School of Health Sciences

CSJM University, Kanpur

Ordinance & Syllabus

for

Bachelor in Medical Radiology & Imaging Technology (BMRIT)

Academic Programme

Ordinance according to NEP-2020

Duration :

3 Years (06 Semesters) & 01 Year (02 Semesters) Internship

Bachelor in Medical Radiology & Imaging Technology (BMRIT)

ORDINANCE
Chapter
"A"

Preamble:

Bachelor in Medical Radiology & Imaging Technology is the health profession concerned with the direct administration of radiation, primarily X-rays, in disease diagnosis and injury assessment and treatment. From the humble beginnings of plain film techniques, we are now with a wide array of imaging methods using Conventional and Digital X-rays, ultrasound, magnetic resonance and Radionuclides. Modern diagnostic radiography and Medical Imaging forms an integral part of medical practice, both in making diagnosis and also in treatment. The term "diagnostic radiography" is used to describe a variety of radiographic or x-ray examinations. These simple procedures as well as those which require the use of contrast agents, make it possible to study organs that otherwise cannot be seen. These professionals are at the heart of modern medicine.

Diagnostic radiographers employ a range of different imaging techniques and sophisticated equipment to produce high-quality images of an injury or disease. They take the images using range of techniques including X-rays, Mammography, Fluoroscopy, CT (computed tomography), MRI (magnetic resonance imaging), Nuclear medicine, Angiography etc. Medical imaging studies have been a cornerstone in medical diagnosis for decades; however, technological advances and the addition of new imaging modalities now place medical imaging among the most dynamic, expanding, and high-demand fields in clinical medicine.

Radiology is a branch of medicine that uses radiation and imaging technology to diagnose and treat disease. It allows the Radiology technologist to produce images of various internal parts of the body, to aid in the detection of injury or disease by using radiation. Radiology is central to the clinical practice of medicine across a wide range of disciplines. It is the best practical way to diagnose, monitor treatment, and detect the progression or relapse of many important and common diseases in a minimally invasive and anatomically precise manner. As a consequence of the increasing sophistication and accuracy of clinical imaging, the utilization and importance of radiology have increased dramatically and consistently over the last 20 years. In recent years, the increasing complexity of Radiology procedures has made Radiology and Imaging technology a highly specialized and sophisticated science requiring competently trained personnel to maintain a high degree of accuracy in radiographic positioning and exposure technique. A qualified Medical Imaging Technologist is skilled in both interventional and Diagnostic Radiology.

Title of the Programme: The Programme shall be called "Bachelor in Medical Radiology & Imaging Technology".

Objectives of the Programme:

At the completion of this course, the student should –

1. Carry out all diagnostic procedures.
2. Use the necessary laboratory services in a modest manner.
3. Manage a wide range of clinical diagnostic techniques.
4. Demonstrate proficiency with latest medical imaging equipment.
5. Develop leadership qualities in order to lead effectively in a laboratory setting.
6. Provide laboratory services as well as excellent communication with doctors and hospital management.
7. To improve knowledge and skills in data processing, reporting, and record keeping, as well as laboratory investigations.
8. Mammography, CT scans, and MRI procedures should be performed independently.
9. Assist in the performance of specific Radiologyal procedures.
10. Capable of image processing
11. Must be capable of operating all Radiologyal and imaging equipment on their own.
12. It is necessary to assure radiation safety and quality assurance.

13. Maintain and care for all Radiologyal and imaging equipment.
14. Able to recognise and manage emergency circumstances. g. Able to analyse photos for technical quality.
15. Able to take verbal, written, and electronic orders and enter them in the patient's medical record.
16. Computer skills are required.
17. Should be able to deliver professional patient care with empathy.
18. Demonstrate professional progress, professionalism, and an eagerness to learn.
19. Capable of demonstrating the key principles of compassion, integrity, and exploration.
20. Demonstrate a genuine interest, initiative, and drive in the Department's overall development as well as 'Leadership Qualities' for others to emulate.
21. He or she is expected to be self-assured and to carry out all responsibilities with utmost sincerity and honesty.

Programme Outcomes:

1. The graduate will be a competent and reflective radio-imaging technician who can function safely and effectively while adhering to legal, ethical and professional standards of practice in a multitude of radio-imaging settings for patients and clients across the lifespan and along the continuum of care.
2. The graduate will utilize critical inquiry and evidence-based practice to make clinical decisions essential for autonomous practice.
3. The graduate will function as an active member of professional and community organizations. The graduate will be a service-oriented advocate dedicated to the promotion and improvement of community health.
4. The graduate will demonstrate a lifelong commitment to learning and professional development.

Programme Specific Outcomes:

1. Understand and apply principles of X-ray, CT, MRI, ultrasound, and nuclear medicine for accurate diagnosis.
2. Acquire proficiency in performing patient positioning, exposure techniques, and image acquisition protocols.
3. Apply ALARA principles to minimize radiation exposure for patients and staff, adhering to regulatory standards.
4. Deliver patient-centered care, respecting ethical standards, patient privacy, and informed consent.
5. Use comprehensive knowledge of anatomy and pathology to identify and report on abnormal findings in imaging studies.
6. Utilize and adapt to digital imaging technologies and PACS for efficient data management.
7. Implement and monitor quality control measures for imaging procedures and equipment to maintain high diagnostic standards.
8. Collaborate effectively with healthcare professionals, sharing imaging insights for integrated patient care.
9. Apply research principles to imaging studies and stay updated on advancements in radiology and imaging practices.
10. Demonstrate critical thinking and problem-solving skills in addressing imaging challenges and patient care scenarios.

Bachelor in Medical Radiology & Imaging Technology (BMRIT)

1. Bachelor in Medical Radiology & Imaging Technology degree will be under the **faculty of Medicine** of C.S.J.M. University, Kanpur.

2. **Duration of Course :**
   - Bachelor in Medical Radiology & Imaging Technology will be a full-time course.
   - Duration will be three years (06 Semesters) followed by a compulsory 01 Year (02 Semester) internship.

3. **No. of Seats :**
   40 (forty)

4. **Admission.**

   Eligibility Criteria:
   For admission in this course candidate has to pass 10 + 2 or its equivalent examination in Science (Biology) conducted by any Board or University incorporated by law and recognized by this University with a minimum of 45% marks in aggregate in Physics, Chemistry & Biology (relaxation of 5% marks for SC/ST student).

   Mode of Admission:
   The candidates for admission to this course shall be selected through an entrance test conducted by the University/ procedure decided by the governing body of the institute or on the basis of merit of marks obtained (Physics, Chemistry & Biology) in 10 + 2 or its equivalent examination.

5. **Medium of instruction :**
   English shall be the medium of instruction in the class and in the University examination.

6. **Method of Teaching :**
   The method of teaching adopted shall be a combination of lectures, demonstrations and practicals by the full time faculty, visiting or part time or guest faculty.

7. **Examination:**
   As per the University norms.

   Duration of Examination:
   Each theory paper shall be of three-hours duration OR as per the University norms.

8. **Attendance to appear in the end semester examination :**
   The permission to appear in end semester examination shall be granted to such candidate only who have fulfill the condition of 75% attendance in each subject separately in theory and practical as per the university rule.
   Regarding attendance requirements students will have to fulfill the condition of 75% attendance. 15% relaxation in attendance, in exceptional circumstances can be made by the Vice Chancellor on the recommendation of the Director of the School.

CHHATRAPATI SHAHU JI MAHARAJ UNIVERSITY, KANPUR

STRUCTURE OF SYLLABUS FOR THE

PROGRAM: Bachelor in Medical Radiology & Imaging Technology (BMRIT)

Syllabus Developed by			
Name of BoS Convenors / BoS Members	**Designation**	**Department**	**College/University**
Prof. Sanjay Kala	Principal	Dean, Faculty of Medicine	GSVM. Medical College, Kanpur
Prof. Dolly Rastogi	Professor	Physiology	GSVM Medical College, Kanpur
Prof. Parvez Khan	Head	Ophthalmology	GSVM Medical College, Kanpur
Prof. Sanjay Kumar	Head	Orthopaedics	GSVM Medical College, Kanpur
Prof. MP Mishra	Ex. Director	JK Cancer Institute	GSVM Medical College, Kanpur
Dr. Chayanika Kala	Associate Professor	Pathology	GSVM Medical College, Kanpur
Dr. Ashok Verma	Head & Associate Professor	Radiology	GSVM Medical College, Kanpur
Dr. Digvijay Sharma	Director	School of Health Sciences	CSJM University, Kanpur
Dr. Munish Rastogi	Assistant Director	School of Health Sciences	CSJM University, Kanpur
Dr. Versha Prasad	Assistant Professor	School of Health Sciences	CSJM University, Kanpur
Dr. Ram Kishore	Assistant Professor	School of Health Sciences	CSJM University, Kanpur

