

**NAGALAND UNIVERSITY**

**Regulation and Syllabus for**

**Bachelor of Science in Medical**

**Radiology and Imaging Technology**

**(B.Sc. MRIT)**

**(3+1 years) Degree course**

**2024**

# Regulations for the Allied Health Sciences Bachelor Programs of the Nagaland University

*The Regulations & syllabus are subject to modifications by the University from time to time.*

## 1. Eligibility for Admission:

- (i) The candidate should have passed the Higher Secondary (10+2) from CBSE or State Education Board or any Govt. recognized Board with at least 50% marks for general candidates (UR) and 45% for SC/ST/OBC/NCL candidates in Physics, Chemistry, and Biology.
- (ii) For B.Sc. (Health Information Management) course, candidates with Physics, Chemistry, and Mathematics in 10+2 may also be considered.
- (iii) The candidate should have attained the minimum age of 17 years during the admission.
- (iv) **Lateral Entry:**

Candidates who have completed a two-year diploma programme in the concerned subject from Boards recognized by Central / State Government(s) / State / Central University with at least 50% marks in aggregate for (UR) candidates and 45% marks in aggregate for SC / ST / OBC / NCL candidates shall be eligible for Lateral Entry to the second year (3<sup>rd</sup> Semester) of Bachelor Programme in Allied Health Sciences.

## 2. Duration of the Course:

- (i) Group A: 4 years, i.e., 3 years or 6 semesters of academic studies and one year of internship (B.Sc.HIM, B.Sc.DTT, B.Sc.AOTT, BSc RTT, BSc. MRIT).  
Group B: 4 and a half years, i.e., 4 years or 8 semesters of academic studies and six months of internship (BPT, BOT courses).  
Group C: 4 years, i.e., 3 and a half year or 7 Semesters of academic studies and six months of internship (BMLS) during the 8<sup>th</sup> semester.
- (ii) The maximum duration of the Bachelor Programme for Group A, B & C above shall be N+2 where N is the normal duration of the programme. No student shall be allowed to continue beyond the maximum duration.

## 3. Medium of Instruction:

The medium of instruction for all the Allied Health Sciences courses shall be English.

## 4. Working Days Per Semester:

Each Semester consists of 90 working days, with eight hours of work per day and 40 hours per week, totalling 720 hours per Semester.

## 5. Internship Hours:

One-year Internship programs will include 1440 hours of practical training and Six Months Internship will include 720 hours of practical training.

## 6. Attendance:

- (i) A candidate must secure a minimum of 80% attendance in theory classes. Students who fail to meet the requirement due to illness may be eligible for a 5% condonation, provided they submit a medical certificate from a registered medical practitioner.
- (ii) 100% in skills training (practical/internship) to qualify for the award of degree. In case of insufficient attendance, the candidate's internship period will be extended accordingly. There are no other exceptions to these rules under any circumstances.

## 7. Submission of Log Books:

- a. At the time of practical examination, each candidate shall submit to the examiners his / her Log book duly certified by the Head of the Department as a bonafide record of the work done by the candidate.
- b. The practical record shall be evaluated by the concerned Head of the Department (Internal Evaluator) and the practical record marks shall be submitted to the University 15 days prior to the commencement of the theory Examinations.
- c. In respect of failed candidates, the marks awarded for record at previous examination will be carried over for the subsequent examination. The candidates shall have the option to improve his performance by submission of fresh records.

## 8. Revaluation / Scrutiny of Answer Papers:

- (i) There is no provision for candidate to request for revaluation of the answer papers of failed candidates in any examination. However, the failed candidates can apply for scrutiny.
- (ii) Nagaland University shall constitute a Result Moderation Committee of 3 members.

## 9. Pattern of Question Paper for University Examination:

Descriptive type Questions	=30%
Descriptive Short Notes	=30%
Short Answer questions	=20%
MCQ Type	=20%

## 10. Assessment:

- (i) Assessment for theory and practical examinations: - Students must attain at least 50% marks in each theory and practical component, both in internal assessments and in the final University examinations to pass the course. The final marks will be 75% from the University examination and 25% will be from the internal assessment.
- (ii) The distribution of marks between theory and practical shall be provided in the **Curriculum and Syllabi** of each course.

- (iii) Assessment for internship: - During the internship, students gain clinical experience and learn to document patient care effectively. Each student must maintain a logbook and a portfolio.

Activity	Marks %	Assessor
Log book	20	Supervisor
Portfolio*	20	Supervisor
Practical	40	Examiners
Viva voce	20	Examiners

\*The portfolio provides one with an opportunity to demonstrate the breadth and depth of your knowledge on certain topics

The portfolio incorporates the follow documents:

- Curriculum vitae
- Progress reports
- “Summary of Competency Achievement” demonstrating the level of competency achieved in each sub-module.
- Samples of work prepared by the intern from at least 5 of the modules of internship training guide.

A presentation delivered covering key aspects of the module

The clinical supervisor will examine the portfolio at regular (at least once in three months) intervals and provide feedback to the Intern.

- (iv) Mode of Evaluation: -

Evaluation for Theory papers during Odd End Semester Examination shall be internally done by the colleges and Theory papers during Even End Semester Examinations shall be externally evaluated or as notified by the University.

## 11. Internship Project:

As part of the internship, students are required to choose a relevant subject and prepare an in-depth project report, which should include the objective, scope of the project, and a detailed report.

## 12. Advancement to the Next Semester:

Advancement to the next semester is contingent upon meeting the following conditions and clearing any backlogs as described: -

A student may not fail in more than two papers in the preceding semester to be eligible to advance to the next semester.

**13. Repeat examination for failed candidates:**

Failed papers in odd semesters can be repeated during the exams of the subsequent odd semester. Similarly, failed papers in even semesters exams can be repeated during the subsequent even semester exams.

**14. Vacation:**

Maximum of 15 days including Saturdays and Sundays

**15. Re-Admission after Break of Study:**

Students shall be allowed to continue after break in studies provided the maximum duration as given in Clause- 2 (ii) is not exceeded.

**16. Award of the Degree:**

- a. Candidates who have passed all written examinations and successfully completed the compulsory internship as per the university's requirements will be awarded the degree.
- b. Final Consolidated Mark sheet shall be issued by the Nagaland University to the candidate after submission of his/her Internship Completion Certificate by the College.

