology, Radiotherapy & Nuclear medicine.

Radiotherapy - deals with the use of ionizing radiation as part of cancer treatment.
Diagnostic Radiology – deals with the imaging of internal organs, bones, cavities and foreign objects with the use of plain X – ray, CT & MRI also includes cardiovascular imaging and interventional radiology.
Nuclear Medicine – this uses radioactive isotopes which can be administered to examine how the body and the organs function and also to detect abnormal areas in different organs. Certain radioactive isotopes can be administered to treat certain cancers such as thyroid cancer.

A Radiological technologist also known as medical radiation technologist or Radiographer performs the following duties

- Imaging of human body using advanced imaging technology such as Magnetic resonance imaging(MRI), Computed tomography(CT), Ultrasonography (USG), Nuclear medicine, Digital & conventional radiography (X-ray) for diagnostic purpose.
- Exposing patient's body to various types of ionizing radiation by using equipments such as linear accelerators (Linac) Cobalt-60 teletherapy unit Brachytherapy (HDR, MDR, LDR) units for treatment of cancer.

Students of this program are taught Human Anatomy, Physiology, Biochemistry, General physics & electronics, Atomic & nuclear physics, Mathematics, Pathology, Community medicine, Radio diagnosis, Radiation Oncology and Radiation Physics.

In Amrita Institute of Medical Sciences, Departments of Radiology & Radiation Oncology are jointly conducting BSc.MRT program from 2005.

The department of radiology has all kinds of advanced imaging equipments such as

1. Five X-ray machines(GE Tejus Digital Radiography, Prognosis DR System & Siemens Multiphos 10) and four portable X-ray units(Siemens multimobilite 300MA, Siemens Multiphos 100 MA & Shimadzu Mobileart) with three CR processors (Fuji FR profect CS, Fuji FCR XG I & Fuji FCR Capsula Excel II) & Two film processors [Kodak Dryview 8900& Promax X-ray film processor(wet processor)].
2. Mammograhy unit (Siemens Mammomat 3000 Nova) for imaging of breast lesions.
3. C-arm (Siemens Axion Artis Zee 1000MA) for interventional & angiographic procedures.
4. Fluoroscopy equipment(Siemens Siereskop 1000MA) for special radiographic procedures.
5. Two MRI(Magnetic Resonance imaging)machines (siemens Magnetom Symphony 1.5 T & GE Signa HDX XT).

6. Three CT(Computed Tomography) machines(Siemens Somatom Emotion 16 slice, GE discovery Pet-CT 8 slice & Siemens cardiac sensation 64).
7. Six Doppler /Ultrasound Machines (Siemens Sonoline G 40,Siemens Acuson Antares, Siemens Sonoline Antares, Aloka alpha 7 ,Siemens adara & Sonosite).

The department of Radiation oncology is well equipped with

- Three linear accelerators(Electa Precise & Synergy) with triple photon energies(4MV,6MV &15 MV),set of electron energies(4,6,8,10,12 & 15 MeV) and EPID.
- Steriotactic RadioSurgery(SRS) & Steriotactic Radiotherapy(SRT) (3D Line system) with micro MLC for treatment of intracranial lesions.
- CT Simulator (Siemens-Somatom Emotion) with lasers system for precise patient set up.
- Computerized treatment-planning system (CMS XIO) with CT/MRI/PET fusion and image contouring for both CT- based 3-Dimensional and Intensity Modulated Radiation Treatment (IMRT) planning.
- Nucletron Simulix Evolution Simulator with Amorphous Silicon EPID for simulation and verification.
- High dose rate (HDR) Brachytherapy (Nucletron-micro Selectron) after loader together with a CT/MRI based treatment planning system for intraluminal, interstitial and intracavitary brachytherapy of a variety of disease sites including head and neck, lung, esophagus, cervix and breast.
- Mould room for designing customized Cerrobend blocks for individual patients & individual immobilization devices.

The department of Nuclear Medicine has

3. Two Gamma cameras, Siemens SYMBIA E (SPECT) variable angle gamma camera for all routine nuclear medicine procedures & GE Infinia Hawkeye 4(SPECT CT) for all routine Nuclear Medicine procedures, Low dose Ct correlation & attenuation correction.
4. PET – CT (Discovery STE 8 slice) for oncology applications , Cardiac & Neurology PET Scans with high quality CT Correlation & also performs standalone CT procedures.

The students receive training in all these equipments and at the end of the course they will be able to Carry out independently all routine good quality radiographic procedures. Operate all advanced imaging equipments such as CT, MRI, Mammography, SPECT &PET. Assist radiologists in all special investigations. Execute all routine therapeutic procedures in radiation oncology using linear accelerators, & Brachytherapy units including simulations using conventional X-ray simulator & CT simulator as per prescription of Radiation oncologists & under the direction of Medical physicists. Operate and assist in maintenance & quality assurance of all equipments used in diagnostic & therapeutic procedures.

Scope & career options

Nowadays a plenty of job opportunities are being created in the field of radiological technology. A large number of hospitals started installing advanced imaging & therapeutic

equipments & there will be an increased need of radiological technologists in the coming years in India and abroad.

After the completion of the course candidates can work as:

11. Radiological technologist
12. Radiotherapy technologist
13. Nuclear medicine technologist
14. Clinical Application specialist

They have excellent overseas job opportunities and for those interested in higher studies various postgraduate courses are available in India or abroad.

MAIN OBJECTIVES OF THE COURSE

At the end of the course the candidate should be:

1. Able to independently do routine, good quality radiographic procedures.
2. Able to assist in special investigations under the guidance of specialists in diagnostic radiology.
3. Able to execute all routine therapeutic procedures in Radiation Oncology, using Linear Accelerator and Cobalt Tele-therapy and Brachy-therapy, including simulations using conventional X-ray Simulators and CT Simulators, as per prescription of Radiation oncologists and direction of Medical Physicists.
4. Able to operate and assist in the maintenance and quality assurance of all equipment used in Diagnostic and Therapeutic procedures

PROGRAM STRUCTURE.

Program Outcomes (PO)

1. PO1: Fundamental knowledge on the subject.
2. PO2: Effective communication skills.
3. PO3: Knowledge in professional ethics.
4. P04: Leadership qualities and team work.
5. PO5: Problem Analysis and solving skills.
6. PO6: Basic knowledge on research methodology.
7. PO7: Higher Technical skills and competencies.
8. PO8: Higher study options in many fields.
9. PO9: Employability in various sectors.
10. PO10: Higher earnings.

Program Specific Outcomes (PSO)

1. PSO1: Basic knowledge about the principles and operations of all Radiology and Radiotherapy equipments.

2. PSO2: They should have effective communication skills with patients and healthcare

3. PS03: They should select appropriate technical factors, positioning skills and staffs
4. POS4: They should have the ability to solve clinical problems and assessment skills Radiation Protection.
5. POS5: They should have the ability to make decisions and use independent judgement
6. PSO6: Employability as Radiology technologist & Radiotherapy technologist in Govt hospitals, Private hospitals, Clinics in India as well as Abroad, Tutor in private sectors, System Application specialist in companies.
7. PSO7: Entrepreneurship in Medical Imaging Sciences.

BMRT40

Value Based Education (Elective Course)

CO1: The attitude to be a good human being, with the curiosity to continue lifelong learning.
CO2: The conviction to do service to humanity - to put the interests of the individual patient as the foremost priority. Acquisition of values of gender sensitivity, environment & sustainablity.
CO3: Acquisition of the "skills for life" in addition to the skills to live.
CO4: Acquisition of positive lifelong values including ethics and etiquette.
CO5: The "practical applications" of the right values

The undergraduate program is a Four-year full time degree that provides education in all areas of Medical Application of Radiation, with emphasis in Diagnostic Imaging and Radiation Oncology.

First Year:

Students undertake a series of courses in subjects designed to provide them with an introductory understanding of the application of all Medical Radiation disciplines in Clinical Medicine.

The courses studied include:

1. Anatomy and Histology-
2. Physiology and Bio chemistry
3. Basic Radiation Physics
4. Atomic and Nuclear Physics
5. Mathematics and Computer Applications.
6. General Subjects - Psychology

Second Year:

In this year, students continue to study a mix of both general and core courses. The syllabus studied is designed to provide students with a more in-depth understanding of practice in radiological technology

Courses studied in second year include:

1. Regional and Imaging Anatomy
2. Radio diagnosis - I
3. Radiation Oncology - I
4. Radiation Physics - I
5. Pathology, dietetics, sociology and community health
6. Clinical posting

Third Year:

In the third year of the program, the students continue to study general and core courses. The third year content is designed to allow students the opportunity to develop knowledge and understanding of more complex and advanced procedures within their specialty.

During the third year, the students will have the opportunity to participate in interdisciplinary lectures, tutorials and group-based activities, designed to develop an understanding of the interdisciplinary nature of Medical Radiations as experienced in the workplace by patients, professionals and the community.

Courses studied in third year include:

- Radio diagnosis II
- Radiation Oncology II
- Radiation Physics II
- Nuclear Medicine and Radiation Safety
- Clinical posting; lectures, seminars and symposia

Fourth Year:

Practical training:

Six months practical training in the department of Radiation Oncology and Six months practical training in the department of radio-diagnosis.

Project work:

The candidates are required to complete a project work in the field of their choice: radio diagnosis or radiation oncology.