I YEAR / I SEM						
COURSE CODE	**TYPE**	**COURSE TITLE**	**CREDITS**	**CIA**	**ESE**	**MAX. MARKS**
BRT25101	CORE	Human Anatomy-I	04	25	75	100
BRT25102	CORE	Human Physiology-I	04	25	75	100
BRT25103	CORE	Clinical Biochemistry	04	25	75	100
BRT25104	CORE	Fundamental of Medical Imaging & Radiotherapy	04	25	75	100
BRT25105	PRACTICAL	Human Anatomy-I	02	25	75	100
BRT25106	PRACTICAL	Human Physiology-I	02	25	75	100
BRT25107	PRACTICAL	Fundamental of Medical Imaging & Radiotherapy	02	25	75	100
		Basics Computer and Information Sciences*	02	-	-	-
		Communication and Soft Skills*	02	-	-	-
		TOTAL	**26**			**700**
I YEAR / II SEM						
BRT25201	CORE	Human Anatomy-II	04	25	75	100
BRT25202	CORE	Human Physiology-II	04	25	75	100
BRT25203	CORE	Basic Radiation Physics	04	25	75	100
BRT25204	CORE	Preventive Medicine & Radiation Protection	04	25	75	100
BRT25205	PRACTICAL	Human Anatomy-II	02	25	75	100
BRT25206	PRACTICAL	Human Physiology-II	02	25	75	100
		TOTAL	**20**			**600**

II YEAR / III SEM						
COURSE CODE	**TYPE**	**COURSE TITLE**	**CREDITS**	**CIA**	**ESE**	**MAX. MARKS**
BRT25301	CORE	Advanced Radiographic Techniques	04	25	75	100
BRT25302	CORE	Special Radiographic Techniques & Procedures	04	25	75	100
BRT25303	CORE	General Pathology	04	25	75	100
BRT25304	CORE	General Microbiology	04	25	75	100
BRT25305	PRACTICAL	Advanced Radiographic Techniques	02	25	75	100
BRT25306	PRACTICAL	Special Radiographic Techniques & Procedures	02	25	75	100
BRT25307	PRACTICAL	General Pathology	02	25	75	100
	TOTAL		**22**			**700**
II YEAR / IV SEM						
BRT25401	CORE	Radiation Physics & Radiation Protection	04	25	75	100
BRT25402	CORE	Research Methodology & Biostatistics	04	25	75	100
BRT25403	CORE	Pharmacology	04	25	75	100
BRT25404	PRACTICAL	Clinical work	04	-	-	100
	TOTAL		**16**			**400**

III YEAR / V SEM						
COURSE CODE	**TYPE**	**COURSE TITLE**	**CREDITS**	**CIA**	**ESE**	**MAX. MARKS**
BRT25501	CORE	Newer Imaging Modalities and Application	04	25	75	100
BRT25502	CORE	Equipment's of Radio Diagnosis	04	25	75	100
BRT25503	ELECTIVE	Interventional Radiology & drugs used in diagnostic Radiology	04	25	75	100
BYOG 101		Foundations of Yoga				
BRT25504	PRACTICAL	Newer Imaging Modalities and Application	02	25	75	100
BRT25505	PRACTICAL	Equipment's of Radio Diagnosis	02	25	75	100
BRT25506	PRACTICAL	Clinical work	04	-	-	100
	TOTAL		**20**			**600**
III YEAR / VI SEM						
BRT25601	CORE	Radiotherapy & Brachytherapy techniques in Malignant and Non-Malignant diseases	04	25	75	100
BRT25602	CORE	Modern Radiological equipment including physics	04	25	75	100
BRT25603	CORE	Orientation in Clinical Sciences	04	25	75	100
BRT25604	PRACTICAL	Clinical work	04	-	-	100
	TOTAL		**16**			**400**
	Grand Total		**120**			**3400**

*** Not Included in University Exam**

NOTE:

1. **Do not mark any Code/Information in Column-A, it will be endorsed by the University.**
2. **CIA** in Column-E stands for **'Continuous Internal Assessment'** and depicts the maximum internal marks. Respective examination will be conducted by subject teacher. **ESE** in Column F stands for **'End Sem Examination/Evaluation'** and depicts the maximum external marks. Respective examination will be conducted by the University.
3. Column-B defines the nature of course/paper. The word **CORE** herein stands for **Compulsory Subject Paper**.
4. Column-D depicts the credits assigned for the corresponding course/paper.
5. **Elective:** It will be a Subject Elective. Students may accordingly select one or more subject papers under this category.
6. **Amongst the electives, one or two electives may be declared as Open (Generic) electives that shall be open as Minor Elective to students of other faculty in 1st or 2nd semester of a UG program.**

INTERNAL ASSESSMENT

- It will be for theory and practical both.
- It will be done through the whole semester.
- Candidate must obtain at least 40% marks in theory and practical's separately in internal assessment to be eligible for the semester university examination.

- **Internal assessment (Theory)** will be done as follows:

a)	Mid-term/ class test etc.	= 10 marks
b)	Assignments/Project/Quiz/ Presentations etc.	= 10 marks
c)	Attendance	= 05 marks
	Total	**= 25 marks**

- **Internal assessment (Practical)** will be done as follows:

a)	Laboratory Manual/Assignments/Class test etc.	= 10 marks
b)	Day to day performance/continuous evaluation/record etc.	= 10 marks
c)	Attendance	= 05 marks
	Total	**= 25 marks**

CRITERIA FOR PASSING

- As per the University Norms.

DIVISION:

- As per the University Norms.

INTERNSHIP

- A candidate will have to undergo internship for a period of one year in a medical college/hospital equipped with modern radiological facility, which fulfills the norms decided by the University.

DEGREE:

The degree of Bachelor in Medical Radiology & Imaging Technology (BMRIT) course of the University shall be conferred on the candidates, who have pursued the prescribed course of study for not less than six semesters and have passed examinations as prescribed under the relevant scheme and completed 01 year of compulsory internship.

Course of Study

Bachelor in Medical Radiology & Imaging Technology (First Semester)

S.N.	COURSE CODE	TYPE	COURSE TITLE	Teaching Hours
1.	BRT25101	CORE	Human Anatomy-I	60
2.	BRT25102	CORE	Human Physiology-I	60
3.	BRT25103	CORE	Clinical Biochemistry	60
4.	BRT25104	CORE	Fundamental of Medical Imaging & Radiotherapy	60
5.	BRT25105	PRACTICAL	Human Anatomy-I	60
6.	BRT25106	PRACTICAL	Human Physiology-I	60
7.	BRT25107	PRACTICAL	Fundamental of Medical Imaging & Radiotherapy	60
			Basics Computer and Information Sciences*	40
			Communication and Soft Skills*	40
		TOTAL		**500**

Bachelor in Medical Radiology & Imaging Technology (Second Semester)

S.N.	COURSE CODE	TYPE	COURSE TITLE	Teaching Hours
1.	BRT25201	CORE	Human Anatomy-II	60
2.	BRT25202	CORE	Human Physiology-II	60
3.	BRT25203	CORE	Basic Radiation Physics	60
4.	BRT25204	CORE	Preventive Medicine & Radiation Protection	60
5.	BRT25205	PRACTICAL	Human Anatomy-II	60
6.	BRT25206	PRACTICAL	Human Physiology-II	60
		TOTAL		**360**

Bachelor in Medical Radiology & Imaging Technology (Third Semester)

S.N.	COURSE CODE	TYPE	COURSE TITLE	Teaching Hours
1.	BRT25301	CORE	Advanced Radiographic Techniques	60
2.	BRT25302	CORE	Special Radiographic Techniques & Procedures	60
3.	BRT25303	CORE	General Pathology	60
4.	BRT25304	CORE	General Microbiology	60
5.	BRT25305	PRACTICAL	Advanced Radiographic Techniques	60
6.	BRT25306	PRACTICAL	Special Radiographic Techniques & Procedures	60
7.	BRT25307	PRACTICAL	General Pathology	60
		TOTAL		**420**

Bachelor in Medical Radiology & Imaging Technology (Forth Semester)

S.N.	COURSE CODE	TYPE	COURSE TITLE	Teaching Hours
1.	BRT25401	CORE	Radiation Physics & Radiation Protection	60
2.	BRT25402	CORE	Research Methodology & Biostatistics	60
3.	BRT25403	CORE	Pharmacology	60
4.	BRT25404	PRACTICAL	Clinical work	60
		TOTAL		**240**

Bachelor in Medical Radiology & Imaging Technology (Fifth Semester)

S.N.	COURSE CODE	TYPE	COURSE TITLE	Teaching Hours
1.	BRT25501	CORE	Newer Imaging Modalities and Application	60
2.	BRT25502	CORE	Equipment's of Radio Diagnosis	60
3.	BRT25503	ELECTIVE	Interventional Radiology & drugs used in diagnostic Radiology	60
4.	BYOG 101		Foundations of Yoga	
5.	BRT25504	PRACTICAL	Newer Imaging Modalities and Application	60
6.	BRT25505	PRACTICAL	Equipment's of Radio Diagnosis	60
7.	BRT25506	PRACTICAL	Clinical work	120
		TOTAL		**420**

Bachelor in Medical Radiology & Imaging Technology (Sixth Semester)

S.N.	COURSE CODE	TYPE	COURSE TITLE	Teaching Hours
1.	BRT25601	CORE	Radiotherapy & Brachytherapy techniques in Malignant and Non-Malignant diseases	60
2.	BRT25602	CORE	Modern Radiological equipment including physics	60
3.	BRT25603	CORE	Orientation in Clinical Sciences	60
4.	BRT25604	PRACTICAL	Clinical work	120
		TOTAL		**300**