**17. Academic Calendar:**

- a. Odd semester shall be from July to December, and Even semester shall be from January to June.
- b. The odd semester and even semester university (end) examinations shall be conducted in the months of December and June respectively.

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**Bachelor of Science in Medical Radiology and Imaging Technology**

**(BSc. MRIT)**

**Semester Wise Distribution of Subjects**

**Total Credits=132; Total Marks=3800.**

Semester	Code	Subject	Credits		Total	MARKS					Total Hours	
			Theory	Practical		Internal		Semester		Total	Theory	Practical
						Theory	Practical	Theory	Practical			
1st Semester	BSc. MRIT-101	Human Anatomy & Physiology	4	1	5	30	20	100	50	200	72	36
	BSc. MRIT-102	Basic Sciences (Biochemistry, Microbiology, Pathology, Pharmacology)	4	1	5	30	20	100	50	200	72	36
	BSc. MRIT-103	English, Computer, Ethics and Medical terminology	4	1	5	30	20	100	50	200	72	36
	BSc. MRIT-104	Biostatistics & Sociology	2	3	5	30	20	100	50	200	36	108
<b>Total</b>					<b>20</b>					<b>800</b>	<b>252</b>	<b>216</b>
2nd Semester	BSc. MRIT - 201	Basic radiological physics	4	3	7	30	20	100	50	200	72	108
	BSc. MRIT - 202	Physics of Radiographic equipment	4	3	7	30	20	100	50	200	72	108
	BSc. MRIT - 203	Hospital practice and patient care	4	2	6	30	20	100	50	200	72	72
		<b>Total</b>			<b>20</b>					<b>600</b>	<b>216</b>	<b>288</b>
3rd Semester	BSc. MRIT - 301	Radiographic Photography and Image Processing Techniques	4	2	6	30	20	100	50	200	72	72
	BSc. MRIT - 302	Clinical Radiography-Positioning Part 1	4	3	7	30	20	100	50	200	72	108
	BSc. MRIT - 303	Contrast & Special Radiography Procedures	4	3	7	30	20	100	50	200	72	108
		<b>Total</b>			<b>20</b>					<b>600</b>	<b>216</b>	<b>288</b>

Semester	Code	Subject	Credits		Total	MARKS					Total Hours	
			Theory	Practical		Internal		Semester		Total	Theory	Practical
						Theory	Practical	Theory	Practical			
4th Semester	BSc. MRIT - 401	Patient care in Medical Imaging Department	4	3	7	30	20	100	50	200	72	108
	BSc. MRIT - 402	Clinical Radiography Positioning Part 2	4	3	7	30	20	100	50	200	72	108
	BSc. MRIT - 403	Physics of Advanced Imaging Modalities	4	2	6	30	20	100	50	200	72	72

		Total			20					600	216	288																		
5 <sup>th</sup> Semester	BSc. MRIT - 501	Cross sectional anatomy and Physiology	4	4	8	30	20	100	50	200	72	144																		
	BSc. MRIT - 502	Research Methodology	4	-	4	25	-	75	-	100	72	-																		
	BSc. MRIT - 503	Quality Control in Radiology	4	4	8	30	20	100	50	200	72	144																		
		<b>Total</b>			<b>20</b>					<b>500</b>	<b>216</b>	<b>288</b>																		
6 <sup>th</sup> Semester	BSc. MRIT - 601	Radiation Safety in Radiology	4	3	7	30	20	100	50	200	72	108																		
	BSc. MRIT - 602	Advanced Imaging Techniques	4	3	7	30	20	100	50	200	72	108																		
	BSc. MRIT - 603	Quality Assurance & Radiation Safety (AERB Guidelines) in Diagnostic Radiology Part 2	4	2	6	30	20	100	50	200	72	72																		
		Total			<b>20</b>					<b>600</b>	<b>216</b>	<b>288</b>																		
4 <sup>th</sup> Year	Internship	12-month compulsory rotational clinical posting Project submission Mid-term assessment Final Practical & Viva			12					<b>100</b>		<b>1440</b>																		
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	Theory	Practical	Total																											
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Total			1440																											

**INTERNSHIP – Minimum 1440 hours (calculated based on 8 hours per day, if 180 working days in one-year span)**

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Bachelor of Science in Medical Radiology and Imaging Technology  
(BSc. MRIT)  
**SEMESTER-1:20 CREDITS**

**BSC. MRIT-101: HUMAN ANATOMY AND PHYSIOLOGY**

**SUBJECT DESCRIPTION:** Human anatomy and physiology is designed to provide students with the working knowledge of the structure and the functions of the human body which is essential foundation for their clinical studies.

**Anatomy:**

**Unit I: BASIC CONCEPTS OF ANATOMY:**

Subdivisions of anatomy, anatomical position and anatomical terms: - Regions, cavities and systems of the body. General Tissues:- Definition of tissues, Classification, location and function of different types of tissues. General features of cartilage - Types of cartilage and their location. General features and classification of bones and joints: Parts of developing long bone, Classify bones with example, Synovial joint with diagram. General features of muscles, vessels and nerves: Classify the types of muscle, their location and functions, Parts of a muscle – belly and tendon, Differentiate artery and vein, Layers of blood vessel.

**Unit II: SKELETAL SYSTEMS:**

Describe the features of bones and joints of the skull, upper limb, lower limb, vertebral column, ribs, sternum - Parts of a long bone , Describe briefly the salient features of clavicle, scapula, humerus, radius, ulna, phalanges, hip bone, femur, fibula, tibia, sternum - Parts of a typical rib and the vertebra , Names of skull bone, carpal bones and tarsal bones , Description of major joints like shoulder, elbow, hip and knee joint.

**RADIOLOGICAL ANATOMY:** Introduction: Standard view of radiographs, Types of Radiographs, X-ray appearance of normal skeleton. Radiographic appearance of shoulder, elbow, wrist and hand, hip, knee, ankle foot

**PATHOLOGICAL CONSIDERATION:** Fracture, dislocation, arthritis, tumors of bone, healing of fractures, Kyphosis, scoliosis.