Distribution of Teaching Hours

First Year				
Sl No:	**Subject**	**Theory (hours)**	**Demonstration (hours)**	**Total Hours**
1	Anatomy & Histology	80	20	100

2	Physiology & Biochemistry	100	10	110
3	Basic Radiation Physics	200	-	200
4	Atomic and Radiation Physics	200	-	200
5	Mathematics and Computer Applications	200	100	300
6	Psychology	200	-	200
7	Clinical Observation/Seminar & Symposium	-	-	330
Total Hours				1440
Second Year				
1	Regional and Imaging Anatomy	160	40	200
2	Radio Diagnosis I	160	40	200
3	Radiation Oncology I	160	40	200
4	Radiation Physics	160	40	200
5	Pathology and Community Health	100	-	100
6	Clinical Observation /Seminar and Symposium	-	-	540
Total Hours				1440
Third Year				
1	Radio Diagnosis - II	180	40	220
2	Radiation Oncology - II	180	40	220
3	Radiation Physics - II	180	40	220
4	Nuclear Medicine and Radiation Safety	180	40	220
5	Clinical Observation /Seminar and Symposium	-	-	560
Total Hours				1440

Fourth Year

In the fourth year there will be clinical postings in the departments of radiation oncology and radio diagnosis of the Amrita Medical Institutions and other participating Medical Institutions. The project work will proceed along with the clinical posting.

Posting and Project work : 1440 hours

FIRST YEAR

During the first year the students will have didactic lecture in the medical college from 10 am to 4 pm

Internal Assessment

Three sessional examinations will be conducted in this year. Average marks of these sessional examinations will be counted as internal marks.

****

Paper I –AHS11
Section A: ANATOMY

COURSE OBJECTIVE:
An outline of anatomy with special emphasis on applied aspects is provided to the students for better understanding of the technical and diagnostic procedure.

Course Outcome:

1. Knowledge of general anatomy and locomotion.
2. Knowledge of basic human anatomy and histology of CVS and Respiratory systems.
3. Knowledge of basic human anatomy and histology of CNS, GI, excretory and reproductive systems.
4. Knowledge of basic human anatomy and histology of endcorine system and special senses.

1. The human body as a whole **1 hour**

Definition
Sub divisions of anatomy
Terms of location and positions
Fundamental planes, Vertebrate structure of man
Organization of body cells and tissues

2. Locomotion and Support **8 hours**

The Skeletal System
Types of bones
Structure and growth of bones
Divisions of the skeleton
Appendicular skeleton, Axial skeleton
Name of all the bones and their parts
Joints: Classification, Types of movements with examples
Muscles: Structure, classification, muscles of abdominal wall, muscles of Respiration, pelvic diaphragm, muscles of head and neck

Practicals: **2 hours**

Demonstrations of all bones:
Showing parts

Joints, X-rays of all normal bones and joints
Muscles: Classification of muscle

3. Anatomy of nervous system **6 hours**

Introduction and divisions of nervous system
Central nervous system: Spinal cord, Anatomy, and functions, Reflex arc
The Brain:
Location, gross features, parts, functional areas
Hindbrain, Midbrain, fore brain
Coverings of brain and peripheral nervous system
anatomy of cerebral blood supply& coverings
Spinal cord –gross features, extent, blood supply and coverings
Injuries to spinal cord and brain
Peripheral nervous system – organization& structure of a typical spinal nerve

Practicals: **1 hour**

Demonstration of brain and spinal cord

4. Anatomy of Cardiovascular system

Gross anatomy & Structural features of the Heart and Great vessels:

Heart **2 hours**

Location, size, surface features, pericardium & valves
Right Atrium :- structural features
Venous area, Septum and atrial appendage
Right Ventricle :- structural features, inflow & Out flow characteristics
Left Atrium :- structural features, venous area, Septum and appendage
Left ventricle :- structural features, inflow & out flow characteristics
Valves :- valve apparatus, location
Structure & functions of each valve
Blood Supply of heart :- coronary arteries, cardiac cycle
Innervations :- sympathetic and parasympathetic sensory
Pulmonary circuit-names of the arteries and veins & positions
Lymphatic drainage of the Heart

Great Vessels **2 hours**

Structure of blood vessels and its organization
Aorta
Blood supply to the cardia
Pulmonary artery & pulmonary vein
General plan of systemic circulation
General plan of fetal circulation
Pulmonary circulation

PRACTICALS **2 hours**

Demonstration to illustrate normal angiograms.
Demonstration of surface features & interior of the heart
Demonstration of aorta and its branches

Histology of cardiac muscles and artery

5. Anatomy of the Respiratory system **4 hours**

Organs of Respiratory System:
Conducting portion, respiratory portion.
(Nose –nasal cavity, paranasal air sinuses
Larynx,trachea,bronchial tree)
Primary Muscles of Respiration
Accessory muscles of respiration
Cross structure and the interior features of nose & nasal cavity
Para nasal air sinuses
Cross structure and interior features of the pharynx and larynx
Cross structures and interior features of the trachea and bronchial tree
Gross structure, histology, position and coverings of the lungs
Pulmonary circulation – pulmonary arteries pulmonary veins & bronchial arteries
Nerve supply to the respiratory system

Practicals **2 hours**

Demonstration of the parts and function
Demonstration of the different parts of the respiratory system with special emphasis On lungs
Histology of lungs

6. Anatomy of the digestive system **1 hour**

Components of the digestive system
Alimentary tube
Mouth, tongue, tooth
Salivary gland, liver, biliary apparatus and its secretion, pancreas and pancreatic Secretion, movements of intestine defecation, GI hormones malabsoption and

Practicals **1 hour**

Demonstrations of the parts and functions
Normal x-rays

7. Anatomy of excretory system & Reproductive system **1 hour**

Organization of the renal system
Kidneys: location, gross features, structure, blood supply and nerve supply
Excretory ducts, ureters, urinary bladder, urethra location gross features and structure

Male reproductive system: **2 hours**

Testis, Duct system, Prostate
Female Reproductive system:
Ovaries, duct system, accessory organs

Practicals **1 hour**

Demonstration of Kidneys, ureter, bladder
Histology of kidney

8. Anatomy of endocrine system **1 hour**

Name of all endocrine glands and their positions
Hormones and their functions

9. Histology **6 hours**

General Slides:

Hyaline cartilage, Fibro cartilage, Elastic cartilage, T.S & L.S of bone, Blood vessels, Tonsils, Spleen, Thymus, Lymph node, Epithelial tissue, Skeletal and cardiac muscle, Peripheral nerve and optic nerve

Systemic Slides **5 hours**

- G.I.T
- Lung-Trachea
- Kidney, Ureter, Urinary bladder
- Endocrine- Adrenal,pancreas,pituitary,thyroid and parathyroid
- Uterus, Ovary, testis

Reference books:

Human Anatomy- Regional and Applied Volume
B.D Chaurasia
Clinical Anatomy For Medical Students
Richard S.Snell

****

Paper I – Section B: PHYSIOLOGY

Course outcome:

- CO1: Knowledge of general physiology, nerve-muscle physiology and haematology.
- CO2: Knowledge of basic human physiology with respect to CVS, Respiratory system and GI system.
- CO3: Knowledge of basic human physiology of excretion and CNS.
- CO4: Knowledge of basic human physiology of special senses and endocrine system.

1. INTRODUCTION TO PHYSIOLOGY AND GENERAL PHYSIOLOGY-1 hr

2. MUSCLE and NERVE - 3 hrs

7. Neurons and glial cells - Structure, function, Types, electrical property, degeneration and regeneration.
8. Muscle- Structure & Functions of skeletal muscle & smooth muscle
9. Neuromuscular transmission – Functional anatomy, Transmission & Clinical importance.

3. HAEMATOLOGY - 9 hrs

1. Fluid compartments, Composition & functions of blood, Plasma protein – names, functions.
2. Erythrocyte - Morphology, Count, Function, Erythropoiesis, Factors affecting erythropoiesis, Structure of Haemoglobin, Erythrocyte Sedimentation rate, Anaemia, Polycythemia, Fate of RBC, Jaundice.
3. Leucocytes - Morphology, Types, Properties & Functions, variations in count.
4. Thrombocytes- Morphology, Count, Function, Variations.
5. Hemostasis. Coagulation and its disorders.

6. Blood groups and its importance, Blood transfusion.
7. Tissue fluid and Lymph
8. Immunity.

4. CARDIOVASCULAR SYSTEM - 10 hrs

- Organisation of CVS, Properties of Cardiac Muscle, Origin and spread of cardiac impulse
- Cardiac Cycle – Electrical (ECG)and mechanical events,
- Cardiac output, Measurement, (Fick's Principle) regulation
- Blood pressure, measurement & variation, determinants, regulation, Shock.
- Regional circulation.(Salient features only)-coronary, Pulmonary, Cerebral, Cutaneous

5. RESPIRATORY SYSTEM - 8 hrs

- Introduction. Functional anatomy, Mechanics of ventilation, Pressure changes, volume changes, Surfactant, Compliance, Airway resistance.
- Alveolar ventilation, Dead space, Ventilation perfusion ratio and its significance,
- Spirogram
- Diffusion of gases, O_2 transport, CO_2 transport.
- Regulation of respiration – Voluntary, Neural, Chemical.
- Abnormalities of respiration Hypoxia, Cyanosis, Dyspnea, Asphyxia, High altitude,
- Dysbarism.