*** Not Included in University Exam**

INTERNSHIP

- There shall be one year (Two Semester) of Internship after the final year examination for candidates declared to have passed the examination in all the subjects.
- During the internship candidate shall have to work full time average 7 hours per day (each working day) for one year.
- Each candidate is allowed maximum of 6 holidays during the entire Internship Program and in case of any exigencies during which the candidate remains absent for a period more than 6 days, he/she will have to work for the extra days during which the candidate has remained absent.
- The Internship should cover all the services provided by the Radio-diagnosis department of the medical college/hospital. Based on the attendance and work done during posting the Director/Principal/ head of institution/department shall issue a '**Certificate of Satisfactory Completion**' of training following which the University shall award the Bachelor in Medical Radiology & Imaging Technology degree or declare the candidate eligible for the same.
- **No candidate shall be awarded degree without successfully completing one year internship**.
- The institution shall have to satisfy themselves that satisfactory infrastructure facilities of the Radio-diagnosis department exist in the Institute / Hospital where the internship training has to be undertaken. The following parameters/guidelines have been suggested:
  a. It is mandatory for the Institution to have its own well-equipped and modern Radio-diagnosis department.
  b. Senior Radiologists should manage the Radio-diagnosis department in the Institutes/Hospitals.
- The institute's Director / Principal can at his discretion grant NOC to the students to do the Internship at the place of his choice provided the concerned Hospital fully satisfies the above criteria. For the purpose of granting NOC, the candidate shall have to submit to the Institution the status of Radiological imaging services available at the place where he intends to do his Internship.

Bachelor in Medical Radiology & Imaging Technology
First Semester
Human Anatomy-I
Subject code: BRT25101
Minimum hours: Theory-60 Hr.

Learning objective - It is designed to provide students with a working knowledge of the structure of the human body which is the essential foundation for their clinical studies. The study of anatomy will include the identification of all gross anatomical structures. Particular emphasis will be placed on the description of bones, joints, muscles, the brain, cardiopulmonary, and nervous system, as these are related to the application of Radiology in patients.

Learning outcomes- The student will be able to –

1. Describe anatomical aspects of muscles, bones, joints, and their attachments of the thorax and upper quadrant and to understand and discuss the analysis of movements with respect to bones, joints, and soft tissues related to the musculoskeletal system of the thorax & upper extremity.
2. Describe structures of the cardio-vascular & amp; respiratory system, mechanism of respiration and the course of blood vessels, and structure of the rib cage & amp; its contents with special emphasis on lungs, tracheobronchial tree, respiratory muscles & amp; heart.
3. Describe the source & amp; course of major arterial, venous & amp; lymphatic systems, related to the upper quadrant, thorax, and heart.
4. Describe various structures of the genito-urinary system, abdomen, pelvic organs, and sense organs and apply knowledge to living anatomy

THEORY

Topics to be covered:

1. General Anatomy:
   - Introduction to Anatomy, terms and terminology.
   - Regions of the Body, Cavities, and systems.
   - Surface anatomy – musculoskeletal, vascular, cardiopulmonary system
   - General Embryology.
   - Applied anatomy.
2. Musculoskeletal system.
   - Connective tissue & its modification, tendons, membranes, special connective tissue.
   - Bone structure, blood supply, growth, ossification, and classification.
   - Muscle classification, structure and functional aspect.
   - Joints – classification, structures of joints, movements, range, limiting factors, stability, blood supply, nerve supply, dislocations and applied anatomy.

2(a). Upper extremity:
   - Bony architecture
   - Joints – structure, range of movement
   - Muscles – origin, insertion, actions, nerve supply
   - Major nerves – course, branches and implications of nerve injuries
   - Development of limb bones, muscles and anomalies
   - Radiographic identification of bone and joints
   - Applied anatomy

2(b). Lower Extremity:
   - Bony architecture

- Joints – structure, range of movement
- Muscles – origin, insertion, actions, nerve supply
- Major nerves – course, branches and implications of nerve injuries
- Development of limb bones, muscles and anomalies
- Radiographic identification of bone and joints
- Applied anatomy

2(c). Spine and thorax

- Back muscles - Superficial layer, Deep muscles of back, their origin, insertion, action and nerve supply.
- Vertebral column – Structure & Development, Structure & Joints of vertebra
- Thoracic cage
- Radiographic identification of bone and joints
- Applied anatomy

2(d). Head and neck:

- Cranium
- Facial Muscles – origin, insertion, actions, nerve supply
- Temporomandibular Joints – structure, types of movement

Bachelor in Medical Radiology & Imaging Technology
First Semester
Human Physiology-I
Subject Code: BRT25102
Minimum Hours: Theory-60 Hr.

Learning objective- The course in Physiology is designed to give the student an in-depth knowledge of the fundamental reactions of living organisms, particularly in the human body. The major topics covered include the following: the cell; primary tissue; connective tissue; skin; muscle; nervous tissue; blood; lymphoid tissues; respiration; blood vessels; circulation; cardiac cycle; systemic circulation; gastrointestinal tract; kidneys; uterus; urinary tract; pregnancy; endocrine system.

Learning outcomes- The student will be able to

1. Describe the physiology of blood.
2. Discuss nerve-muscle physiology.
3. Define and describe physiological functions of cardio vascular and respiratory system.
4. Define and describe physiological functions of Digestive system.
5. Define and describe physiological functions of Endocrine system.

THEORY

Topics to be covered:

1. General Physiology
   - Cell: morphology, Structure and function of cell organelles
   - Structure of cell membrane
   - Transport across cell membrane
   - Intercellular communication
   - Homeostasis
2. Blood
   - Introduction-composition & function of blood
   - W.B.C., R.B.C., Platelets formation & functions, Immunity
   - Plasma: composition, formation & functions, Plasma Proteins:-types & functions
   - Blood Groups- types , significance, determination
   - Hemoglobin
   - Haemostasis
   - Lymph-composition, formation, circulation & functions
3. Cardiovascular system
   - Conducting system-components, impulse conduction
   - Heart valves
   - Cardiac cycle- definition, phases of cardiac cycle
   - Cardiac output- definition, normal value, determinants. Stroke volume and its regulation
   - Heart rate and its regulation
   - Arterial pulse, Blood pressure-definition, normal values, factors affecting blood pressure
   - Shock-definition, classification, causes and features
   - Basic idea of ECG
   - Cardiovascular changes during exercise
4. Respiratory System
   - Mechanics of respiration

- Lung volumes and capacities
- Pulmonary circulation, transport of respiratory gases
- Factors affecting respiration
- Regulation of respiration-neural regulation, voluntary control and chemical regulation
- Hypoxia, Hypercapnoea, Hypocapnoea
- Artificial respiration
- Disorders of respiration- dyspnoea, orthopnoea, hyperpnoea, hyperventilation, apnoea, tachypnoea
- Respiratory changes during exercise.

5. Nerve Muscle Physiology
   - Muscles- classification, structure, properties, Excitation contraction coupling
   - Motor unit, EMG, factors affecting muscle tension,
   - Muscle tone, fatigue, exercise
   - Nerve –structure and function of neurons, classification, properties
   - Resting membrane potential & Action potential their ionic basis
   - All or None phenomenon
   - Neuromuscular transmission

Bachelor in Medical Radiology & Imaging Technology
First Semester
Clinical Biochemistry
Subject Code: BRT25103
Min. Hrs. - Theory: 60 Hrs.

Learning objective- This course provides the knowledge and skills in fundamental organic chemistry and introductory biochemistry that are essential for further studies It covers basic biochemical, cellular, biological and microbiological processes, basic chemical reactions in the prokaryotic and eukaryotic cells, the structure of biological molecules, introduction to the nutrients i.e. carbohydrates, fats, enzymes, nucleic acids and amino acids.

Learning outcomes- At the end of the course, the candidate will able to –

1. Describe structures & functions of cell in brief.
2. Describe biochemistry of connective tissues.
3. Discuss acid base balance.
4. Define nutrition, balance diet & amp; nutritional disorders.
5. Describe Nucleotide and Nucleic acid Chemistry
6. Discuss role of enzymes.
7. Describe Carbohydrate Chemistry, Amino-acid Chemistry & amp; Vitamins.
8. Discuss Carbohydrate Metabolism, Lipid Metabolism, Amino acid and Protein Metabolism.

THEORY

Topics to be covered:

1. Nutrition: RDA, BMR, SDA, caloric requirement and balanced diet.
2. Carbohydrates: Definition, classification and general functions. Carbohydrate Metabolism - Glycolysis, T.C.A cycle.
3. Lipids: Definition, classifications and general functions. Essential fatty acids and their importance, Cholesterol, Lipoproteins. Metabolism-□□Oxidation of fatty acids, fatty liver and ketosis.
4. Amino Acids : Definition, classification, essential and non essential aminoacids.
5. Proteins: Definition, classification, and Bio-medical Importance. Metabolism: Formation and fate of ammonia, Urea cycle and its significance.
6. Study of hemoglobin and myoglobin with their functions.
7. Enzymes: Definition, classification with examples, Factors affecting enzyme action, isoenzyme and co-enzyme, Clinical importance of enzymes.
8. Biochemistry of connective tissue - Introduction, various connective tissue proteins: collagen, elastin- structure and associated disorders.
9. Vitamins: Definition, classification and functions, dietary source, daily requirement and deficiency disorders.
10. Diabetes mellitus - definition, types & causes.