### **Unit III: MUSCULAR SYSTEMS:**

Name the muscles and know the attachments, nerve supply and actions of important muscles of head & neck, trunk, upper limb and lower limb. Describe the location and nerve supply of: Deltoid, Pectoralis major, Intercostal muscles, Diaphragm, Gluteus maximus, Gluteus medius, Gluteus minimus, sternocleidomastoid

### **UNIT IV: CIRCULATORY SYSTEMS:**

**The heart** – covering, chambers, and external features, Blood supply , Great vessels of the heart , Pericardium and pericardial cavity, Surface marking of apex of heart, Chambers of heart , Valves of heart , Coronary vessels supplying the heart , Branches of Aorta.

**Blood vessels** - position and distribution of major arteries and their branches, Position and the tributaries of superficial and deep veins, dural venous sinuses – Position and branches of brachial artery, radial artery, ulnar artery, palmar arches, femoral artery, popliteal artery, anterior and posterior tibial artery, dorsalis pedis artery – Position of cephalic, basilic and median cubital vein of the upper limb - Position of long and short saphenous vein of lower limb - Location of superior sagittal sinus, inferior sagittal sinus, straight sinus, transverse sinus and sigmoid sinus in the cranial cavity

RADIOLOGICAL ANATOMY: Chest – PA view, oblique view

PATHOLOGICAL CONSIDERATIONS: Congenital heart diseases, acquired heart diseases, infarction, collateral circulation

### **UNIT V: LYMPHATIC SYSTEM:**

General and regional arrangements of the lymphatic system, the lymphatic organs, lymph nodes of axilla, inguinal region, thorax, abdomen and neck, Location and drainage areas of different groups of lymph nodes in the body, Location and functions of thymus, spleen, lymph nodes and tonsils

### **UNIT VI: RESPIRATORY SYSTEM:**

The nasal cavity, larynx, trachea, lungs and pleura, the paranasal air sinuses - Describe briefly the conducting and respiratory part, Types and location of paranasal sinuses. Larynx - Extend and

relation of trachea with the esophagus, Pleura and pleural cavity, Lobes of lung and difference between the right and left lung.

RADIOLOGICAL ANATOMY: Plain X-ray chest, Bronchogram

PATHOLOGICAL CONSIDERATION: Tracheostomy, pleural effusion, pneumothorax, bronchoscopy

#### **UNIT VII: DIGESTIVE SYSTEM:**

Mouth, salivary glands, pharynx, esophagus, stomach, small and large intestine, the liver and biliary system, and the pancreas. Types of major salivary gland, their location and functions, Parts of pharynx, Location and the parts of stomach. Parts of large and small intestine and their location, Lobes of liver and portal triad. Location and parts of gall bladder - Parts of pancreas, its secretion and functions. Blood supply of the stomach and intestine, Portal vein formation

RADIOLOGICAL ANATOMY: Barium swallow, barium meal, barium enema, cholecystogram

PATHOLOGICAL CONSIDERATION: Hypertrophic congenital pyloric stenosis, peptic ulcers, carcinoma, cholecystitis, cholelithiasis, oesophagoscopy, gastroscopy, sigmoidoscopy, gastrostomy, ileostomy, colostomy, gastrectomy, colectomy, cholecystectomy

#### **Unit VIII: URINARY SYSTEM:**

Kidneys, ureter, urinary bladder, urethra - Location and internal structure of kidney - Microscopic structure of a nephron - Extend of ureter and the constrictions - Position of urinary bladder and its relation in males and females.

RADIOLOGICAL ANATOMY: X-ray KUB, IVP

PATHOLOGICAL CONSIDERATION: Dysuria, cystitis, pyelonephritis, calculus kidney

#### **Unit IX: REPRODUCTIVE SYSTEM:**

Male reproductive organs – testes, epididymis, seminal vesicle and prostate - relation of prostate with the neck of urinary bladder.

Female reproductive organs - uterus, ovary, fallopian tube, cervix, vagina and mammary gland - Uterus – location, parts and layers - Parts of fallopian tube - Location of ovary and ovulation

RADIOLOGICAL ANATOMY: Hysterosalpingogram

PATHOLOGICAL CONSIDERATION: Abnormalities of uterus, polycystic ovary, cancer cervix, benign prostatic hypertrophy, cancer prostate.

**Unit X: NERVOUS SYSTEM:**

Central nervous system – Brain – lobes, sulci and gyri, ventricular system, blood supply, circle of Willis and spinal cord. Parts of brain, Lobes of brain, Major sulci - central sulcus, lateral sulcus, parietooccipital and calcarine sulcus, Major gyri - pre and postcentral gyrus. Important functional areas - Motor, sensory, visual and auditory areas - Ventricles of brain and Flow of Cerebrospinal fluid - Circle of Willis and significance - External features of spinal cord - Meninges

**Unit XI: PERIPHERAL NERVOUS SYSTEM:**

Cranial nerves and somatic nerves; Formation and branches of brachial, lumbar and sacral plexus. The basic organization of the autonomic nervous system - Spinal nerves - Cranial nerves in order, Major branches of brachial plexus - ulnar nerve, radial nerve, musculocutaneous nerve, axillary nerve and median nerve in the upper limb, Major nerves from the lumbosacral plexus - femoral nerve and sciatic nerve

RADIOLOGICAL ANATOMY: X-ray skull

PATHOLOGICAL CONSIDERATION: Hemiplegia, quadriplegia, paraplegia, hydrocephalus, Erb's paralysis, claw hand, wrist drop, foot drop

**Unit XII: ENDOCRINE SYSTEM:**

The location of pituitary, thyroid, parathyroid, pancreas, adrenal, testis and ovary Pathological consideration: Pituitary tumors, gigantism, acromegaly, thyrotoxicosis, goiter, hyperthyroidism, hypothyroidism, diabetes mellitus

**Unit X III: SENSORY ORGANS**

Basic structure and function of eye, ear and skin

**Physiology:**

**Unit I: BLOOD:**

Composition, properties and functions of blood, Blood groups, Blood indices - MCV, MHC, MCHC, ESR, PCV, Lymph – Formation, circulation, composition and functions of lymph.