6. DIGESTIVE SYSTEM - 7 hrs

- Functional anatomy of GI tract,
- Secretions - Salivary secretion & its regulation, Gastric secretion and its regulation,
- Peptic ulcer, Pancreatic secretion and its regulation, Functions of liver. Bile – storage and functions. Intestinal juice
- Movements - Mastication, Deglutition, Movements of stomach, Small intestine, Large intestine. vomiting, Defeacation.
- GI Hormones,
- Digestion & Absorption of carbohydrates, Proteins, Fat & vitamins

7. Excretion - 7 hrs

- Functional anatomy of kidney, Structure and function of kidney and nephron
- Renal blood flow, Glomerular filtration rate, Definition, Measurement and factors
- affecting Tubular functions – Reabsorption, Secretion, Acidification, concentration and abnormalities.
- Micturition – Bladder innervation, Micturition reflex.
- Functions of skin

8. ENDOCRINOLOGY - 6 hrs

- Introduction to endocrinology (Different glands, hormones)
- Pituitary gland (Anterial and posterior glands, actions and applied aspects.
- Thyroid gland (Actions and applied aspects)
- Calcium homeostasis (Parathyroid, Vitamin D, Calcitonin, actions and applied aspects
- Pancreas (Endocrine part – insulin, glucagon – actions and applied aspects
- Adrenal cortex and medulla (Actions and applied aspects)

9. REPRODUCTIVE SYSTEM - 3 hrs

- Male Reproductive System- Different parts, spermatogenesis, hormones
- Female reproductive system – Different parts, Sexual cycles – Menstrual cycles – Ovarian, endometrium
- Lactation, Pregnancy & Contraception (Basics only)

10. CENTRAL NERVOUS SYSTEM (Basics only) **- 10 hrs**

a) Organization of Nervous system.
b) Synapse, Properties & Function
c) Reflexes, Reflex action, Property ,Function.
d) Sensory system – Receptor, Ascending sensory pathway (basics only), Thalamus, sensory cortex
e) Motor System – Spinal control of Motor activity, Motor areas in Cerebral Cortex,
f) Pyramidal & extra pyramidal tracts (basics only),
g) Basal ganglia & Cerebellum.
h) Hypothalamus
i) Autonomous nervous system
j) Cerebro spinal fluid- formation and functions.

11. SPECIAL SENSES (Basics only) **- 4 hrs**

- Audition
- Vision

Revision and evaluation session – 4-5 hours

Reference books:

Essentials of Medical Physiology
Anil Baran Singha Mahapatra

****

Paper II – AHS12
Section A: BIOCHEMISTRY

Course outcome:

- CO1: Knowledge of biochemistry of cell structure, functions, digestion, enzymes and protreins.
- CO2: Knowledge of biochemistry of carbohydrates, minerals and vitamins.
- CO3: Knowledge of biochmestry of liver and renal function tests, specialized laboratory investigations and lipids.
- CO4: Knowledge of biochemistry of metabolism, homeostasis, nucleic acids and cancer.

I. CELL STRUCURE & FUNCTIONS **1hr**

- Mitochondria
- Endoplasmic reticulum, Lysosomes
- Fluid mosaic model for membrane structure

II. DIGESTION AND ABSORPTION OF NUTRIENTS **2hrs**

- Digestion of carbohydrates
- Fats
- Enzymes in digestion of proteins

III. ENZYMES **1hr**

- Normal serum range and diagnostic importance of serum AST, ALP,ALT,CK,GGT and AMYLASE.

IV. PROTEINS **1hr**

- Essential amino acids
- Plasma proteins
- Immunoglobulins

V. CARBOHYDRATES **2hr**

- Diabetes mellitus- symptoms and complications
- Glucose tolerance test
- Action of insulin and glucagon on carbohydrate metabolism

VI VITAMINS **2hrs**

1 Deficiency manifestations of Vitamin A, C, D, E, K
2 Vit B Complex

VII MINERALS **1hr**

- Factors maintaining serum calcium level and important functions of calcium
- Importance of trace elements

VIII HEMOGLOBIN **1hr**

- Hemoglobin metabolism

IX LIVER FUNCTION TESTS **1hr**

- Jaundice and types of jaundice
- Enzymes in liver disease
- Alcoholic liver disease
- Infections of the liver

X RENAL FUNCTION TESTS **1hr**

- Serum Creatinine

XI SPECIALIZED LABORATORY INVESTIGATIONS **1hr**

Principle and applications of

- Radioimmunoassay (RIA)
- ELISA
- Colorimetry
- Flow cytometry

XII LIPIDS **1hr**

- Essential fatty acids (EFA)
- Poly unsaturated fatty acids (PUFA)
- Phospholipids

XIII METABOLISM 1**hr**

- TCA cycle (steps only)

XIV MAINTENANCE OF HOMEOSTASIS **1hr**

- Plasma buffers
- Renal mechanisms in pH regulation
- Anion gap
- Metabolic acidosis,

XV NUCLEIC ACIDS **1hr**

- DNA and RNA
- Purine and pyrimidine bases,

XVI CANCER **1hr**

- Chemical and physical carcinogens
- Tumor markers.

Reference books:

The Text Book of Biochemistry
Dr. D.M.Vasudevan, Sreekumari.S
Text Book of Biochemistry
T.N.Pattabhiraman
Essentials of Biochemistry

U.Sathyanarayanan

****

Paper II – Section B: PHARMACOLOGY

Course outcome:

- CO1: Basic knowledge in pharmacology.
- CO2: Detailed systemic pharmacology.
- CO3: Detailed knowledge of drugs and groups of drugs.

Course

4. General Pharmacology – 4 hours
5. Evaluation of drugs in man, drug prescribing and drug interactions – 3 hours
6. Sedatives, hypnotics and pharmacotherapy of insomnia – 1 hour
7. Drugs effective in convulsive disorders – 1hour
8. Opioid analgesics – 1 hour
9. Analgesic – antipyretics and non-steroidal anti-inflammatory drugs – 1 hour
10. Psychopharmacology – 1 hour
11. Drug therapy of parksinsonism and other degenerative disorders of the brain – 1 hour
12. Local anesthetics – 1 hour
13. Adrenergic and adrenergic blocking drugs – 1 hour
14. Histamine and anti histamic drugs – 1 hour
15. Pharmacotherapy of cough – 1 hour
16. Pharmacotherapy of bronchial asthma and rhinitis – 1 hour
17. Digitalis and pharmacotherapy of cardiac failure – 1 hour
18. Vasodilator drugs and pharmacotherapy of angina pectoris – 1 hour
19. Pharmacotherapy of hypertension – 1 hour
20. Drugs and blood coagulation – 1 hour
21. Drugs effective in iron deficiency and other related anemias – 1 hour
22. Diuretics – 1 hour
23. Emetics, drug therapy of vomiting, vertigo and diarrhea – 1 hour
24. Pharmacotherapy of constipation – 1 hour
25. Pharmacotherapy of peptic ulcer – 1 hour
26. Sulfonamides, Trimethoprim, cortimoxazole, nitrofurans and quinolones – 1 hour
27. Penicillins and antibiotics effective mainly against gram positive organisms – 1 hour
28. Amonoglycosides and other antibiotics effective mainly against gram negative organisms – 1 hour
29. Antibiotics effective against both gram positive and gram negative organisms – 1 hour
30. General principles of chemotherapy of infections – 1 hour
31. Chemotherapy of urinary tract infections – 1 hour
32. Antiseptics, disinfectants and insecticides – 1 hour
33. Thyroid and antithyroid drugs – 1 hour
34. Insulin and ant diabetic drugs – 1 hour
35. Adrenal cortical steroids – 1 hour
36. Vitamins and antitoxidants – 1 hour
37. Drugs, pregnancy and the newborn – 1 hour

Reference books:

Essentials of Medical Pharmacology
Tripathi
Basics and Clinical Pharmacology
Katzung

****

Paper III – AHS 13
Section A: MICROBIOLOGY

Course Outcome:

- CO1: To understand the morphological characters of bacteria.
- CO2: To master the preparation of smear, fixation and staining of bacterial smears and its quality control methods
- CO3: Learn to use microscope , autoclave, hot air oven, water bath, steamer, filters
- CO4: To differentiate between innate and adaptive immunity, and explain the main defences lines as well as biological barrier to the infections.
- CO5: Employ antigen –antibody interaction to conduct different immunological and serological tests in the laboratory

Introduction to medical microbiology	- 1 hr
Morphology and physiology of bacteria	- 1 hr
Sterilization and disinfection	- 2 hrs
Normal Microbial flora of the human body	- 1 hr
Infection	- 2 hrs
Antibiotics	- 1 hr
Hospital infections and prevention	- 2 hrs
Immunity	- 1 hr
Antigen, Antibody, Antigen-antibody reactions	- 1 hr
Immune response	- 1 hr
Hypersensitivity	- 1 hr
Immunoprophylaxis	- 1 hr
Tuberculosis	- 1 hr
Typhoid	- 1 hr
Virus infections	- 1 hr
HIV/AIDS	- 1 hr
Hepatitis viruses	- 1 hr
Medical Mycology	- 1 hr
Medical Parasitology	- 1 hr
Malaria	- 1 hr
Urinary Tract Infections	- 1 hr
Respiratory Tract Infections	- 1 hr
Gastrointestinal Infections	- 1 hr
Sexually Transmitted Disease	- 1 hr
Infections of the nervous system	- 1 hr
Practical Demonstrations	
Gram Staining	- ½ hr
Acid Fast Staining	- ½ hr

Antibiotic Susceptibility Testing - ½ hr
CSSD Visit - ½ hr
Theory Class Hours - 28 hrs
Practical Demonstration hours - 2 hrs
Total hours - 30 hrs

Referrence books:

Text Book of Medical Paracytology
C.K.Jayaram Panicker

Text Book of Microbiology
Anand Narayan

****

Paper III – Section B: PATHOLOGY

Course Outcome:

- CO1: Knowledge of general and systemic pathology.
- CO2: Knowledge of pathology of neoplasms.
- CO3: Knowledge of basics of community health.