Bachelor in Medical Radiology & Imaging Technology
First Semester
Fundamentals of Medical Imaging & Radiotherapy
Subject code – BRT25104
Min. Hrs. - Theory: 60 Hrs.

Learning Objective- To enable the students to gain knowledge on the field of radiation along with the basic atomic and electric physics to the designing of x-ray circuits and its system.

Learning Outcome- At the end of the course, the students will be able to differentiate different types of radiation and its uses for medical diagnosis and therapy.

THEORY

Topics to be covered:
The X-ray machine: X-ray Tube and its type, Collimator, filter, Target material,
Basic Radiologyal Physics

1. X-rays: Discovery of X-rays, X-ray production and properties: Bremsstrahlung radiations Characteristics X-rays, factors affecting X-ray emission spectra, Factors affecting X-ray quality and quantity, heel effect, soft and hard X-rays.
2. X-ray tube: historical aspects, construction of X-ray tubes, requirements for X-ray production (Electron source, target and anode material), tube voltage, current, space charge, early X-ray tubes (Coolidge tubes, tube envelop and housing) cathode assembly, X-ray production efficiency, advances in X-ray tubes, anode angulation and rotating tubes, line focus principle, space charge effect, tube cooling, Modern X-ray tubes-stationary anode, rotating anode, grid controlled X-ray tubes, heel effect, off focus radiation, tube insert and housing, Tube rating, Quality and intensity of x-rays, factors influencing them.
3. Interaction of ionizing radiation with matter, type of interactions of X-and gamma radiation, Photoelectric & Compton, Pair production, annihilation radiation.
4. Exponential attenuation (linear/mass attenuation coefficients), Half Value Thickness (HVT), Tenth Value Thickness (TVT), dependence on energy and atomic number.
5. **Radiographic Film**: Structure of film emulsion, film characteristics (speed, base + fog, gamma, latitude), effect of grain size on film response to exposure, interpretation of characteristics curve, Grain technology Gelatin Basic film types, Direct exposure duplicated films, Single coated emulsions, Films for specialised use, manufacturing process. Structure, properties of different parts, handling, film wrappings. Handling of exposed and unexposed films. Types, applications, advantages/limitations of different types, and safe light requirements.
6. **Cassettes**: Structure and function, Types, Design features, and consideration with loading/unloading, Care and maintenance (cleaning).
7. **Intensifying screens**: Structure and functions, common phosphors used, types, screen mounting, care and maintenance of film screen contact. Intensifying factor, speed, and detail-crossover effect, resolution, Photo-stimulable phosphor Imaging.

8. **Processing:** manual processing, care of processing equipment-automatic processor manual VS automatic processing, principles, Latent image.
9. **Dark Room-** The processing area, Darkroom design, construction, illumination, entrance safe lighting, types
10. Radiographic exposure, Radiographic Quality, Grid and type of grid.
11. Physical principles of diagnostic Ultrasound Piezoelectric Effect. Acoustic intensity, reflection, impedance & absorption. Ultrasound transducer, Beam, Operational Modes & Biological effects.
12. Compound Tomography, Principles of operation system components & image reconstruction.
13. Physical principles of Magnetic Resonance Imaging: Basic concept, system components, biological hazards, advantage over CT

Bachelor in Medical Radiology & Imaging Technology
First Semester
Human Anatomy-I
Subject code: BRT25105
Minimum hours: Practical-60 Hrs.

PRACTICAL

Topics to be covered:

1. Identification and description of all anatomical structures.
2. The learning of Anatomy is by demonstration only through dissected parts, slides, models, charts, etc.
3. Demonstration of dissected parts (upper extremity, lower extremity & thoracic).
4. Demonstration of the skeleton- articulated and disarticulated.
5. During the training more emphasis will be given on the study of bones, muscles, joints, nerve supply of the limbs, and arteries of limbs.
6. Surface anatomy:
   -surface land mark-bony, muscular and ligamentous.
   -surface anatomy of major nerves, and arteries of the limbs.
7. Points of palpation of nerves and arteries.

Bachelor in Medical Radiology & Imaging Technology
First Semester
Human Physiology-I
Subject Code: BRT25106
Minimum Hours: Practical-60 Hrs.

PRACTICAL

Topics to be covered:

Practical classes include hematology experiments, clinical examinations, amphibian chart, and recommended demonstrations.

1. Haematology: To be done by the students

a. Study of Microscope and its uses
b. Determination of RBC count
c. Determination of WBC count
d. Differential leukocyte count
e. Estimation of hemoglobin
f. Calculation of blood indices
g. Determination of blood groups
h. Determination of bleeding time
i. Determination of clotting time

Demonstrations only

j. Determination of ESR
k. Determination of PCV

2. Clinical Examination

a. Examination of Radial pulse.
b. Recording of blood pressure
c. Examination of CVS
d. Examination of Respiratory system

3. Amphibian Experiments – Demonstration and Dry charts Explanation.

a. Normal cardiogram of amphibian heart.
i. Properties of Cardiac muscle
ii. Effect of temperature on cardiogram.

4. Recommended Demonstrations

a. Spirometry
b. Artificial Respiration
c. ECG
d. Perimetry

Bachelor in Medical Radiology & Imaging Technology
First Semester
Fundamentals of Medical Imaging & Radiotherapy
Subject code – BRT25107
Min. Hrs. - Practical: 60 Hrs.

PRACTICAL

1. X-ray tubes general features and mobile equipment.
2. Care and maintenance of X-ray equipment and image intensifier
3. To study the effects of Kilo Voltage Peak (KVP) and Milli Ampere Second (MAS)
4. To check the safety of the dark room.
5. To check the speed of the intensifying screen.
6. To check the developing time test and function.
7. Silver recovery method

Bachelor in Medical Radiology & Imaging Technology
First Semester
Basic computers and information science
Min Hrs. - 40

The students will be able to appreciate the role of computer technology. The course has focus on computer organization, computer operating systems and software, and MS windows, Word processing, Excel data worksheets and PowerPoint presentations. Topics to be covered under the subject are as follows:

1. Introduction to computer: Introduction, characteristics of the computer, block diagram of computer, generations of computer, computer languages.
2. Input-output devices: Input devices (keyboard, point and draw devices, data scanning devices, digitizer, electronic card reader, voice recognition devices, vision-input devices), output devices (monitors, pointers, plotters, screen image projector, voice response systems).
3. Processor and memory: The Central Processing Unit (CPU), the main memory.
4. Storage Devices: Sequential and direct access devices, magnetic tape, magnetic disk, optical disk, mass storage devices.
5. Introduction of windows: History, features, desktop, taskbar, icons on the desktop, operation with folder, creating shortcuts, operation with Windows (opening, closing, moving, resizing, minimizing and maximizing, etc.).
6. Introduction to MS-Word: introduction, components of a word window, creating, opening and inserting files, editing a document file, page setting and formatting the text, saving the document, spell checking, printing the document file, creating and editing of table, mail merge.
7. Introduction to Excel: introduction, about worksheet, entering information, saving workbooks and formatting, printing the worksheet, creating graphs.
8. Introduction to PowerPoint: introduction, creating and manipulating presentation, views, formatting and enhancing text, slide with graphs.
9. Introduction of Operating System: introduction, operating system concepts, types of operating system.
10. Computer networks: introduction, types of network (LAN, MAN, WAN, Internet, Intranet), network topologies (star, ring, bus, mesh, tree, hybrid), components of network.
11. Internet and its Applications: definition, brief history, basic services (E-Mail, File Transfer Protocol, telnet, the World Wide Web (WWW)), www browsers, use of the internet.
12. Application of Computers in clinical settings.

Bachelor in Medical Radiology & Imaging Technology
First Semester
Communication and soft skills
Min Hrs. - 40

Major topics to be covered under the Communication course —

1. Basic Language Skills: Grammar and Usage.
2. Business Communication Skills. With a focus on speaking - Conversations, discussions, dialogues, short presentations, and pronunciation.
3. Teaching the different methods of writing like letters, E-mails, reports, case studies, collecting patient data etc. Basic compositions, and journals, with a focus on paragraph form and organization.
4. Basic concepts & principles of good communication
5. Special characteristics of health communication
6. Types & processes of communication Barriers of communication & how to overcome Introduction to Quality and Patient Safety.

Bachelor in Medical Radiology & Imaging Technology
Second Semester
Human Anatomy-II
Subject code: BRT25201
Minimum hours: Theory-60 Hrs.

Learning objective- Studies are concerned with the topographical and functional anatomy of the limbs. Particular attention is paid to the muscles, bones and joints of the regions. The head and neck and central nervous system (CNS) are studied with particular reference to topics of importance to Radiology. The study of the CNS includes detailed consideration of the control of motor function.

Learning outcomes- The student will be able to –

1. Describe anatomy of lower quadrant including spine, pelvis and lower extremities: list bones, joints, soft tissues, muscles related to musculoskeletal system of spine & lower extremities and to localize various surface land-marks, apply related Radiologyal and living anatomy
2. Describe anatomy of structures of head, face and neck
3. Describe and outline various parts of nervous system: Source, course & components of various trans-sections of spinal tracts and C.N.S; Source, course & components of various trans-sections of brain, cranial nerves (Special emphasis to III, IV, V, VI and VII) and peripheral nerves.
4. Describe blood circulation of C.N.S. & spinal cord.
5. Describe the course of peripheral nerves.
6. Discuss anatomical basis of clinical conditions of nervous system.
7. Demonstrate movements of lower extremity joints – Identify & describe the origin/insertion, nerve /blood supply, root value & function of various skeletal muscles (including lower extremity and spine).