**Unit II: MUSCULAR SYSTEM:**

Neuromuscular junction Muscle tone

**Unit III: CARDIOVASCULAR SYSTEM:**

Function of heart – systole, diastole, heart sound, cardiac output, conducting system of heart, blood pressure, circulation of blood

**Unit IV: RESPIRATORY SYSTEM:**

Mechanism of Respiration, Gaseous exchange in lungs and tissues, lung volume and capacities

**Unit V: DIGESTIVE SYSTEM:**

Deglutition, peristalsis, movements of the stomach, small intestine & large intestine, defecation, Functions of the liver, gall bladder, bile, pancreas

**Unit VI: EXCRETORY SYSTEM:**

Functions of kidneys, formation of urine, micturation

**Unit VII: REPRODUCTIVE SYSTEM:**

Oogenesis, Menstrual cycle, ovarian cycle, Spermatogenesis, maturation of sperm

**Unit VIII: NERVOUS SYSTEM:**

Reflex action, Sensory pathway, Motor pathway, CSF formation, circulation properties and composition, lumbar puncture

**Unit IX: ENDOCRINE SYSTEM:**

Functions of pituitary, thyroid, parathyroid, adrenals, pancreas, gonads

**Unit X: SENSE ORGANS:**

Visual and accommodation pathway, Mechanism of hearing

**References:** a) Textbook of Physiology by A.K. Jain

b) Textbook of Physiology by Chaudhuri Sujit K

c) Ghai's textbook of practical physiology by VP Varshney & Mona Bedi

**SUBJECT DESCRIPTION:** This subject on Basic Sciences is designed to provide the students introduction to Biochemistry, Pharmacology, Pathology and Microbiology,

**Unit I: Biochemistry:**

Basics of carbohydrates, Amino acids, Protein and Non-protein, Lipids, Enzymes, Minerals- Iron, Calcium & Magnesium, Normal value ranges

**Unit II: Pharmacology:**

General definitions- Pharmacology, Drugs, Medical pharmacology, Toxicology, Pharmacodynamic properties, Pharmacokinetic properties

- Introduction to pharmacology, Basic pharmacology terminology and concepts
- Introduction to pharmacodynamics
- Introduction to pharmacokinetics- absorption, distribution, elimination
- Mechanism of drug action, dosage forms, routes of administration
- Common generic and trade names
- Medication errors, Legal aspects in pharmacology

**UNIT III: Pathology**

General Pathology Adaptations, Cell Injury and Repair: Hyperplasia, atrophy, metaplasia, necrosis and apoptosis - Differences between apoptosis and necrosis.

Acute and Chronic inflammation: Five cardinal signs of inflammation- Outcomes of acute inflammation- Chronic inflammation -Granulomatous inflammation -Acute phase proteins

Tissue repair, regeneration and hemodynamic disorders: Cutaneous wound healing-Pathologic aspects of repair-Hyperaemia and congestion-Thrombosis and Virchow triad-Embolism-Infarction-Shock; Bronchial asthma, COPD - Tumors

Diseases of immune system: Hypersensitivity reaction -Type I, II, III, and IV hypersensitivity reactions

Neoplasia: Definition of neoplasia. Differences between benign and malignant tumors; Metastasis; Carcinogenesis – Causes; Carcinoma of oral cavity – Causes; Etiology of Carcinoma cervix – type of virus implicated, high risk sero-types, Screening investigations; Breast carcinoma – Risk factors.

**UNIT IV: Microbiology**

Introduction and historical background of Microbiology, classification special characteristics of organisms, cultivation (Different types of Media) and identification of organisms, Sterilization techniques; Basics of Immunology- Ag Ab reaction & Basics in Immune response & Hypersensitivity, Parasites and Fungi

**References:**

1. Textbook of Biochemistry for Medical Students 6th Edition, DM Vasudevan, Sreekumari S , KannanVaidyanathan.
2. Textbook of Microbiology 9th Edition, Ananthanarayan, Paniker.
3. Text book of pathology & Genetics by Purnima S. Rao

## **BSC. MRIT-103: ENGLISH, COMPUTER, ETHICS AND MEDICAL TERMINOLOGY**

**SUBJECT DESCRIPTION:** The subject is on communicative English, learning word processing, other basic computer application such as excel, power point, medical ethics and medical terminology for technologists.

- **ENGLISH:**

**Unit I: STUDY TECHNIQUES:** Organization of effective note taking and logical processes of analysis and synthesis Use of the dictionary. Enlargement of vocabulary Effective diction

**Unit II: APPLIED GRAMMAR:** Correct usage the structure of sentences, the structure of paragraphs Enlargements of Vocabulary

**Unit III: WRITTEN COMPOSITION:** Precise writing and summarizing Writing of bibliography Enlargement of Vocabulary

**Unit IV: READING AND COMPREHENSION:** Review of selected materials and express oneself in one's words. Enlargement of Vocabulary.

**Unit V: THE STUDY OF THE VARIOUS FORMS OF COMPOSITION:**

Paragraph, Essay, Letter, Summary, Practice in writing

**Unit VI: VERBAL COMMUNICATION:** Discussions and summarization, Debates, Oral reports, use in teaching

**Unit VII: LANGUAGE AND COMMUNICATION SKILLS:** Basic concepts in English communication - Grammar and Usage - Pronunciation. Communication Skills: Formal conversation, Informal conversation, Telephone conversation - Case Presentation - Interviews. Writing Skills: Writing paragraphs, formal letters, reports - Case study - E-mails. Study Skills: How to take notes – preparing assignments - listening to lectures – summary writing - exam preparation

### **MEDICAL ETHICS**

**Unit VIII:** Medical ethics – Definition, Goal, Scope, Basic principles of medical ethics - Confidentiality, Malpractice and negligence, Autonomy and informed consent, Right of patients, Medico legal aspects of medical records, Medico legal case and type ,Records and documentation , Development of standardized protocol to avoid near miss or sentinel events - Obtaining an informed consent. Introduction to NABH guidelines

- **COMPUTER**

**Unit IX:** Introduction to computer - Input & output devices, CPU, Memory, Storage devices. Introduction of Windows OS - MS-Word: Creating, opening, inserting, formatting, saving, and printing the document, Spell check, Creating and editing table , Mail merge.