1. Introduction to Pathology **3 hrs**

- Histopathology- Methods and techniques
- Cytology-FNAC,Exfoliative advantages and limitations of cytology
- Hematology-Sample collection.
- Immunohistochemistry,Immunofluorescence, Electron microscopy, Flow cytometry

2. Cell injury & adaptations **1 hr**

- Etiology
- Reversible & - Irreversible cell injury
- Necrosis & Apoptosis
- Gangrene - Dry - Wet
- Atrophy, Hypertrophy, Hyperplasia, Metaplasia, Dysplasia.

Fatty change

3. Inflammation & Repair **2hrs**

- What is inflammation
- Signs of inflammation, Acute and chronic inflammation, Types of inflammation, Giant cells, Macrophages, Ulcer, abscess, Acute inflammation, Systemic effects of acute inflammation
- Factors affecting healing- Complications of healing

4. Hemodynamic Disorders **2 hrs**

-Definition of edema and causes of edema

- Exudate and transudate

Shock – Definition and types of shock

Thrombosis

Embolism- Definition and types of emboli ,- Pulmonary thromboembolism

5. Neoplasia **2 hrs**

- Definition
- Difference between benign and malignant cells, Nomenclature of tumors
- Routes of metastasis of tumours,- Staging of tumour,- Etiology of cancers - Diagnosis of cancer, including tumour markers

6. CVS **1hr**

- Definition of Ischaemia, Infarction, Aneurysm
- Rheumatic heart disease, Infective endocarditis, Atherosclerosis
- Myocardial infarction,Hypertension and pericardial effusion

7. Respiratory system **1hr**

- Tuberculosis, Pleural effusion, Pneumonia, COPD and tumours

8. GIT **1hr**

- Peptic ulcer, - Carcinoma of oesophagus, Stomach & Colon,
- Inflammatory bowel disease (UC & Crohns)

9. Liver and GB **1h**

- Hepatitis. Cirrhosis, Tumours of liver

1. Cholecystitis and GB calculi

10. Renal **1hr**

- Glomerulonephritis & Pyelonephritis
- Renal calculi -Nephrotic syndrome, Renal tumors, Polycystic renal diseases-

Internal assessment Exam -1 ½ hrs

11. MGS **1hr**

- Cryptorchidism,Orchitis, epididymitis, Prostatic hyperplasia

1. Carcinoma penis, Testicular tumors

12. FGS & Breast **1hr**

Ovarain tumours,- Fibroid- Carcinoma cervix- Carcinoma endometrium pap smear

Fibroadenoma breast, Carcinoma Breast-Predisposing factors & TNM

13. CNS **1hr**

- Meningitis & encephalitis.- Alzheimer's disease,

Tumours - Meningioma, Gliomas, Metastasis

CSF collection, indication and contraindication, tests performed, cytocentrifuge

14. Skin & soft tissue **1hr**

Skin- SCC, Melanoma,BCC inflammatory lesions lipoma,

15. Bone **1hr**

Osteoporosis, Osteomyelitis,Rickets ,Osteomalacia

Tumours – Osteosarcoma, Osteoclastoma , Ewings sarcoma & Arthritis

16. Endocrine **1hr**

Organs, Pituitary, Adrenal brief; Thyroid – Goitre thyroiditis and tumours

Diabetes and its complications

17. Anaemias - Types of anaemia **1hr**

18. WBC disorders Non neoplastic and neoplastic **1hr**

19.Lymphoreticular system- Lymphadenitis, Lymphomas **1hr**

20. Platelet and coagulation abnormalities-Primary & Secondary Hemostasis **2hrs**

21 .Clinical Pathology I Blood collection, anticoagulants used,vacuettes and their color code.complete hemogram and the various parameters ,Bone marrow – Indication of BM study & collection procedure, PT ,APTT sample collection **1hr**

22. Clinical Pathology II –Urine analysis –Physical,Chemical, microscopic, Dipstick parameters **1hr**

23 Transfusion Medicine- Blood grouping, cross matching, Screening of donor, Precautions to take when you start blood transfusion,Monitoring during transfusion,Transfusion reactions, Blood components. **1Hr**

Internal assessment Exam -1 ½ hrs

Lab visit: Histopathology lab-1hr

Hematology lab &blood bank:1 hr

Cytology lab:1hr

Total Hours: 29 hrs lecture+3hrs exam+3 hrs lab visit=35 hrs

Referrence Books:

Basic Pathology: An introduction to the mechanisms of disease
Sunil R Lakhani, Susan A Dilly,Caroline J Filayson

****

Paper IV (AHS 14) – Section A: INTRODUCTION TO COMPUTER APPLICATION

Course outcome:

- CO1: basic under-standing of use of computer.
- CO2: Applications of computer in clinical departments.
- CO3: Deatiled knowledge on how to use hospital information system.

Coure Description: This course is designed for students to develop basic understanding of used of computer and its applications in Clinical Departments

Unit	Time (hours) Th.	Pr.	Learning Objective	Content	Teaching Learning activities	Assessment Methods
1	**10**	**5**	**Identify & define various concepts used in computer Identify application of computer**	Introduction * Concepts of computers * Hardware and Software * Trends and Technology * Application of Computers	* Lecture cum discussion * Explain using charts * Panel discussion	* Short answer questins * Objective Type
II	**5**	**10**	**Describe and use of Disk Operating System (DOS) Demonstrate skill in the use of MS Office**	Introduction to Disk Operating System * DOS * Windows (all version) * MS Word * MS Excel with Pictorial Presentation * MS - Access * MS-Power Point	* Lecture * Discussion * Demonstration * Practice session	* Short answers * Objective Type * Practical Exam and Viva voice
III	**10**	**5**	**Demonstrate skill in using multimedia** **Identify features of computer aided teaching and testing**	* Multimedia : types & uses * Computer aided teaching & testing	* Lecture * Discussion * Demonstration	* Short answers * Objective Type * Practical Exam and Viva voice

IV	**10**	**5**	**Describe and use of the statistical packages**	* Statistical packages: Types and their features	* Lecture * Discussion * Demonstration * Practice Session	* Short answers * Objective Type * Practical Exam and Viva voice
V	**5**	**5**	**Describe the use of Hospital Management System**	* Hospital Management System : Types and uses * Electronic patient records	* Lecture * Discussion * Demonstration	* Short answers * Objective Type * Practical Exam and Viva voice

****

Paper IV – Section B: QUALITY ASSURANCE AND ACCREDITATION

Course outcome:

- CO4: Introduction and basic concept of quality.
- CO5: Standardization and Implementation

Course Objectives:

Modernization and its brand conscious make an organization thrive towards perfection in the comparative world of business. The underlying factor that allows an organization to stand the test of time is quality. The students are given the working knowledge of the subject.

Course Content:

Introduction to quality - 2 hrs
Definition, Concept, Benefits - 2 hrs
Function - 2 hrs
Design - 2 hrs
Formulation - 2 hrs
Standardization - 2 hrs
Implementation - 2 hrs
Factors affecting quality - 2 hrs
Need for quality - 2 hrs
Quality cycle - 2 hrs
Quality objectives - 2 hrs
Quality policy - 2 hrs
Quality measurable - 2 hrs
Quality Control, Quality Standards, Q C Tools - 6 hrs
Quality Documents, QC Records, Kazen techniques - 2 hrs

Such as Market-in, TOC, Q C Circles,	- 2 hrs
Suggestion scheme, TPM, Kanban,	- 2 hrs
JIT, Zero defect programme	- 2 hrs
ISO	- 4 hrs
Quality management system Quality manual	- 4 hrs
Quality procedures	- 4 hrs
Quality records	- 4 hrs
Quality audit	- 4 hrs
Correlative and preventive action	- 2 hrs
SQC (Statistical Quality Control techniques)	- 2 hrs
Cost effectiveness	- 2 hrs
Cost of quality system	- 2 hrs
Benefit in total cost	- 4 hrs
Cost measuring system	- 4 hrs
TQM- Concept, awareness, aspects train	- 4 hrs
Total	**- 80hrs**

Detailed Course Plan

Unit- I

Introduction to quality –Definition, concept, Benefits-Functions-Design- Formulation- Standardization

Unit-II

Implementation –Factors affecting quality –Need for Quality Cycle –Quality objectives- Quality policy

Unit-III

Quality measurable –Quality Control Quality Standards. Q C Tools –NABH, NABL, JCI~Quality Documents, QC Records. Kazen Technique such as Market-in, TQC .Q C Circles –Suggestion scheme. TPM, Kanban –JIT, Zero defect programmes

Unit-IV

ISO- Quality management system- Quality manual-Quality procedure- Quality records- Quality audit

Unit- V

Corrective and preventive action –SQC (Statistical Quality Control technique)
Cost effectiveness- Cost of quality system- Benefit in total cost –Cost
Measuring system- TOM- concept, awareness, aspects training

Reference Text:

1. Dale H Bester field. Carol Bester field, Glen H Bester field, Mary Bester field –Scare, Total Quality Management .Wesley Logman (Singapore)Pte.Ltd. Indian Branch, 482F.I.E, Patparganj, Delhi 110092, India
2. K.Shridhara bhat, Total Quality management .Himalaya Publishing Hollse. "Ramdoot" Dr Bhalerao Mag. Girgaon, Mumbai-400004

****

Paper V (AHS 15): ENGLISH

Course Description : The course is designed to enable students to enhance ability to comprehend spoken and written English (and use English) required for effective communication in their professional work. Students will practice their skills in verbal and written.