THEORY

Topics to be covered:

1. Nervous system
   - Classification of nervous system
   - Nerve – structure, classification, microscopy with examples.
   - Neurons, classification with examples. Simple reflex arc.
   - Parts of a typical spinal nurve/Dermatome
   - Central nervous system – disposition, parts and functions
   - Cerebrum
   - Cerebellum
   - Midbrain & brain stem
   - Blood supply & anatomy of brain
   - Spinal cord- anatomy, blood supply, nerve pathways
   - Pyramidal, extra pyramidal system
   - Thalamus, hypothalamus
   - Structure and features of meningies
   - Ventricles of brain, CSF circulation
   - Development of nervous system & defects
   - Cranial nerves – (course, distribution, functions and palsy)
   - Sympathetic nervous system, its parts and components
   - Parasympathetic nervous system
   - Applied anatomy

2. Sensory system
   - Structure and function of
     - Visual system
     - Auditory system
     - Gustatory system
     - Olfactory system
     - Somato sensory system
3. Cardiovascular system
   - Circulatory system – major arteries and veins of the body, structure of blood vessels
   - Heart structure, positions, chambers, valves, internal & external features
   - Blood supply to heart
   - Conductive system of heart
4. Lymphatic system
   - Circulation, structure & functions
   - Lymph nodes
5. Respiratory system
   - Structure of upper and lower respiratory tract

   Thorax:
   - Pleural cavities & pleura
   - Lungs and respiratory tree
   - Heart and great vessels
   - Diaphragm
6. Digestive system
   - Parts of digestive system
   - Abdominal cavity – divisions
   - Muscles of abdominal wall
   - Liver
   - Pancreas
   - Spleen
   - Alimentary canal
   - Gall bladder
   - Intestine (small & large)
7. Urinary and Reproductive system
   - Urinary system
   - Pelvic floor, innervations
     - Kidney, Ureter, bladder, urethra
   - Genital system – male and female
     - Reproductive system of male
     - Reproductive system of female
8. Endocrine system
   - Pituitary gland
   - Thyroid
   - Parathyroid

Bachelor in Medical Radiology & Imaging Technology
Second Semester
Human Physiology-II
Subject Code: BRT25202
Minimum Hours: Theory-60 Hrs.

Learning objective- The course in Physiology is designed to give the student an in-depth knowledge of fundamental reactions of living organisms, particularly in the human body.

Learning outcomes- At the end of the course student will be able to:

1. Describe physiology of special senses.
2. Discuss Exercise physiology.
3. Define and describe physiological functions of Nervous system.
4. Define and describe physiological functions of renal system.
5. Define and describe physiological functions of Reproductive system.

THEORY

Topics to be covered:

1. Nervous system
   - Introduction, central and peripheral nervous system, functions of nervous system
   - Reflexes- monosynaptic, polysynaptic, superficial, deep & withdrawal reflex
   - Sense organ, receptors, electrical & chemical events in receptors
   - Sensory pathways for touch, temperature, pain, proprioception & others
   - Control of tone & posture: Integration at spinal, brain stem, cerebellar, basal ganglion levels, along with their functions
   - Motor mechanism: motor cortex, motor pathway: the descending tracts-pyramidal & extra pyramidal tracts-origin, course, termination & functions. Upper motor neuron and lower motor neuron paralysis.
   - Spinal cord lesions- complete transection & hemisection of the spinal cord
   - Autonomic nervous system: features and actions of parasympathetic & sympathetic nervous system
   - Hypothalamus
   - Higher functions of nervous system
   - Special senses- eye, ear, nose, mouth
2. Renal System
   - Physiology of kidney and urine formation
   - Glomerular filtration rate, clearance, Tubular function
   - Water excretion, concentration of urine-regulation of Na^+, Cl^-, K^+ excretion
   - Physiology of urinary bladder
3. Digestive System
   - Digestion & absorption of nutrients
   - Gastrointestinal secretions & their regulation
   - Functions of Liver & Stomach.
4. Endocrinology
   - Physiology of the endocrine glands – Pituitary, Pineal Body, Thyroid, Parathyroid, Adrenal, Gonads, Thymus, Pancreas. Hormones secreted by these glands, their classifications and functions.
5. Male & female reproductive system
   - Male - Functions of testes, pubertal changes in males, testosterone - action & regulations of secretion.
   - Female - Functions of ovaries and uterus, pubertal changes, menstrual cycle, estrogens and progestron - action and regulation.

Bachelor in Medical Radiology & Imaging Technology
Second Semester
Basic Radiation Physics
Subject code – BRT25203
Min. Hrs. - Theory: 60 Hrs.

Learning objective- To enable the students to gain knowledge on the field of radiation along with the basic atomic and electric physics.

Learning outcome- At the end of the course, the students will be able to differentiate different types of radiation and its uses for medical diagnosis and therapy.

THEORY

Topics to be covered:

Fundamental of Physics
– Matter & energy
– Radiation & spectra

–**Electricity and Magnetism-** Electric charges, Coulomb's Law-Unit of charge-Electric potential, unit of potential-Electric induction, capacitance and Capacitors, series and parallel connection-electric current, unit, resistance, ohm's law, electric power, Joule's law. Ohm's law, resistivity, series and parallel combination, Kirchhoff's law, the heating effect of current.

Magnetism- Magnetic field, Electromagnetic induction, mutual and self-induction, Flaming right-hand rule.

– Atoms & nuclei- atomic structure-atom model-Nucleus, electronic configuration, periodic table-Isotopes, Ionization, excitation, Binding energy, electron volt

decay (Alpha Beta and gamma rays)

-**X-ray generator circuits:** Rectification-half and full wave-self rectification, X-ray generator; filament circuit, kilo Voltage circuit, single phase generator, three phase generator, constant potential generator, High frequency generator, ripple factor, Fuses, switches and interlocks-Exposure switching and timers, HT cables-earthing.

– Interaction of X-rays- Gamma rays and electron radiation with matter and principles of

differential absorption in biological materials, LET.

Electromagnetic radiation, Quantum nature of radiation-mass energy equivalence Fluorescence-electromagnetic spectrum.

Bachelor in Medical Radiology & Imaging Technology
Second Semester
Preventive Medicine and Radiation Protection
Subject code – BRT25204
Min. Hrs. - Theory: 60 Hrs.

Learning Objective- The objective of this particular section of the foundation course is to sensitize potential learners with essential knowledge on basic concept of health and universal disease conditions and basic idea on radiation protection.

Learning outcome- At the end of the course, student will be able to understand and work under various health organization and also will be able to give and apply protection from different types of radiation causing health hazards.

THEORY

Topics to be covered:

1. Definition of Health, Determinants of Health, Health Indicators of India, Health Team Concept.
    a. National Health Policy
    b. National Health Programmers (Briefly objectives and scope)
    c. Population of India and Family welfare programme in India.
2. Family :
    b. The family, meaning and definitions
    c. Functions of types of family
    d. Changing family patterns
    e. Influence of family on individuals Health, family and nutrition, the effects of sickness in the family and psychosomatic disease.

3. **Regulatory Bodies & regulatory Requirements:** International Commission on Radiation Protection (ICRP), NCRP, IAEA, National Regularity body (AERB - Atomic Energy Regulatory Board) - Responsibilities, organization, Safety Standards, Codes and Guides, Responsibilities of licenses, registrants & employers and Enforcement of Regulatory requirements.

4. **Role of Radiographer in Planning, QA & Radiation Protection:** Role of technologist in radiology department - Personnel and area monitoring., Setting up of a new X-ray unit, staff requirement, AERB specifications for site planning and mandatory guidelines – Planning of X-ray rooms, dark rooms – Inspection of X-ray installations - Registration of X-ray equipment installation- Certification -Evaluation of workload versus radiation factors – Occupational exposure and protection Tools/devices. ICRP, NRPB, NCRP and WHO guidelines for radiation protection, pregnancy and radiation protection. NABH guidelines, AERB guidelines, PNDT Act and guidelines

Bachelor in Medical Radiology & Imaging Technology
Second Semester
Human Anatomy-II
Subject code: BRT25205
Minimum hours: Practical-60 Hrs.

▪

PRACTICAL

Topics to be covered:

1. Demonstration of dissected parts (abdominal viscera, face and brain).
2. Demonstration of skeleton- articulated and disarticulated.
3. During the training more emphasis will be given on the study of CNS, PNS, Cardiovascular System, Respiratory System, Digestive System, Urinary System bones & reproductive system muscles, joints, nerve supply of the limbs and arteries of limbs.
4. Audio visual material for practical study of related anatomical parts.
5. Demonstration on Anatomical models
6. Students visit to Anatomy Museum

Bachelor in Medical Radiology & Imaging Technology
Second Semester
Human Physiology-II
Subject Code: BRT25206
Minimum Hours: Practical-60 Hrs.