**Unit X:** MS Office: MS-Excel: Creating, data entry, formatting, saving, and printing the worksheet - Creating graphs. MS-Power point: Creating and formatting presentations, enhancing text, slides with graphs and tables.

**Unit XI:** Computer networks: Types of network - LAN, WAN, Intranet. The Internet and its Applications, Application of Computers in clinical settings.

**Unit XII:** Introduction to - PACS-Picture Archiving in Communication in Medicine - DICOM – Digital Imaging for Communication in Medicine

- **Medical Terminology**

**References:**

- a) Manipal Academy of higher education; English book for Nurse by Selva Rose, 3<sup>rd</sup> Edition
- b) Selva Rose. 1997, Career English for Nurses. Published by: Orient Blackswan Ltd
- c) Quirk Randolph and Greenbaum Sidney, 1987. A University Grammar of English, Hong Kong: Longman group (FE) Ltd/ Pearson.
- d) Thomson A.J. and Maituiet A.V. 1987, A Practical English Grammar, Delhi: Oxford University Press.
- e) Gimson A.C.1989, An Introduction to pronunciation of English. Hodder Arnold; 4th Revised edition (1 May 1989).
- f) O'Connor J.D, 1986. Better English pronunciation
- g) Quirk Randolph and Greenbaum Sidney, 1987. A University Grammar of English, Hong Kong: Longman group (FE) Ltd/ Pearson.
- h) Computer Fundamentals: Pearl Software
- i) Fundamentals of Computers: E.Balagurusamy
- j) Principles of Bioethics: Tom Beauchamp & Childress



## BSC. MRIT-104: BIOSTATISTICS/SOCIOLOGY

**SUBJECT DESCRIPTION:** The subject is on biostatistics and sociology where students learn about different types of data and presentation of data and about sociology

- Unit I** : Biostatistics General Statistics
- Unit II : Definition and importance of biostatistics
- Unit III : Types of data, rates and ratio
- Unit IV : Methods of collection of data-primary and secondary data Sampling of data
- Unit VI : Measures of central tendency (Mean, median, mode) , Measures of Dispersion (Mean deviation, standard deviation, Range)
- Unit VII : Presentation of data (Bar diagram, Pie diagram, Histogram, Frequency, Polygon,
- Unit VIII : Frequency curve, Cumulative frequency curve, Line diagram) Correlation and Regression analysis, Basic concept of probability

### References:

- (a) Croxton – elementary statistics
- (b) Biostatistics: Basic Concepts and Methodology for the Health Sciences- Wayne W. Daniel , Chad L. Cross
- (c) Introduction to Biostatistics and Research Methods Fifth Edition- P.S.S. Sundar Rao, J. Richard
- (d) Mahajan’s Methods in Biostatistics for Medical Students and Research Workers-Bratati Banerjee.
- (e) Sociology of Health and Medicine-Nagla madhu
- (f) Sociology: Principles of Sociology with an Introduction to Social Thoughts-C N Shankar Rao
- (g) Handbook Of Medical Sociology For Nursing,Physiotherapy And Paramedical Students-Varun Malhotra

## SEMESTER-2: 20 CREDITS

### **BSC. MRIT-201: BASIC RADIOLOGICAL PHYSICS**

**SUBJECT DESCRIPTION** –This subject will introduce student to the basic physics concepts, principles necessary to learn the physics related to radiology.

#### **Unit I: STRUCTURE OF MATTER:**

Constituents of atoms, atomic and mass, energy units, electron shells, atomic energy levels, nuclear forces, Nuclear energy levels. Atomic structure Nucleus, Electromagnetic spectrum, Energy quantization, Relationship between wavelengths, Frequency, Energy.

#### **Unit II: PHYSICS UNITS AND MEASUREMENTS**

Force, Work, Power, energy temperature and heat SI units of above parameters. Atomic Number, Mass No., electron orbit and energy levels Periodic table, Isotopes, Isobars, Ionization and excitation. Electromagnetic radiation.

**Unit III: 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 Magnetism: Magnetic induction magnetic Properties Hysteresis magnetic effect of current Electrical instruments, Galvanometer, voltmeter, ammeter and multimeter.

**Unit IV: RECTIFICATION AND TRANSFORMERS:** Principle of rectification, wave form of half wave and full wave current/voltage wave form; Rectifiers: Introduction, energy bands in solids, the semiconductor, p-type and n-type semiconductors, density of charge carriers and conductivity, p-n junction, p-n junction diode, p-n junction diode as rectifier (half-wave and full-wave rectifier), rectifiers relative merits and demerits; silicon, germanium diodes. Principles of transformer, Electromagnetic induction, transformer design, efficiency of transformer, source of power loss

**Unit IV: ELECTROMAGNETIC RADIATION:** Electromagnetic radiation spectrum, common properties of electromagnetic radiation; relationship between energy, frequency, wavelength and velocity e.g. X-rays and gamma rays. Properties of X-rays and gamma rays; General properties of X-rays, velocity, frequency etc., photographic effect, photochemical effect – discolouration of salts, heating effect, biological effect; ionization of gases e.g., air.

#### **Unit V: RADIOACTIVITY:**

Natural and artificial radioactivity, Isotope, isobar and isotone, alpha decay beta decay and spectra, gamma emission, positron decay, electron capture and internal conversion, , exponential decay. Half-life. activity, Curie, Becquerel specific activity

Radiation sources Natural and artificial production of radio isotopes Nuclear fission, nuclear reactor, reactor produced isotopes, fission products Gamma ray source for medical uses.

#### **Unit VI: RADIATION QUANTITIES AND UNITS:**

Photons, Fluence, Exposure – Roentgen, absorbed dose, rad, Gray, Roentgen to rad conversion, , equivalent dose, effective dose and their units., Flux-Fluence-absorbed dose and KERMA, exposure rate constant, gamma ray constant, Measurement of exposure, Free air chamber, Thimble chamber,

#### **Unit VII: INTERACTION OF RADIATION WITH MATTER**

Attenuation of X-ray or Gamma rays, absorption and scattering, half value layer, Coherent scattering, Photoelectric absorption, Compton scattering, Pair production and photo electric disintegration. X-ray transmission of through Medium, Linear, and mass attenuation coefficients, total attenuation coefficient, HVT, TVT and interaction of charged particle and neutrons with matter. LET, Interaction of X and Gamma rays with fat, soft tissue, and bone. Relative importance of different types of interactions.