Course Outcome

- CO1: Develop their intellectual, personal and professional abilities.
- CO2: Acquire basic language skills (listening, speaking, reading and writing) in order to communication with speakers of English language
- CO3: Acquire the linguistic competence necessarily required in various life situations

Unit	Time (Hours)	Learning Objective	Content	Teaching Learning activities	Assessment Methods
1.	**10**	**Speak and write grammatically correct English**	* Review of grammer * Remedial study of grammer * Building vo cabulary * Phonetics * Public speaking	* Demonstrate use of dictionary * Class Room conversation * Exercise on use of grammer * Practice in public speaking	* Objective type * Fill in the blanks * Para Phrasing
II	**10**	**Develop ability to read, understand and express meaning fully, the prescribed text**	* Read and comprehend prescribed course books	Exercise on : * Reading * Summarizing * Comprehension	* Short answers * Essay Type
III	**8**	**Develop writing skills**	* Various forms of Composition * Letter writing * Note taking * Precise writing * Anecdotal re cords * Diary writing * Reports on health Problems etc. * Resume / CV	Exercise on writing : * Letter * Note * Precise * Diary * Anecdote * Health problems * Story writing * Resume / CV * Essay Writing * Discussion on written reports / documents	* Assessment of the skills based on the check list

IV	**6**	**Develop skill in spoken English**	Spoken English * Oral report * Discussion * Debate * Telephone conversation	Exercise on : * Debating * Participating in Seminar, panel, Symposium * Teleponic Conversation	* Assessment of the skills based on the check list
V	**2**	**Develop skill in listening comprehension**	Listening Comprehension * Media, audio, video, Speeches etc.	Exercise on : * Listening to audio, video, tapes and identify the key points	* Assessment of the skills based on the check list
VI	**4**	**Develop skill in Grammer**	Grammer * Transformation of Sentences * Correction of sentence * Vocabulary Building * Composition * Essay writing - on topics of every day life	Exercise on : * Voice * The Sentence * Parts of Speech * Direct and Indirect Speech * Affirmative and Negative * Change the Question Tag * Correction of Syllabus * Idioms * Letter writing – Personal, Official matters connection with daily life	* Assessment of the skills based on the check list

****

Second Year

Paper VII BMRT7

Regional and Imaging Anatomy

1. CO1: General anatomy of the head and neck including the brain, the thorax, the abdomen, the pelvis, the vertebral column and spinal cord, the upper and lower extremities and their associated articulations.
2. CO2: Sectional anatomy in transverse, sagittal and coronal planes utilizing contemporary 3D medical imaging.
3. CO3: Skills to acquire knowledge about pathologies that are difficult to evaluate with Conventional Radiography.

Time allotted: Theory: 160 hrs.
Demonstration: 40 hrs.

The anatomical relationships of bones, organs, blood vessels, nerves and muscles. The unit will address in turn the general anatomy of the head and neck including the brain, the thorax, the abdomen, the pelvis, the vertebral column and spinal cord, the upper and lower extremities and their associated articulations. Each topic will include consideration of osseous, muscular and vascular components, nerves and viscera. The related sectional anatomy in transverse, sagittal and coronal planes will be address utilizing contemporary 3D medical imaging.

☐ *Upper Limb:* relevant osteology; regional anatomy of the shoulder, axilla, arm, forearm, and wrist; detailed plain radiographic anatomy of skeletal mature and skeletal immature individuals; MRI of the glenohumeral joint.

☐ *Lower Limb:* relevant osteology; regional anatomy of the hip, thigh, leg and foot regions; detailed plain radiographic anatomy of skeletal mature and skeletal immature individuals; MRI of the hip and knee joints.

☐ *Head and Neck:* relevant osteology of the skull and cervical spine; regional anatomy of the mouth, nasal cavities, pharynx, and structures of the neck, brain and its blood supply; sectional anatomy of the head and neck; plain and contrast radiographic anatomy, computerised tomography and MRI of the head and neck.

☐ *Regional anatomy of the thorax:* relevant osteology; thoracic wall, lungs and pleura, and the mediastinum; sectional anatomy.

☐ *Imaging anatomy of the thorax:* plain radiographic anatomy; coronary arteriography, mammography; computerized tomography.

☐ *Regional anatomy of the abdomen:* relevant osteology, abdomen wall, peritoneum, supracolic and infracolic organs; retroperitoneum, sectional anatomy.

☐ *Regional anatomy of the pelvis and perineum:* pelvic wall, male pelvic organs, female pelvic organs, contents of the male and female perineum; sectional anatomy.

☐ *Imaging anatomy of the abdomen and pelvis:* plain radiographic anatomy; computerized tomography; angiography; contrast radiographic anatomy of the gastrointestinal tract, urinary tract, biliary tract and hysterosalpingogram.

☐ *Ultrasonic anatomy:* introduction to terminology; major organs and structures that can be imaged using ultrasound.

- *Age related Changes:* Introduction to ossification changes in the skeleton and the appearance in X-rays, Ultrasonography, CT.

- *Imaging features of Foreign Bodies:* Detection of foreign objects and substances in radiological examination. Radio-opaque drugs, poisons, other substances.

REFERENCE BOOKS

- Radiotraphic anatomy - Messchan
- Gray's anatomy
- Dean. Basic Anatomy and Physiology for Radiographers. Hamilton et al, Surface and Radiological Anatomy.

Paper VIII BMRT8

Radio-Diagnosis – I

1. CO1: Introduction to Radiographic procedures.
2. CO2: Knowledge about positioning terminology and positioning related to body cavities, bony thorax ,upper extremities ,shoulder girdle and lower extremities
3. CO3: Knowledge about conventional modalities with respect to recent advances in Radiography

Time allotted: Theory : 160 hrs.
Demonstration : 40 hrs.

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
7. Radiographic films, single coated, double coated films

8. Various stages of film processing
9. X-ray developer, fixer, replenisher
10. Dark room construction, dark room safe light, pass box
11. Fog in x-ray film
12. Automatic x-ray film processing
13. Practical aspects in radiography of children
14. Bed side radiography, High KV Radiography, soft tissue radiography
15. Digital radiography introduction.
16. Software used in digital X-ray storage, viewing and sharing.
17. Digital image enhancement in radiography.

II. (a) UPPER EXTREMITY

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

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

(b) LOWER EXTREMITY

Basic and 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, ilium, spectal 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, lumbar- lumbosaiccral vertebrae, lumbo sacral junction and scaro iliac joints, sacroiliac joints and coccyx.

(e) BONY THORAX

Techniques for sternum, sternoclavicular joints, Ribs, upper and lower.

(f) THORACIC VISCERA

Techniques for Trachea, and pulmonary apex, chest (lungs and heart).

(g) ANTERIOR PART 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, Panormic tomography of the mandible.

- 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

Paper IX BMRT9

Radiation Oncology –I

1. CO1: X-ray - production and properties , X-ray Technology – X-ray tubes, rectifiers, generators , transformers, KV and MV stabilizers ,timers
2. CO2: Principles of Diagnostic Radiology- Filters, Collimators and Grids
3. CO3: Effects of X-ray, Film construction and image production
4. CO4: Working of an Image Intensifier tube, Fluoroscopy
5. CO5: Physics of Mammographic Equipments
6. CO6: Computed Tomography – CT scanner, its generations, collimators, beam attenuation and its coefficients with Image Reconstruction Techniques with recent advancement in modalities.
7. CO7: Magnetic Resonance Imaging- Physics and Instrumentation of Magnetic Imaging

Time allotted: Theory : 160 hrs.
Demonstration : 40 hrs.

1. Cancer registry, Epidemiology and Prevention of cancer,
2. Oncopathology
3. Methods of cancer treatment
    1. Medical oncology
    2. Radiation oncology
    3. Surgical oncology
    4. Hormones in oncology

4. Radiobiological basis of Radiotherapy

    Radiobiology: Direct and indirect effect of radiation, cell survival curves, linear energy transfer (LET), oxygen effect, cell cycle, radio sensitivity of normal and tumor cells; Radiation response of various tumors, normal tissue tolerance, radio resistance, the 4 R's of radiotherapy, radiation dose and fractionation in radiotherapy, time-dose fractionation, therapeutic ratio, radiation response modifiers, radiobiological effects in radiosurgery.