PRACTICAL

Topics to be covered:

Recognize the abnormalities in the ECG and spirometry findings in clinical examination

a. Examination of Sensory system
b. Examination of Motor System
c. Examination of reflexes
d. Examination of cranial nerves

Bachelor in Medical Radiology & Imaging Technology
Third Semester
Advanced Radiographic Techniques
Subject code – BRT25301
Min. Hrs. - Theory: 60 Hrs.

Learning Objective- The objective is to learn basic knowledge on ultrasound, CT scan and MRI equipments for various imaging and equipments used for imaging and techniques.

Learning Outcomes- At the end of the course, students will be able to assist the radiologist and sinologist on:
• Transducer selection
• Patient selection and preparation
• Managing image quality and artefacts in ultrasound, CT scan and MRI
• Sufficient knowledge about contrast media selection and its adverse effect.

THEORY

Topics to be covered:

1. Ultrasound:

– Principle of Ultra Sound, characteristic of sound wave, sound propagation in tissue, speed, frequency, wavelength, amplitude, intensity, attenuation, reflection, refraction, scattering.

– Types of ultrasounds- A-mode, B-mode and M-mode ultrasound, Near and Far field ultrasound, working principle of Transduce and different type of transducer. Ultrasound artefact and remedy.
– Description of Equipment-
Physics of Doppler ultrasound and type of Doppler ultrasound (continuous wave Doppler, pulse wave Doppler, duplex scanning, Color Doppler and power Doppler) Doppler artefact and remedy.
– Indication and Clinical Application of ultrasound

2. CT scan:

– Basic principle of CT scan, generation of CT scan, pixel. Voxel and matrix elements.
– Description of Equipment- Gantry, control consol, Patient couch
– Conventional CT scan
– Indications and contra-indications

3. MRI

The basic principles of MRI, MRI instrumentation, RF coil, Gradient coil, Shim coil, TR, TE, FID, T1 Relaxation, T2 Relaxation, T1 weighted, T2 weighted and proton density imaging.
Pulse sequence in MRI (Spin echo and Gradient echo pulse sequence) Inversion recovery pulse sequence (FLAIR and STIR).
– Preparation of Patients for MRI
– Contrast Media in MRI (Gadolinium-based contrast media (GBCA), the effect of T1 and T2 on GBCA
– Indication and Contraindication
– Clinical application, Procedure

Bachelor in Medical Radiology & Imaging Technology
Third Semester
Special Radiographic Techniques & Procedures
Subject code – BRT25302
Min. Hrs. - Theory: 60 Hrs.

Learning objective- The main objective is to aware the student about the conventional and special technique of radio imaging technique like (manual image processing & fluoroscopy / dynamic imaging/contrast media) along with the image formation, developing and reading. To learn basic and special projections for the better and delineation diagnosis of the disease conditions of different anatomical structure (upper and lower extremities, shoulder joint, pelvis griddle, whole spine).

Learning outcomes- At the end of the course, student will be expert in practicing various radiographic positioning and procedure independently and understanding the radiographic diagnosis. The students will have knowledge on:
• Image recording techniques of various parts of the body
• Guidelines for radiodiagnosis
• Contrast media and its component.

THEORY

Topics to be covered:

1. Special procedure and related Contrast Media
   - Contrast Media
   - Emergency in Radiology Department
   - Excretory System
     a) IVP
     b) RGU
     c) MCU
   - G.I. Tract
     a) Barium Swallow
     b) Barium Meal Series
     c) Barium Meal Follow Through
     d)Enteroclysis
     e) Barium Enema
   - Hysterosalpingography (HSG)
   - Nephrostogram
   - Myelography
   - Dacryocystography
   - vertebroplasty
   - Angiography
   - Tomography
2. Radiography of body parts and their poisoning
   - Upper limb
   - Lower limb
   - Abdomen, Head and Neck
3. Guideline for design and location of X-ray equipment

Bachelor in Medical Radiology & Imaging Technology
Third Semester
General Pathology
Subject code – BRT25303
Min. Hrs. - Theory: 60 Hrs.

Learning Objectives-

- To provide general insight into the history and basics of General Pathology**.**
- To Impart knowledge about general outline of pathology**.**
- To provide brief knowledge about basic procedure done in pathology laboratory.

Learning outcome-

At the end of the course, the students will have knowledge in inflammation and repair aspects as well as the various pathological change of the human body.

THEORY

Topics to be covered:

1. Cell Injury and Cellular Adaptations.

a) Normal Cell
b) Cell Injury- types of cell injury, etiology of cell injury, morphology of cell injury, cellular swelling.
c) Cell death: types- autolysis, necrosis, apoptosis & gangrene.
d) Cellular adaptations-atrophy, hypertrophy, hyperplasia & dysplasia.

2. Inflammation

a) Acute inflammation - vascular event, cellular event, inflammatory cells.
b) Chronic Inflammation - general features, granulomatous inflammation, tuberculoma.

3. Hemodynamic Disorders:

Edema, hyperemia, congestion, hemorrhage, circulatory disturbances, thrombosis,
Ischemia & infarction.

4. Neoplasia:

Definition, how does it differ from hyperplasia, Feature of Benign Tumor and Malignant Tumor
difference between benign tumor and malignant tumor.

5. Healing

Definition, different phases of healing, factors influencing wound healing.

Bachelor in Medical Radiology & Imaging Technology
Third Semester
General Microbiology
Subject code – BRT25304
Min. Hrs. - Theory: 60 Hrs.

Learning objective-

- To provide knowledge of bacteria, Sterilization etc.

Learning outcome-

At the end of the course, the students will be able to understand the pathogenesis of the diseases caused by the organisms in the human body.

THEORY

Topics to be covered:

1. **General characters and classification of Bacteria.**
2. **Characteristics of Bacteria**
   Morphology- Shape, Capsule, Flagella, Inclusion, Granule, Spore.
3. **Growth and Maintenance of Microbes**
   Bacterial division, Batch Culture, Continuous culture, bacterial growth- total count, viable count, bacterial nutrition, oxygen requirement, CO_2 requirement, temperature, pH, light.
4. **Sterilization and Disinfection.**
   Physical agents- Sunlight, Temperature less than 100^0C, Temperature at 100^0C, steam at atmospheric pressure and steam under pressure, irradiation, filtration.
   Chemical Agents- Alcohol, aldehyde, Dyes, Halogens, Phenols, Ethylene oxide.
5. **Culture Media**
   Definition, uses, basic requirements, classification, Agar, Peptone, Transport Media, Sugar Media, Anaerobic Media, Containers of Media, Forms of Media
6. **Staining Methods**
   Simple, Grams staining, Ziehl-Neelsen staining or AFB staining, Negative Impregnation
7. **Collection and Transportation of Specimen**
   General Principles, Containers, Rejection, Samples- Urine, Faeces, Sputum, Pus, Body fluids, Swab, Blood.
8. **Care and Handling of Laboratory Animals**
   Fluid, Diet, Cleanliness, Cages, ventilation, Temperature, Humidity, handling of Animals, Prevention of disease.
9. **Disposal of Laboratory/Hospital Waste**
   Non-infectious waste, Infected sharp waste disposal, infected non-sharp waste disposal.

Bachelor in Medical Radiology & Imaging Technology
Third Semester
Advanced Radiographic Techniques
Subject code – BRT25305
Min. Hrs. -Practical: 60 Hrs.

PRACTICAL

1. Based on Theory topics.

Bachelor in Medical Radiology & Imaging Technology
Third Semester
Special Radiographic Techniques & Procedures
Subject code – BRT25306
Min. Hrs. - Practical: 60 Hrs.

PRACTICAL

1. Radiography in various positions for all the special Radiologyal procedures, using contrast media as per syllabus.
2. Positioning and treatment of various cases patients by using:
   a. Prescribed filters and wedges
   b. Protection of various organs

Bachelor in Medical Radiology & Imaging Technology
Third Semester
General Pathology
Subject code – BRT25307
Min. Hrs. -Practical: 60 Hrs

PRACTICAL

1. Components & setting of the Compound microscope.
2. Focusing of object.
3. Use of low & high power objectives of microscope.
4. Use of oil immersion lens.
5. Care and Maintenance of the microscope.
6. Different types microscopy
   - Dark field microscopy
   - Fluorescence Microscopy
7. Electron Microscopy in brief. 1. Introduction to Pathology

Bachelor in Medical Radiology & Imaging Technology
Fourth Semester
Radiation Physics & Radiation Protection
Subject code – BRT25401
Min. Hrs. - Theory: 60 Hrs.

Learning objective- The objective is to learn aim, objective, philosophy and principle of radiation physics and protection to protect oneself from biological effect of radiation and monitoring of radiation exposure.

Learning outcomes- At the end of the course, student will have knowledge on:
- Radiation physics and its determinants
- Quality control and assessment of equipments installed in radio department.
- Layout planning of radiology department.