#### **References:**

- a) The physics of radiation therapy, Faiz M. Khan, 5th edition (2014), Lippincott, Williams and Wilkins, USA.
- b) Christensen's Physics of Diagnostic Radiology – Christensen & Christense
- c) Fundamental of Xray Fundamental of Xray and Radium Physics Joseph
- d) Basic Medical Radiation Physics – Stanton
- e) Physics for Radiography - Hay and Hughs
- f) Ball and mores essential physics radiographers, IV edition, Blackwell publishing.
- g) Basic Medical Radiation physics – Stanton.
- h) Christensen's Physics of Diagnostic Radiology – Christensen

## BSC. MRIT- 202: PHYSICS OF RADIOGRAPHIC EQUIPMENT

**SUBJECT DESCRIPTION:** The students will be able to understand and appreciate the construction, essential parts and functioning of radiographic equipment used for imaging.

**Unit I: X-ray Tube:** X-ray tube design: History, early tube design (Coolidge tube), X-ray tube design requirements: cathode assembly, anode assembly, anode configurations – stationary, rotating anode x-ray tubes, filament current, tube current, thermionic emission, space charge effect, anode heel effect, line focus principle, tube housing, efficiency of x-ray production, modern x-ray tubes, grid controlled x ray tube, heat dissipation methods, tube rating charts, anode cooling curves, tube overloading, operating conditions. Filtration and scatter radiation.

X-ray production: Characteristic and Bremsstrahlung radiation, X-ray spectrum, quantity and quality of x-ray beam.

**Unit II: X-Ray generators and circuits:** Types of generators – single phase, three phase, high tension generator, falling load generator, capacitor discharge generator. High tension circuits- autotransformer, filament circuit, operating console (kV, mA, timer circuits), timers- synchronous timer, electronic timer, mAs timer, automatic exposure control (AEC), X-ray tube circuit, – Rectification - half wave & full wave rectification -three phase circuits- 6 and 12 pulse rectifier circuits, voltage ripple.

### **Unit III: X-Ray Grids /Bucky**

Scattered Radiation -Significance of scatter – Beam limiting devices.-Grid principle and structure – Types of Grids - vertical bucky- versatile bucky -Stationary grid, parallel grid, focused grid – crossed grid, moving grid – Potter Bucky Diaphragm- Control of scattered radiation and grids/Bucky - Methods of minimizing formation of scatter radiation, types of grids and grid ratio- use of cones – diaphragm/ light beam devices - effectiveness of collimation - limitations of the primary beam/the light beam diaphragm -Effects of scatter radiation on radiograph image quality, patient dose and occupational exposure.

**Unit IV: X-Ray Cassettes & Intensifying screens:** Fluorescence – constituents of intensifying screens – types of screens-intensification factors-speed of screen – screen unharness. Cassette-construction-types of cassettes- use of fluorescent screen in radiology, effect of screen in reduction of patient dose.

**Unit V - Computed radiography:** its principle, physics & equipment. Digital Radiography. CR Cassettes, CR Reader, principle of image formation, advantages and disadvantages.

- **Unit VI: FLUOROSCOPY:**

Fluoroscopy imaging technique, history, fluoroscopy imaging components, image intensifiers – construction, principles, brightness gain, automatic brightness control (ABC), optical coupling, television camera – vidicon, plumbicon, picture tube, cine fluorography. Digital Radiography Flat panel detectors: construction, principle, pixel binning, digital subtraction angiography, road mapping. Direct and indirect digital radiography and fluoroscopy systems. Digital radiography and Computed radiography its advantages, disadvantages, and applications.

**Unit VII: TOMOGRAPHY:**

Theory of tomography – multi section radiography, tomographic equipment Computed tomography, scanning principle, Generations of CT, Reconstruction of image, storing the image, viewing the image, evaluation of the image. Equipment for computed tomography, Table, scanning gantry X-ray generator, image quality. Dual energy x-ray absorptiometry (DEXA)

**Unit VIII:** Picture archiving and communication system (PACS)

**References:** a) Christensen's Physics of Diagnostic Radiology – Christensen & Christensen

b) Physics for Radiography Hay and Hughes

c) Handbook of Physics in Diagnostic Imaging - Roshan S. Livingstone

d) The Essential Physics of Medical Imaging - Jerrold T. Bushberg

e) Physics of Radiology and Imaging by Thayalan

## **BSC. MRIT-203: HOSPITAL PRACTICE AND PATIENT CARE**

**SUBJECT DESCRIPTION:** The students will be able to learn and appreciate the role of technologists in patient care, hospital practice, their principles, and procedures such as first aid, managing infections and departmental procedures.

### **Unit I: GENERAL PRINCIPLE OF HOSPITAL PRACTICES:**

Modern hospital treatment is based on teamwork; it is essential that the student should appreciate the technologists' role and that the importance of co-operation with wards and other departments. The students should be attached to wards or the accident and emergency department for a definite training period, the length of time being suited to the individual hospital.

Hospital procedure: Hospital staffing and organization; records relating to patients and departmental statistics; professional attitude of the technologist to patients and other members of the staff; medico- legal aspects; accidents in the departments appointments organization; minimizing waiting time; out-patient and follow-up clinics; stock-taking and stock keeping.

### **Unit II: CARE OF THE PATIENT:**

FIRST contact with patients in the department; management of chair and stretcher patients and aids for this, management of the unconscious patient; elementary hygiene; personal cleanliness; hygiene in relation to patients (for example clean linen and receptacles, nursing care; temperature pulse and respiration; essential care of the patient who has a tracheotomy; essential care of the patient who has a colostomy; bedpans and urinals; simple application of a sterile dressing. Care of patients with infectious/ contagious diseases

### **Unit III: FIRST AID:**

Aims and objectives of first aid; wounds and bleeding, dressing and bandages; pressure and splints, supports etc. Shock; insensibility; asphyxia; convulsions; resuscitation, use of suction apparatus, drug reactions; prophylactic measures; administration of oxygen; electric shock; burns; scalds; hemorrhage; pressure points; compression band. Fractures; splints, bandaging; dressing, foreign bodies; poisons; Basic life support, CPR

**Unit IV: INFECTION:**

Bacteria, their nature and appearance; spread of infections; auto-infection or cross infection; the inflammatory process; local tissue reaction, general body reaction; ulceration; asepsis and antisepsis.