5. Cancers of various sites
    - Skin cancers: squamous cell carcinoma, basal cell carcinoma, malignant melanoma, skin appendage tumors
    - Head and neck tumors: oral cavity, nasal cavity and para nasal sinuses, naso pharynx , oro pharynx, laryngo pharynx , larynx, salivary glands, ears
    - Thoracic tumors : lung, esophagus, thymus
    - Gastrointestinal tumors: stomach pancreas, liver, gall bladder, colon, rectum anal canal
    - Urological tumors: kidney, ureter, urinary bladder, urethra
    - Gynaecological cancer: uterus, ovary, cervix, vagina, vulva
    - Male genital tumors : prostrate, testis, penis
    - Breast Cancer

- Tumors of bone and soft tissue : osteo sarcoma, Ewing's tumor, fibro sarcoma,
- Lympho reticular tumors : Hodgkin's disease, non Hodgkin's lymphoma
- Hematological malignancies : Leukemia, multiple myloma
- CNS tumors : gliomas, meningioma, medullo blastoma
- Cancer in children : retino blastoma, Wilm's tumor, neuroblastoma, rhabdo myo sarcoma
- Endocrine tumors : thyroid, pituitary, adrenal
- Orbital and ocular tumors
- Metastasis of unknown primary site

Paper X BMRT10

Radiation Physics - I

1. CO1: X-ray - production and properties , X-ray Technology – X-ray tubes, rectifiers, generators , transformers, KV and MV stabilizers ,timers.
2. CO2: Principles of Diagnostic Radiology- Filters, Collimators and Grids
3. CO3: Effects of X-ray, Film construction and image production.
4. CO4: Working of an Image Intensifier tube, Fluoroscopy
5. CO5: Physics of Mammographic Equipments.
6. CO6: Computed Tomography – CT scanner, its generations, collimators, beam attenuation and its coefficients with Image Reconstruction Techniques with recent advancement in modalities.
7. CO7: Magnetic Resonance Imaging- Physics and Instrumentation of Magnetic imaging

SECTION: I

X-rays :

Production and properties – Continuous and characteristic x-rays-xray spectra- Intensity and Quality of X- rays- Hard and Soft x-rays- Heel effect.

SECTION : II

X-ray Technology -1

X-ray tubes: Diagnostic and therapy tubes, Gas tubes, Collidge tube- Rotating anode tube- Line focus tube voltage – Self rectifier circuit. Half wave rectifier circuit – Full wave rectifier circuit. – Dual focus tube – Hooded anode tube- other therapy tubes (qualitative study – x-ray generators of circuits- Auto transformer- Filament transformer- Rectification of anode

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- pre- reading KV meter- crystal spectrometer.

SECTION: III X-ray Technology 2

Timers:

Synchronous, Electronic, Ionization, Photo, MAS timers

- Pulse counting
- Rating factors controlling rating
- Use of rating charts

-Accelerators

SECTION: IV

Principles of Diagnostic Radiology:

Physical principles – Filters and Filtration – Inherent and Added Filtration – Heavy metal filter- Effect of filtration on low and high energy beams.

Collimators – Grids – grid characterists – Types of grids- Evaluation of grid performance – stroboscopic effect.

SECTION: V

Effects of X-rays

Fluorescence – Phosphorescence – Luminescence

X- ray Films:

Film construction – image production – Development – Fixation and Hardening-processing – Properties of X-ray films – Density characteristic curves – 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)

SECTION: VI

Images:

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 VII

New Imaging Techniques

a. Computerised Tomography

CT scanner – various generation of CT – Collimators, CT beam attenuation, linear attenuation coefficients, Hounsfield Unit, back-projection, filtered back-projection and Fourier transform. Computed tomography system components inherent in computer acquisition, processing and image display

b. Magnetic Resonance Imaging

Basic properties of the hydrogen nucleus, precession in a magnetic field (classical picture); Larmor equation; energy levels in a magnetic field; size of bulk magnetisation; effects of RF ("B1") fields; Rotating frame, free precession and signals (FIDs), principle of slice selection; importance of RF pulse profile, Gradients and 1-D profiles - frequency encoding; mention of projection-reconstruction imaging (not in detail); introduction to sequence timing diagrams.

SECTION VIII

:Special procedures

- Fluoroscopy – Tomography – Stereoscopy – Myelography – Mammography – Pelvimetry – xero radiography.

Paper XI BMRT11

Pathology, And Community Health.

CO1: Knowledge of general and systemic pathology.
CO2: Knowledge of pathology of neoplasms
CO3: Knowledge of basics of community health.

Total time allotted :100 hrs.

PATHOLOGY 60 hrs

- Disorders of circulation
  - Thrombosis
  - Embolism
  - Infarction
  - Oedema

- Mechanism and changes in inflammation
- Detailed study of tumours
  - Characteristics
  - CLASSIFICATION
  - Astiology & pathogenesis
  - All the common beningn and malignant turmors

- Common Infection
  - Common acute bacterial infection
  - Detailed study of tuberculosis, Leprosy, Syphilis
  - Commonest fungal infection with a short account of opportunistic fungal infection
  - Brief account of all viral infections including AIDS
  - Common protozoa and helminthes

- Detailed study of biological effects of radiation
- Regenerative changes

  Fatty change
  Necrosis
  Gangrene
  Pathogenic calcification
- Genetic diseases

  Down's syndrome

Haemophilia

- Immunology
  Auto immune diseases
  Rheumatoid arthritis
  SLE
  Immuno deficiency –AIDS
- Brief study of nutritional diseases
- Radiation and pregnancy

DISEASES OF INDIVIDUAL ORGAN SYSTEMS

1. CVS	- I H D - R H D - 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 - Appendicits - Peritonitis
4. Gall bladder	- Stones -Cholecystitis
5. Pancreas	- Pancreatitis - Stones - Diabetis mellitus
6. Male Reproductive system	- Hydrocoele - Orchitis & Epididynitis - Benign prostate hypertrophy - Brief mention of tumors
7. Female Reproductive system	- Cervicitis - Ca Cx - Ca Endometrium

- Disorders of Menstruation
- Lyomyoma
- Brief account of ovarian tumors
- Disease of pregnancy – PHT – Ectopic

8. Breast
- Fibro adenoma
- Ca breast

9. Blood
- Anaemias
- Leukaemia
- Bleeding disorders

10. Lymphoreticular Systems
- Lymphadenitis
- Lymphomas

11. Bones
- Congenital
- Osteomylitis
- Rickets osteomalacia
- Bone turmors
- Arthritis

12. Endocrine
- Thyroid
- Pituitary
- Adrenal
- Parathyroid

13. Brief account of eye and ear infection

14. Skin
- Psoriasis
- Eczema
- Skin tumors (Bassal, squamous
- Malignant Melanoma)

15. Kidney
- Stones
- Glomerulonephritis
- Pyelonephritis
- Renal failure
- Nephrotie syndrome
- Tumors

16. Foetus and Embryo
- Abortion
- Growth Retardation
- Congenital Malformations
- Cancers
-Intra Uterine Death

Reference:

- Robbins, Angell and Kumar, Basic Pathology, W.b. Saunders company, Philadelp-thia.

- Smith – La, Microbilogy and pathology, The C.V. Mosby Company, St. Louis.
- Morse, M.E., samer, M.L. & Godale, R.H. Microbiology and Pathology for Nurses, W.B. Saunders Company, Philadelphia.
- Govan, Mae Farlane & Callander – Pathology Illustrated, Churchill Livinstone – International Student edition, London, 1981

III. COMMUNITY MEDICINE (40 hrs)

[Recommended Text Book: Park's textbook of Preventive & Social Medicine by K.Park]

1) General concepts of health and disease with reference to
   Natural history of disease and levels of prevention
   Determinants of health
   Epidemiology and scope

2) Role of environment in health and disease

3) Communicable diseases - an overall view of communicable diseases classified according to principal mode of transmission.
   Non communicable diseases.
   National Health Programmes in relation to communicable and noncommunicable diseases.

4) Health problems of vulnerable groups- Pregnant and lactating women, infants and pre-school children, Geriatrics.

5) Family Planning, Objectives of National Family Planning Programmes and Family Planning methods. A general idea of advantages and disadvantages of the methods.

6) Occupational Health- Definition, Scope, Occupational diseases, Prevention of occupational disease and hazards with special emphasis on radiation hazards and protection.

7) Mental health – Community aspects of mental health and mental health as part of Primary Health Care.

8) Health care of community – Health care delivery system including relevance of Primary Health Care.

9) Public Health Administration- overall view of the health administration set up at different levels.

10) <u>International Health Agencies</u>

Park K. Park's Text Book of Preventive and Social Medicine (latest edn), Banarasidas Banot Publishers, Jabalpur.

Rao, Kasturi Sundar, An Introduction to Community health nursing, B.I. Publications, Chennai.

Park J.E. and Park K., Text Book of Community Health for Nurse, Assam Publicaitons, Jabalpore.

Ghosh B.N.A. Treatise in Hygience and Public Health.

Third Year - Paper XII BMRT12

Radiation Physics – II

1. CO1: Knowledge about Special Radiographic Investigations and Imaging
2. CO2: Radiographic Techniques for Imaging of Breast tissue
3. CO3: Knowledge to acquire cross sectional images utilizing Computed tomographic equipment,Patient care and clinical procedures and protocols and skills to diagnose pathologies with respect to other radiographic modalities
4. CO4: Knowledge to acquire cross sectional images utilizing Magnetic Resonance and skills to distinguish weighted images ,diagnose pathologies and to compare MR images with CT images.
5. CO5: Digital radiography- Knowledge about Digital Radiography with comparison with conventional modalities
6. CO6: Diagnostic ultrasound – Knowledge about physical principles with clinical applications

Time allotted: Theory : 180 hrs.
Demonstration : 40 hrs

Section I

RADIOTHERAPHY

Principles of Radiotherapy – High energy Machines – Co 60, Cs 137, LINAC source choice and design – Treatment head – shutter mechanism – Beam collimation and Penumbra Beam shaping devices – Beam modification – shielding – Beam flattening – Tissue compensators – Wedge Filters – Beam direction devices – Front and Back pointer.