THEORY

Topics to be covered:

Radiation Physics :

1. Atomic structure as applied to generation of X-rays and radioactivity spectrum of diagnostic imaging and therapy X ray.
2. Effects of variation of tube voltage current, filtration, III waveform and target material on X-ray production lows of radioactivity and decay schemes of different alpha, Beta, gamma ray. Megatron and position emitters as used in medicine especially in radiotherapy.
3. Artificial radionuclide generators employed in medicine in general and radiotherapy sources in particulars.
4. Interaction of radiation with matter attenuation absorption and scattering phenomenon.
5. Photoelectric absorption Compton scattering pair-production and annihilation process ionization, effects of geometry of thickness of the absorber. Dependence on the nature and atomic number of the absorber and on radiation quality.
6. Transmission of X-ray through body tissues linear energy transfer.
7. Range of secondary electrons and electron build up relative amount of scatter from homogeneous and homogonous beam defining the passage through a patient.
8. Physical requirements of beam defining devices e.g. cones, diaphragm, collimators etc.
9. Units of radiation measurements specification of quality and half- valve thickness (HVT) and its measurements, filters and filtration.
10. Measurement of radiation and dosimeteric procedures.
11. Radiation detectors and their principles of working.
12. Definition of Bragg-peak , percentage depth dose, peak scatter factor, tissue air-ratio, tissue maximum ratio, scatter air ratio, isodose curves and radiation penumbra of different beams.
13. Wedge filters, wedge angle, hinge angle.
14. Compensator beams flattering filters, scattering foils.
15. Physical properties of phantom materials, bolus and substitutes.
16. Factor used for treatment dose calculations, Daily treatment time and monitor units calculation method, physical aspects of electron and neutron therapy.

Radiation Protection :

1. Definition of radiation hazards maximum permissible dose and annual limit of intake (ALI) permissible dose levels on and around sealed source housing and installation principles of radiation protection and MPD of different ICRP rules, stochastic and non-stochastic effects.

2. Importance of ‘ALARA’ physical principles of design and planning of installation safe work practice in teletherapy and brachytherapy.
3. Shielding materials Radiation survey and personnel monitoring devices film badge, TLD badges pocket dosimeters.

Bachelor in Medical Radiology & Imaging Technology

Fourth Semester

Research Methodology and Biostatistics

Subject Code: BRT25402

Min. Hrs. : 60 Hrs.

Learning Objective: The objective of this module is to help the students understand the basic principles of research and methods applied to draw inferences from the research findings

Learning Outcomes: The student will be able to

1. Describe the basic principles of research and methods applied to draw inferences from the research findings
2. Discuss the basic concepts of Biostatistics
3. Explain Design, Methodology of Experiment/Survey, Demography & vital statistics, Sampling & interpretation of Data

THEORY

Topics to be covered:

Research Methodology

1. Introduction to Research methodology:
   Meaning of research, objectives of research, Motivation in research, Types of research & research approaches, Research methods vs methodology, Criteria for good research.
2. Research problem:
   Statement of research problem, Statement of purpose and objectives of research problem, Necessity of defining the problem
3. Research design:
   Meaning of research design, Need for research design, Features for good design, Different research designs, Basic principles of research design.
4. Measurement & scaling techniques: Measurement in research-
   Measurement scales, sources of error in measurement, Technique of developing measurement tools, Meaning of scaling, its classification, important scaling techniques.
5. Methods of data collection: collection of primary data, collection data through questionnaires & schedules, Difference between questionnaires & schedules.
6. Computer technology:
   Introduction to Computers, computer application in research computers & researcher.

Biostatistics

1. **Introduction**: Meaning, definition, characteristics of statistics. Importance of the study of statistics, Branches of statistics, Statistics and health science , Parameters and Estimates, Variables and their types, Measurement scales.
2. **Tabulation of Data**: Basic principles of graphical representation, Types of diagrams – histograms, frequency polygons, smooth frequency polygon, cumulative frequency curve, Normal probability curve.
3. **Measures of Central Tendency**: Need for measures of central Tendency, Definition and calculation of **Mean** – ungrouped and grouped, interpretation and calculation of Median-ungrouped and grouped, Meaning and calculation of Mode, Geometric mean & Hormonic mean, Guidelines for the use of various measures of central tendency.

4. **Measures of Dispersion** : Range, mean deviation, standard deviation & variance.
5. **Probability and Standard Distributions:** Meaning of probability of standard distribution, the binominal distribution, the normal distribution, Divergence from normality – skewness, kurtosis.
6. **Correlation & regression :** Significance, correlation coefficient, linear regression & regression equation.
7. **Testing of Hypotheses , Level of significance, Degrees of freedom.**
8. **Chi-square test, test of Goodness of fit & student t-test.**
9. **Analysis of variance & covariance:** Analysis of variance (ANOVA), what is ANOVA? Basic principle of ANOVA, ANOVA technique, Analysis of Co variance (ANCOVA)
10. **Sampling:** Definition, Types- simple, random, stratified, cluster and double sampling. Need for sampling - Criteria for good samples, Application of sampling in community, Procedures of sampling and sampling designs errors.

Bachelor in Medical Radiology & Imaging Technology

Fourth Semester

Pharmacology

Subject code – BRT25403

Min. Hrs. - Theory: 60 Hrs.

Learning objective- The objective of this course is to help the students understand the basic concepts of drugs, their mechanism of action on the human body.

Learning outcome- At the end of the course, the students have thorough knowledge of the basic principle of pharmacokinetics and pharmacodynamics as well as the commonly used drugs, mechanism, indications, contraindications, drug dosage and adverse effects.

THEORY

Topics to be covered:

1. **General Pharmacology:**
   - Introduction, Definitions, Classification of drugs, Sources of drugs, Routes of drug administration,
   - Distribution of drugs, Metabolism and Excretion of drugs, Pharmacokinetics, Pharmacodynamics,
   - Factors modifying drug response.
   - Elementry knowledge of drug toxicity, drug allergy, drug resistance, drug potency, efficacy & drug antagonism.
   - Adverse drugs reactions & management
2. **Autonomic Nervous system:**
   - General considerations – The Sympathetic and Parasympathetic Systems, Receptors, Somatic Nervous System
   - Cholinergic and Anti-Cholinergic drugs, Adrenergic and Adrenergic blocking drugs, Peripheral muscle relaxants.
3. **Cardiovascular Pharmacology :**
   - Antihypertensive and drugs useful in Angina.
4. **Neuropharmacology (in brief) :**
   - Sedative-Hypnotic Drugs: Barbiturates, Benzodiazepines
   - Antianxiety Drugs: Benzodiazepines, Other Anxiolytics
5. **Inflammatory/Immune Diseases-**
   - Non-narcotic Analgesics and Nonsteroidal Anti-Inflammatory Drugs: Acetaminophen, NSAIDs, Aspirin, Nonaspirin NSAIDs, drug Interactions with NSAIDs
   - Glucocorticoids: Pharmacological Uses of Glucocorticoids, adverse effects, Physiologic Use of Glucocorticoids
6. **Digestion and Metabolism (in brief):**
   - Gastrointestinal Pharmacology: Peptic Ulcer Disease, Constipation, Diarrhea
   - Drugs Used in Treatment of Diabetes Mellitus: Insulin, Oral Hypoglycemics
7. **Pharmacology of different dyes used in Radiologyal procedures.**

Bachelor in Medical Radiology & Imaging Technology

Fourth Semester

Clinical Work

Subject code – BRT25404

Min. Hrs. - Practical : 60 Hrs.

Students shall be deputed to various labs of Radiology department wherein they shall undergo practical training of handling patients, collection and processing of investigation (X Ray, Special procedures, CT Scan, MRI, Ultrasound etc) and equipments.

Identification of patient's particulars based on CR number, Lab Number and transfer of samples from collection to different labs.

Process of performing various tests in different labs.

Each student is required to maintain a logbook of the various posting. Student's performance shall be evaluated on continuous basis by the faculty concerned.

Bachelor in Medical Radiology & Imaging Technology
Fifth Semester
Newer Imaging Modalities and Application
Subject code – BRT25501
Min. Hrs. - Theory: 60 Hrs.

Learning objective- The objective is to learn about the clinical aspects of different type of imaging modalities and clinical application of various radio imaging modalities.

Learning outcome- At the end of the course, student will have knowledge on scanning protocol, indications, patient preparation, image quality.

THEORY

Topics to be covered:

1. 3D ultrasound, 4D Ultrasound, Tissue harmonic Imaging, elastography. endoscopic ultrasound, cardiac echo and, non-cardiac applications of Doppler. transcranial doppler applications,
2. CT angiography, virtual endoscopy, duel-energy CT applications, DEXA scanning bone mineral densitometry calcium scoring. CT Guided interventions, CT myelography, CT, dacryo-cisternography, CT cystography. CT-minimum intensity projection, maximum projection, segmentation intensity techniques, 3D CT.
3. MR angiography, TOF imaging techniques in MRA, PC-MRA, CE-MRA, 3D-MR, high filed' magnetic spectroscopy. diffusion MRI, perfusion MRI, MR-spectroscopy, resonance imaging, MRI- fast imaging, functional body MRI, molecular imaging, MRI artifacts and solutions, MR-vascular imaging, time of flight. contrast enhancement, echo planar imaging method. gradient and spin echo (GRASE) method, magnetization preparation. functional Brownian motion imaging diffusion imaging. and diffusion; diffusion coefficient, apparent diffusion coefficient (ADC); diffusion weighted images, ADC map images, blood oxygen level dependent (BOLD) contrast, MRCP.

Bachelor in Medical Radiology & Imaging Technology
Fifth Semester
Equipment of Radio Diagnosis
Subject code – BRT25502
Min. Hrs. - Theory: 60 Hrs.