**Unit V: PRINCIPLES OF ASEPSIS:**

Sterilization - methods of sterilization; use of central sterile supply department; care of identification of instruments, surgical dressings in common use, including filamented swabs, elementary operating theatre procedure; setting of trays and trolleys in the radiology department.

**Unit VI: DEPARTMENTAL PROCEDURES:**

Department staffing and organization; records relating to patients and departmental statistics; professional attitudes of the technologist to patients and other members of the staff, medico-legal aspects accidents in the department; appointments; organization; minimizing waiting time; out-patient and follow up clinics; stock taking and stockkeeping.

**Unit VII: DRUGS IN THE DEPARTMENT:**

Storage: classification; labelling and checking, regulations regarding dangerous and other drugs; units of measurement, special drugs, anti-depressive, anti-hypertensive etc.

**References:**

1. Principles of Hospital Practice and Patient Care by P Srinivasulu Reddy, Paras Medical Books Pvt Ltd
2. Textbook of nursing foundation-I Clement
3. Principles and practice of nursing –Sr Nancy.Vol 1 & 2
4. Care of patient in diagnostic Radiography" Chesney & Chesney ( Blackwell Scientific )
5. Chesney's Care of the patient in Diagnostic Radiography" Pauline J . Culmer. ( Blackwell Scientific )
6. Aid to Tray and Trolley Setting" Marjorie Houghton ( Bacilliere )
7. First Aid' Haugher & Gardner ( Hamlyn. )
8. Practical nursing and first- aid" Ross and Wilson ( Livingstone

## SEMESTER-3: 20 CREDITS

### **BSC. MRIT- 301: RADIOGRAPHIC PHOTOGRAPHY AND IMAGE PROCESSING TECHNIQUES**

**SUBJECT DESCRIPTION:** The students will learn about different radiographic photography and will know about different image processing techniques.

**Unit I: X-ray film materials:** Structure of film emulsion-Grain Technology-Gelatin-Basic film types-Film formats and packing-Direct exposure duplitized films-Single coated emulations-Films for specialised use-manufacturing process.

Sensitometry: Photographic density—characteristic curve –information from the characteristic curve-speed Vs definition

Storage of x-ray film-unprocessed film-radiographs

**Unit II: Intensifying screens and cassettes:** Intensifying screen- phosphor-Construction-Intensifying factor-speed and detail-crossover effect-resolution-mottle-reciprocity-screen asymmetry- screen-film contact- screen types and cleaning.

New phosphor technology-influence of kilo voltage. Photostimulable phosphor imaging x-ray cassette-design-types- Identification of cassettes- General care of cassettes and storage.

**Unit III: Photochemistry:** Film processing-latent image formation-Mechanism-theory-Developer-nature of development-pH scale-constitution of developer-development time-factors in the use of developer. Fixers-constitution of fixing solution-factors affecting the fixer-replenishment of fixer--silver conservation-Drying –developer and fixer for automatic film processor-rinsing-washing and drying.

**Unit IV: Processing equipment:** Materials for processing equipment-manual processor-care of processing equipment-automatic processor-manual VS automatic-principles and typical equipment Microprocessor control-Cine Processing-Daylight systems-Processing faults-maintenance

**Unit V: Processing room:** Day light processing-location of the dark room-dark room illumination-equipment and layout-x-ray viewing room.



Daylight handling-daylight systems with cassettes-without cassettes.

**Unit VI; Radiographic image**-components of image quality-un-sharpness in radiographic image-contrast of the radiographic image-distinctness of the radiographic image-size, shape and spatial relationships.

Presentation of radiographs-opaque letters and legends- perforating devices-actinic markers-Identification of dental films-preparation of stereo radiographs-viewing conditions

**Unit VII: Monitor photography**- Characteristics of the video image-television camera-imaging camera—imaging film-sensitometric characteristics-processing-final image.

Laser-light and laser-laser imaging-laser imagers—imaging plates-principle of photo stimulated luminescence - 5- 5

**References:**

1.Radiographic Imaging - Chesney & Chesney, Blackwell scientific publications, oxford (1981)

Reference books

1.Radiographic imaging-Derrick P. Roberts and Nigel L. Smith. Churchill Livingstone, Edinburgh (1994)

2.Radiographic Latent image processing - W.E.J. Mckinney

3.Photographic processing, quality control and evaluation of photographic material -J.E. Gray

4.Photographic processing Chemistry - L.F.A. Mason.

5. Physical and photography principles of Medical Radiography - Seeman & Herman.

## BSC. MRIT -302: CLINICAL RADIOGRAPHY- POSITIONING PART 1

**SUBJECT DESCRIPTION** – In this paper in clinical radiography- positioning, the student is expected to understand positioning practices related to clinical radiography.

**Unit I: Upper limb:** Technique for hand, fingers, thumb, wrist joint carpal bones, forearm, elbow joint, radio ulnar joints and humerus supplementary techniques for the above. E.g., Carpal tunnel view, ulnar groove, head of the radius, supracondylar projections.

**Unit II: Lower limb:** Technique for foot, toes, great toe, tarsal bones, calcaneum, ankle joint, lower leg, knee, patella & femur.

**Unit III: Supplementary techniques:** Stress view for torn ligaments,

- a. Subtalar joint and talocalcaneal joint.
- b. Inter condylar projection of the knee.
- c. Tibial tubercle.
- d. Length measurement technique.

**Unit IV: Shoulder girdle and thorax:** Technique for shoulder joint, scapular, clavicle, acromio clavicular joints, sternum, ribs, sterno-clavicular joint. Supplementary projections and techniques

- a. Recurrent dislocation of shoulder.
- b. Traumatic dislocation of shoulder.
- c. Cervical ribs.

**Unit V: Vertebral column:** Technique for atlanto-occipital joint, cervical spine, cervico thoracic spine, thoracic spine, thoraco- lumbar spine, lumbo sacral spine, sacrum and coccyx. Supplementary techniques to demonstrate:

- a. Scoliosis.
- b. Kyphosis
- c. Spondylolisthesis
- d. Disc lesion
- e. Union of spinal graft.