Section II

Phantoms- Functions used in dose calculation – TAR – BSF – PDD – Isodose curve – Characteristics – Comparison of charts for beams of various energies.

Patient data acquisition – Body contours – Patient immobilization, Simulators – Treatment simulation – Treatment verification – 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

Radioactive sources used – Ra, Co, Cs, I, Ir, Au- 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 – Treatment of cancer of cervix Paterson – Parker and Paris technique (qualitative)- after loading applicators – manual –remote.

Section V

Nuclear Medicine

Radioisotopes used – measurement of sample activity – Detection of radioactivity in the body – simple collimator system – whole body counting – scanners- Gamma Cameras.

Radiopharmaceutical – Radionuclides – Types of radiations used – Biological, Physical and Effective half life – Specific activity – Thyroid uptake – Plasma volume – elusion.

Positron emission Tomography – brief

Single Photon Emission Computerised Tomography – brief.

Section VII

Radiobiology

Biological effects of Radiation – Types of tumors – Tumor lethal dose – Tissue Tolerance dose – Therapeutic ratio – Effects of Radiation on cell cycle – Target theory (Brief) – Cell survival cure- Response to radiation – Lethal dose- LD50 – Oxygen Effect- Oxygen Enhancement Ratio – RBE – LET – QF- Fractionation – NSD, TDF, CRF

Section VIII

New Imaging modalities

Ultrasonography

Characteristics of ultrasound beam and propagation in human tissue. Basic principles of ultrasound imaging equipment – interaction of ultrasound energy and tissue – modes of ultra – sound imaging – probes, transducers and Ultrasound beam shapes- B-Mode, real time, gray scale – Ultrasound imaging systems- Doppler Ultrasound – Care of instrument.

Paper XIII BMRT13

Radio Diagnosis – II

1. CO1: Basic Principles of Radiotherapy ,Knowledge about Heavy Energy Machines- Coblat-60,LINAC Treatment of Cancer with Ionizing Radiation, knowledge about dose calculations,
2. CO2: Devices used for patient immobilisations, Skills in Treatment Stimulation and Verifications, Knowledge about workflow for planning and delivery of Radiation Therapy Treatments.
3. CO3: Brachytherapy – Knowledge of Sources , different treatment techniques
4. CO4: Ultrasonography – Basic principles of ultrasound imaging equipment
5. CO5: Knowledge about interaction of ultrasound energy with tissue

6. CO6: Different modes of ultrasound, Basics of Doppler Ultrasound
7. CO7: Radiobiology – Biological effects of Radiation on tumor cells & cell cycle

Time allotted: Theory : 180 hrs.
Demonstration : 40 hrs.

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.

- CNS:

  Radiological Anatomy, Cerebral angiography. Patient preparation. Examination procedure and Radiographic techniques.

  Myelography
  Ventriculography and Encephalography
  Discography

  (a) Digestive System:

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

  - Biliary system:

    Radiological Anatomy, and Radiological procedures. Oral cholecystography, Intra venous chole cyctangiography, cholangiography, operative, post operative, percutaneous and ERCP.

  1.1 Urinary system:

  Radiological Anatomy, contrast media used in urography.Excreting urography, Retrograde urography, Retrograde cystography, Female cysto urethrography, male cysto urethrography.

  1.2 Reproductive system:

  Radiological Anatomy, Contrast media used in HSG Hysterosalpingography, Radiographic pelvimetry and cephalometry; vesiculography, localization of IUCD.

  1.3 Circulatory System:

  Diagnostic visceral and peripheral angiography

  1.4 Cardiovascular system:

  Cardiographic angiography, cathereization methods and Techniques, catheterization studies and procedures.

  1.5 Sialography – Parotid, sub maxillary and sub linqual
  1.6 Broncography – Oral and Crico – thyroid
  1.7 Dacto cystography – Lacrimal ducts

II.

1. Mamography : Film – mammography, Film- screen mammography, Xero mammography, Techniques.

2. Computed tomography – CT imaging protocols for the head, neck, thorax, spine, abdomen, pelvis, and musculoskeletal system. These include procedure indications, patient education, preparation, orientation and positioning, patient history and assessment, contrast media usage, scout image, selectable scan parameters, and filming and archiving of the images.

- Magnetic Resonance Imaging : Overview of MRI system; magnets - types, field strength, homogeneity, stability, shimming, fringe field and shielding; gradient coils - geometry, amplitudes and rise-times; eddy-currents; pre-emphasis; shielded gradient sets

  Image contrast - proton density; TE and T2-weighting; TR and T1-weighting; inversion-recovery sequences; examples of sequence parameters used clinically; Factors affecting SNR in MRI - gamma, B0, spin density, temperature, coil design, pixel size, no of acquisitions, bandwidth, sources of noise; signal sampling; gradient strength and resolution; line width broadening; chemical shift artifact

4. Digital radiography – Digital angiography – Digital subtraction angiography.

1. Dignostic ultrasound – physical principles, clinical applications, Ultrasound colour Doppler techniques.

- Nuclear medicine – clinical nuclear medicine
- Position emission tomography – principles, clinical studies
- Macroradiogrophy
- Stereography
- MMR or flurography
- Cine radiography
- Fluroscopy
- Image intensifier
- Kymography
- Subtraction radiography
- Indirect Radiography
- Pulsed radiography

III. Quality control of diagnostic X-ray machines, acceptance tests. Description and functioning of various QA and acceptance testing Devices – KVp meter, KVp cassettes, mA and mAS measuring systems, resolution device, focal spot and field congruence test tools, cassette test device, spinning top, use of Pocket Dosimeters for QA etc.

Paper XIV BMRT14

Radiation Oncology – II

1. CO1: Clinical Implementation of Technology- Imaging for Radiation Therapy planning: CT, MRI, PET, Ultrasound, Role of Simulators: Virtual simulation, Conventional simulator Knowledge about Patient Immobilization and support devices Mould room techniques, Treatment Techniques.
2. CO2: Computerized Radiation Treatment Planning: 2D, 3D conformal.
3. CO3: Treatment verification: Portal Imaging, Portal radiography
4. CO4: Special Techniques in Radiotherapy: Intensity Modulated Radiation Therapy (IMRT), Stereoradiosurgery (SRS, SRT), Intraoperative radiotherapy (IORT), Tomotherapy, Image Guided Radiotherapy (IGRT), Total Body Irradiation with Photon beams, Total Skin Electron Therapy ,Brachytherapy,Cyberknife

Time allotted: Theory : 180 hrs.
Demonstration : 40 hrs.

1. Radiation Oncology: Overview

2. **Clinical Implementation of Technology:**
   - Imaging for Radiation Therapy planning: CT, MRI, PET, Ultrasound
   - Simulators: Virtual simulation, Conventional simulator
   - Patient Immobilization and support devices; Mould room techniques
   - Treatment Techniques: External Beam Radiation Therapy:
     CNS
     Head and Neck
     Breast
     Lung, Esophagus
     Liver, Pancreas, Bladder, Rectum
     Cervix, Uterus, Vagina, Vulva, ovary
     Prostate, Testes
     Lymphomas
     Sarcomas
     Bone
   - Radiation Reaction: Radiation tolerance of various organs and tissues, acute radiation reaction and its management, delayed radiation reactions, long term effects of radiation, complications of radiation therapy in children, patient follow up

3. **Computerized Radiation Treatment Planning**: 2D, 3D conformal.

   - Treatment verification: Portal Imaging, Portal radiography

   - Special Techniques in Radiotherapy: Intensity Modulated Radiation Therapy (IMRT), Stereoradiosurgery (SRS, SRT), Intraoperative radiotherapy (IORT), Tomotherapy, Image Guided Radiotherapy (IGRT), Total Body Irradiation with Photon beams, Total Skin Electron Therapy

   Particulate beam therapy: protons, neutrons, heavy ions, neutron capture therapy
   Hyperthermia, Photodynamic therapy

5. Brachytherapy:
   Radio nuclides used in Brachytherapy, Brachytherapy sources, manual brachytherapy, remote afteroading brachytherapy, LDR, MDR, HDR and, PDR; intracavitary, interstitial, intraluminal, intravascular and surface applications, intraoperative brachytherapy

6. Quality Assurance in Radiation Therapy

Periodic Quality Assurance Checks

1. Light field vs digital
2. ODIi vs MDI
3. Laser alignment
4. MLC QA (optical)
5. Rotation check for isocentre
6. Light field vs radiation field
7. Beam quality (j20/j10)

7. Mould room techniques

Patient positioning in Radiotherapy

Immobilization and Beam defining devices

Plaster of Paris mould (POP), Thermoplastic mould, Acrylic mould, Vacuum immobilization cushion & Stereo tactic radiotherapy

Beam modifying devices, Tissue compensators, Conformal/secondary beam shaping block, Surface mould Brach therapy, Special Procedures Intra-oral prosthesis, corneal shield for electron therapy, Build up glove with lead shield for protection of nail bed, Bolus material, Jig for treatment of penile cancers.