Learning objective- The objective is to learn about the various equipment used for diagnosis of the medical conditions with various radio imaging modalities.

Learning outcome- At the end of the course, students will have knowledge on radio diagnosis equipment.

THEORY

Topics to be covered:

Equipment and description:

1. Color Doppler
   - Flow Imaging
   - Indication
   - Clinical Application
2. **CT Scan**
   - Advancement in CT- various generations of CT scans, Equipment of CT (gantry-Xray tube, collimation, Filter, high-frequency generator, detector), control consol, couch, Detector technology, slip ring technology, post-processing for CT scan, CTDI CTDIweighted CTDIvol, Dose length product (DLP).
   - Spiral CT/Helical CT scan, Pitch, Detector pitch,
   - Preparation of Patient
   - Contrast Media
   - Indication and Contraindication
   - Technical aspects of various procedures in CT
3. **Nuclear medicines, PET scans, and Mammography**
   - Definition
   - Characteristics of Radio Nuclide
   - Commonly used Radio Nuclides
   - Description of Equipment
   - **Mammography**
   - General anatomy of Breast, Screening mammography, Diagnostic mammography, Mammography equipment- high-frequency generator, X-ray tube, Focal spot size, Target, filter, Grid, Compression peddle, AEC,
   - Screen film mammography, Magnification mammography, Computed radiography mammography, Digital mammography, Digital breast tomosynthesis, Stereotactic mammography, Duel energy subtraction mammography.

Bachelor in Medical Radiology & Imaging Technology
Fifth Semester
Interventional Radiology & Drugs used in Diagnostic Radiology
Subject code – BRT25503
Min. Hrs. - Theory: 60 Hrs.

Learning objective- The objective is to learn about the special procedures done with the interventional approaches in radiology department with the help of Radiologyal equipment's.

Learning outcomes- At the end of the course, student will have knowledge on:
1. Equipment's, procedure, technique and outcome of interventional radiology
2. Drugs, contrast media & equipment's of interventional radiography
3. Sterilized techniques and radiation protections.

THEORY

Topics to be covered:

Interventional Radiology

- Definition
- Indication
- Clinical Application
- Name of different type of procedures

Anesthesia in Diagnostic Radiology

- Facilities regarding general Anesthesia in the X-ray Department.
- Anesthetic Problems associated specific technique)
  a) Vascular Studies
  b) Seldinger Technique
  c) Carotid Angiography
  d) Venography
  e) Oral Cholecystography
  f) Percutaneous Trans Hepatic Cholecystography
  g) T-tube cholangiography
  h) PCNL
  i) TIPS (Trans intrahepatic portal systemic shunt)
  j) CT and NMR

Bachelor in Medical Radiology & Imaging Technology
Fifth Semester
Newer Imaging Modalities and Application
Subject code – BRT25504
Min. Hrs. -Practical: 60 Hrs.

PRACTICAL

1. Based on the theory

Bachelor in Medical Radiology & Imaging Technology
Fifth Semester
Equipment of Radio Diagnosis
Subject code – BRT25505
Min. Hrs. - Practical: 60 Hrs

PRACTICAL

1. Application of various procedures in well-equipped Hospitals and Diagnostic Centers.
2. Uses and functioning method of the ultrasound probe.
3. Patient evaluation of different disease and their diagnosis.
4. Working method of CT scan and MRI.
5. Calculation of radio nuclide

Bachelor in Medical Radiology & Imaging Technology
Fifth Semester
Clinical Work
Subject code – BRT25507
Min. Hrs. - Practical : 120 Hrs.

Students shall be deputed to various labs of Radiology department wherein they shall undergo practical training of handling patients, collection and processing of investigation (X Ray, Special procedures, CT Scan, MRI, Ultrasound etc) and equipments.

Identification of patient's particulars based on CR number, Lab Number and transfer of samples from collection to different labs.

Process of performing various tests in different labs.

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Bachelor in Medical Radiology & Imaging Technology Sixth Semester
Radiotherapy & Brachytherapy techniques in Malignant and Non-Malignant diseases
Subject code – BRT25601
Min. Hrs. - Theory: 60 Hrs.

Learning Objective- The objective is to learn radiotherapy and brachytherapy techniques to be used in malignant and non-malignant diseases.

Learning Outcome- At the end of the course, student will be expert handling patients with malignant and non-malignant disease referred to radiology department. Knowledge to allocate the patients to various modalities according to their pathological condition.

THEORY

Topics to be covered:

1. Orthovoltage Techniques in skin tumours, and cancers of the breast, Advantages and disadvantages of orthovoltage in radiotherapy.
2. Tele isotope cobalt therapy Techniques in skin and deep sealed tumours parallel opposed fields and small beam directed therapy and wedge field Techniques in head and neck tumours especially cancers of larynx treatment, Techniques for cancer of maxillary antrum and pituitary tumours.
3. Treatment techniques in cancer of breast by telecobalt and low energy megavoltage X-rays and electron beam.
4. Tele and brachy-therapy techniques of treatment of different stages of carcinoma cervix uteri with special emphasis on HDR and LDR brachytherapy.
5. Three field Techniques in cancer of esophagus and bladder.
6. Radiotherapy technique in medulo blastoma. Whole body and hemi body radiation Techniques.
7. Treatment Techniques of malignant and non-malignant conditions in ovarian and kidney tumors.
8. Radiation Treatment techniques of lymphomas with special emphasis on mantle field irradiation radiotherapy, techniques in head and neck cancer.

Salient features of computers in radiotherapy and its application.

1. Introduction to computer, Hardware and software component.
2. Input and output data systems computerized treatment planning systems in tele brachytherapy and documentations.

Radiologyal protection

1. Dose limits of occupational workers & Publics.
2. Principle & Method of Protection.
3. Monitoring devices.

Bachelor in Medical Radiology & Imaging Technology
Sixth Semester
Modern Radiological equipment including physics
Subject code – BRT25602
Min. Hrs. - Theory: 60 Hrs.

Learning objectives- The objective is to learn about the various equipment used for digital radiography of medical conditions with various digital modalities.

Learning outcomes- At the end of the course, students will have knowledge on digital Radiography equipment.

THEORY

Topics to be covered:

Computed Radiography: Working principle of CR, Phosphorescence, photostimulable luminescence (PSL), CR imaging plate, CR cassette, Charge-coupled device (CCD). Computed radiography its advantages, disadvantages and applications.

Digital Radiography: Principle of digital radiography, physics & Equipment Direct and Indirect digital radiography,

Flat panel detector (FDP), Thin film transistor (TFT), Digital radiography its advantages, disadvantages and applications.

Picture archiving and communication system (PACS), DICOM, RIS, HIS.

Dental X-ray: Introduction, Dental X-ray tube**,** Type of Dental X-ray film.

Portable X-ray: Mobile X-ray unit- Principle and Functioning, Components of Mobile X-ray units, X-ray Tube and Generator, Mobile C-Arm Units, Applications of Mobile X-Ray Units, Advantages of Mobile X-Ray Units,

Bachelor in Medical Radiology & Imaging Technology
Sixth Semester
Orientation in Clinical Sciences
Subject code – BRT25603
Min. Hrs. - Theory: 60 Hrs.

Learning Objective- The objective is to learn basic pathological conditions related to cardiology, surgery, nephrology, orthopedic, gastrology, neurology and general medicine for the diagnosis.

Learning outcome- At the end of the course, student will be expert handling patients with different disease condition referred to radiology department. Knowledge to allocate the patients to various modalities according to their pathological condition.

THEORY

Topics to be covered:

Medicine

- **Respiratory & cardiac diseases:** Pericarditis, Valvular diseases, Rheumatic Heart Disease, Heart failure, Chronic Bronchitis, Emphysema, Brochitis, Pneumonia, Tuberculosis, Pleural effusion, Empyema, Spontaneous Pneumothorax.
- **Gastro intestinal diseases**: Aclasia cardia, Peptic ulcer, Intestinal obstruction, Crohn's disease, Ulcerative colitis, Pancreatitis, Portal Hypertension, Ascitis, Cirrhosis, Cholecystitis, Diseases of Renal System, Glomerulo nephritis, Nephrotic Syndrome,
- **Renal diseases:** Urinary calculi, Polycystic Kidney disease
- **Disease of brain:** Cerebral Vascular Disorders, Meningitis, Encephalitis.

Orthopaedics

- Fracture
- Type, mechanism, Healing, Delayed Union, Non- complication
- Injuries of the shoulder girdle, Dislocation of shoulder
- Fracture of Humerus, Elbow Forearm
- Fracture of Distal Radius & ulna
- Injuries of the carpal
- Dislocation of Hip
- Femur, Tibia, Ankle, calcaneum
- Acute & chronic osteo arthritis
- Rhematoid arthritis
- Paget's Disease
- Ankylosing spondylitis
- Club foot
- Bone Tumour-Benign Malignant

Surgery

- Cholelithiasis
- Peritonitis
- Supraphrenic Abscess
- Appendicitis
- Benign Hypertrophy of prostate
- Sinusitis

Obstetrics

- Diagnosis of Pregnancy
- Normal Labour

Bachelor in Medical Radiology & Imaging Technology
Sixth Semester
Clinical Work
Subject code – BRT25604
Min. Hrs. - Practical: 120 Hrs.

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