8. Computer Networking and Information System in Radiation Oncology Networks:

1. Hardware: Servers, workstation, peripherals
2. Software: Servers, clients
3. Topology: Bus, Star, Ring, Fiber distributed data interface
4. Communication protocol, connectors, network infrastructure

Information System

- Over view of hospital information system
- Integration of radiation oncology systems to HIS
- DICOM and DICOM RT
- DICOM conformance
- PACS

Paper XV BMRT15

Nuclear Medicine and Radiation Safety

1. CO1: Nuclear Medicine Instrumentation
2. CO2: Knowledge about Radiopharmateuticals and Radioisotopes used.
3. CO3: Physics of Positron Emission Tomography and Single Photon Emission Tomography
4. CO4: Radiation Safety – Knowledge about Radiation Units, Instruments used for Radiation Detection & Personal Monitoring Devices Knowledge about Radiation Hazards ,protection and regulations

Time allotted: Theory : 180 hrs.
Demonstration : 40 hrs

Radio pharmacy and Chemistry for Nuclear Medicine

Integrated survey of radio pharmacy and chemistry essential to nuclear medicine procedures. Explanation of technical skills with practical examples in preparation for clinical practice. Includes design and function of radionuclide generator, radiopharmaceutical kit preparation, and chemical principles including chemical bonding, calculation of eluant, isotopic labeling, and disposal of nuclear waste and radiation emergency procedures in event of a spill.

Nuclear Medicine Instrumentation

Variety of equipment and methods employed in radiation detection, measurement, and diagnostic imaging. Practical considerations along with concepts of data analysis, measurement concerns, and spectroscopy. Topics include gas-filed detectors, basic scintillation systems and spectroscopy, imaging systems – both stationary and tomographic – including hardware, software and accessories, and quality control.

Nuclear Medicine Procedures

Methods of performing patient organ visualization procedures in Nuclear Medicine. Review of anatomy, physiology and pathology of various organs, radiopharmaceuticals, applicable instrumentation, methodologies, and techniques utilized. Therapeutic and in vivo clinical procedures, including radiation safety techniques, patient care, and patient preparation for nuclear studies. Imaging studies include lung ventilation, perfusion, cardiac procedures, indications, renal studies, GI bleeding, Meckel's diverticulum, thyroid studies, brain scans and bone scans.

Radiation Protection and Safety

Safe handling of radioactive materials and disposal of radioactive waste. Radiation safety regulations and safety guidelines including personnel monitoring and accurate record keeping.

Part II - Radiation Safety

Units – Roentgen, Rad, Gy, REM, Sievert – Biological Effects of Radiation Exposure – somatic, genetic, acute chronic, stochastic and deterministic effects.
Radiation Detection Instruments
Ionization chamber - Proportional counter – G M Counter – Scintillation counter – Thermo-luminiscent Dosimeter – Film. Solid state detectors – Chemical Dosimeters

Radiation exposure control – Critical organs and tissues – Quantities used in Radiological protection – Radiation weighing factors – equivalent dose – Tissue weighing factors – Effective dose.
Time, distance and shielding calculations, primary and secondary protective barriers, radiological protection survey. Patient Exposures in Diagnostic Radiology,
- Radiation monitoring instruments – Pocket dosimeters, film badges, TLD, area monitoring instruments, survey monitors.
Radiation hazards – evaluation and control – Radiation emergencies – medical management of personnel exposed to ICRP Recommendations (Brief) – Operational Units – Current codes of practice for protection of radiation workers an public against ionizing radiation arising from medical and dental use. AERBN safety codes – National regulatory requirements.
Radiation protection measures in the departments of Radiology, Radiotherapy and Nuclear Medicine.

Radiation protection standards and regulations; need for protection, philosophy of radiation protection, basic radiation protection criteria, external and internal exposure, additive risk model and multiplicative risk model, risk coefficients, dose to the fetus, dose limits to occupational exposure, for public and special exposure situations, ICRP and AERB recommendations, basic safety standards, source, practices, types of exposure, interventions.

Administrative and legislative aspects of radiation protection – Historical background of legislation in the atomic energy field – Need for control of radiation exposure at national and international levels – National control through acts with supporting regulation at central and state levels – International control through specialized agencies – Third party liability and insurance in the atomic energy fields.

Atomic energy act, radiation protection rules, notifications, transport regulations, waste disposal rules, licensing, approval of devices, Installations, sites and packages containing radioactive material.

Radiation protection measures in the departments of Radio-diagnosis, Radiotherapy and Nuclear Medicine. Radiation Hazards in brachytherapy and teletherapy departments. Handling of patients, radiation safety during source transfer operation, special safety consideration for Linear accelerator installations, – Minimizing radiation exposures by adopting different techniques

Fourth Year

Clinical postings in the departments of radiation oncology and radio diagnosis of the Amrita Medical Institutions and other participating Medical Institutions. The **project work** will proceed along with the clinical posting.

PATTERN OF QUESTION PAPERS

Paper I
The duration of this theory paper will be three hours; the paper will have one section of 70 marks.

Pattern of Question Paper

Structured Essay (2 out of 2)	- 30 marks (2 x 15 marks)
Short Notes (5 out of 7)	- 25 marks (5 x 5 marks)
Short answer question (5 out of 7)	- 15 marks (5 x 3 marks)
Total Marks	- 70 marks

Paper II
The duration of this theory paper will be three hours; the paper will have two sections. 40 marks for Section A & 30 marks for Section B and a total of 70 marks.

Pattern of Question Paper

Section A

Structured Essay	- 10 marks
Short Notes (3 out of 4)	- 15 marks (3 x 5 marks)
Short answer question (5 out of 7)	- 15 marks (5 x 3 marks)
Total Marks	- 40 marks

Section B

Structured Essay	- 10 marks
Short Notes (2 out of 3)	- 10 marks (2 x 5 marks)
Short answer question (5 out of 7)	- 10 marks (5 x 2 marks)
Total Marks	- 30 marks

Paper III, IV, V and VII to X
The duration of each theory paper will be three hours; the paper will have only one section of 100 marks.

Pattern of Question Paper

Structured Essay (4 out of 4)	- 40 marks (4 x 10 marks)

Short Notes (6 out of 8) - 30 marks (6 x 5 marks)
Short answer question (10 out of 12) - 30 marks (10 x 3 marks)

Total Marks - 100 marks

Paper VI

The duration of this theory paper will be two hours; the paper will have one section of 50 marks.

Pattern of Question Paper

Structured Essay (2 out of 2) - 20 marks (2 x 10 marks)
Short Notes (3 out of 4) - 15 marks (3 x 5 marks)
Short answer question (5 out of 7) - 15 marks (5 x 3 marks)

Total Marks - 50 marks

Paper XI

The duration of this theory paper will be three hours; the paper will have two sections. 50 marks for Section A & 50 marks for Section B and a total of 100 marks.

Pattern of Question Paper

Section A

Structured Essay (2 out of 2) - 20 marks (2 x 10 marks)
Short Notes (3 out of 4) - 15 marks (3 x 5 marks)
Short answer question (5 out of 7) - 15 marks (5 x 3 marks)

Total Marks - 50 marks

Section B

Structured Essay (2 out of 2) - 20 marks (2 x 10 marks)
Short Notes (3 out of 4) - 15 marks (3 x 5 marks)
Short answer question (5 out of 7) - 15 marks (5 x 3 marks)

Total Marks - 50 marks

Paper XII to XV

The duration of each theory paper will be three hours; the paper will have only one section of 80 marks.

Pattern of Question Paper

Structured Essay (3 out of 3) - 30 marks (3 x 10 marks)
Short Notes (4 out of 6) - 20 marks (4 x 5 marks)
Short answer question (10 out of 12) - 30 marks (10 x 3 marks)

Total Marks - 80 marks

SCHEME OF EXAMIANTION

Paper No	Subject	Theory		Practical		Project	Total	Grand Total
		External	Internal	External	Internal			
FIRST YEAR								
Paper I	Anatomy & Histology	70	20					
Paper II	Physiology and Biochemistry	70	20					
Paper III	Basic Radiation Physics	100	20					
Paper IV	Atomic & Nuclear Physics	100	20				610	
Paper V	Mathematics and Computer Applications	100	20					
Paper VI	General Psychology	50	20					
SECOND YEAR								
Paper VII	Regional and Imaging Anatomy	100	20					
Paper VIII	Radio-diagnosis I	100	20					
Paper IX	Radiation Oncology I	100	20				600	
Paper X	Radiation Physics I	100	20					2010
Paper XI	Pathology & Community Health	100	20					
THIRD YEAR								
Paper XII	Radiation Physics II	80	20					
Paper XIII	Radio-diagnosis II	80	20					
Paper XIV	Radiation Oncology II	80	20				400	
Paper XV	Nuclear Medicine and Radiation Safety	80	20					
FOURTH YEAR								
	Radio-diagnosis (Practical – 50, Viva – 25)			75	75	100	400	
	Radiation Oncology (Practical – 50, Viva – 25)			75	75			

IMPORTANT TELEPHONE NUMBERS

Amrita Institute of Medical Sciences	: 0484-2801234/2851234
Principal's Office	: 0484-2858131/2858131
Chief Programme Administrator	: +91 7034028019, Oncall: 1919
Programme Co-ordinator	: +91 7034028118, Oncall: 6976