Adaptation of techniques to demonstrate specific pathologies.

**Unit VI: Pelvic girdle and hip region:** Technique for whole pelvis. Ilium, ischium, pubic bones, sacroiliac joint, symphysis pubis, hip joint, acetabulum neck of femur, greater and lesser trochanter.

**Supplementary techniques-**

- a. Congenital dislocation of hips
- b. Epiphysis of femur:

c. Lateral projections for hip joints to show femoral head and neck relationship.

**Unit VII: Skeletal survey:** Skeletal survey for metabolic bone disease, metastases, hormonal disorder, renal disorders.

**Unit VIII: Skull:** Basic projections for cranium, facial bones, nasal bones and mandible.

**Unit IX: Technique for**

a. Petrous temporal for mastoids. Internal auditory canal. - Accessory nasal sinuses.

b. Temporo - mandibular joint. - Orbits and optic foramen. - Zygomatic arches.

c. Styloid process. - Pituitary fossa. - Jugular foramen.

**Unit X: Dental Radiography:**

Technique for intra oral full mouth, occlusal projections, extra oral projections including orthopantomography, Supplementary techniques.

**Unit XI: Upper respiratory system:**

Technique for post nasal airways, larynx, trachea, thoracic inlet - Valsalva manoeuvre. - Phonation.

**Unit XII; Lungs and Mediastinum:**

Technique for routine projections: Antero-posterior, obliques, lordotic, apical projection, use of penetrated postero-anterior projection. - Expiration technique. - Technique for pleural fluid levels and adhesions.

**Unit XIII - Abdominal viscera:**

For plain film examination, Projection for acute abdomen patients. Technique to demonstrate:

1. Foreign bodies
2. Imperforate anus.

**Unit XIV- Radiography using mobile X-ray equipment:**

Radiography in the ward: Radiography in the specialized unit, such as:

1. Intensive care unit
2. Coronary care
3. Neonatal unit. - Radiography in the operating theatre.

**Practical**

Radiographic positioning of all parts of the body.

**Reference books**

1. Clark's Handbook for radiographers – Charles Sloane, Ken Holmes & Craig Anderson, Hodder Education, UK
2. Diagnostic Radiography – A concise practical Manual – Glenda J Bryan
3. Text book of Radiologic -Technology" Jacoby and Paris ( Mosby )

4. Contrast Radiography" Scarrow (Schering Chemical)
5. A manual of Radiographic positioning" Greenfield and Cooper (Lipincott)
6. Illustrated guide to X-ray Techniques" Culliman (Blackwell)
7. A Guide to Radiological Procedures" Stephen Chapman & Richard Nakielny. (A Prism books (P) Ltd., Bangalore)
8. Applied angiography for Radiographers Paul & Douglas (W.B. Saunder company)

## **SEMESTER-4: 20 CREDITS**

### **BSC. MRIT -303: CONTRAST AND SPECIAL RADIOGRAPHIC PROCEDURE**

**SUBJECT DESCRIPTION:** The students should learn and appreciate about contrast radiography and different kinds of special radiographic procedure.

#### **SUBJECT DESCRIPTION:**

##### **Unit I - Contrast radiography**

*Radiological contrast media*—classification—need for radiological contrast media- methods of administration—dosage—reactions to contrast media- role of radiographer in management of patient with contrast reaction.

*For all contrast investigations*- patient preparation, positioning, patient care during the study- post procedural patient care—types of contrast media used and dosage- alternative contrast used- side effects and its identification—treatment of complication during the procedure - pathological conditions- indications and contraindications- injection procedure —techniques for radiographic projections - radiographic appearances— radiation protection.

##### **Unit II - Sialogram**

**Unit III - Barium studies**- different types – Barium swallow Barium meal study of upper GIT, Barium meal follow through, Barium enema, small bowel enema, distal colonography, defecography.

**Unit IV - Percutaneous Transhepatic Cholangiogram, ERCP, T-Tube cholangiography, per-operative cholangiography.**

**Unit IV - IVP-rapid sequence-infusion pyelography-high dose urography, Cystogram, Anterior Urethrogram RGU, MCU, RGP**

1. Angiography, Diagnostic & therapeutic, venography, Lymphangiogram
2. Orthography, Discography
3. Myelogram, Hysterosalpingography, Sinography, Fistulogram, Ductogram

##### **Non-contrast Special radiography-**

##### **Unit V: Pediatric Imaging:**

special needs of patient and radiographer- use of dedicated equipment and accessories-

modified technical considerations - selection of exposure factors - image quality considerations  
– radiation protection of the patient - special techniques in children for contrast studies.

### **Unit VI - Geriatric radiography**

Equipment and accessories – exposure factor considerations in special care. Elderly patients profile - difficulties during radiography – technical considerations - projections with unconventional special positioning.

### **Unit VII - Trauma/Emergency Radiography**

Selection of suitable X-Ray equipment – patient position - radiographic projections and sequence for each patient – modification of routine positioning – radiation protection – patient care.

### **Unit VIII - Operation Theater Radiography**

O.T Procedures - Operative cholangiography – orthopaedic procedures – maintenance of asepsis – preparation of radiographer and equipment/accessories  
– careful safe use of mobile and fluoroscopic equipment – radiation protection – patient care  
– rapid availability of radiographic image - cooperation with OT staff - type of studies done - clinical applications - clinical applications - per operative radiographs - peroperative fluoroscopy studies - patient care - radiation protection of all staff.

### **Reference Books:**

1. Textbook of radiology for residents and technicians – 4<sup>th</sup> Edition, Satish K Bhargava
2. Radiological Patient Care – Jensen Chesney
3. Atlas of dental and maxillofacial radiological imaging - Brownie

## **BSC. MRIT- 401: PATIENT CARE IN MEDICAL IMAGING DEPARTMENT**

**SUBJECT DESCRIPTION:** The students should learn how to take patient care in different radiographic procedure.

### **Unit I -Patient care in Medical Imaging Department**

Patient management is based on teamwork, it is essential that the student should appreciate the technologist's role and that the importance of co-operation with wards and other departments. The students should be attached to wards or the accident and emergency department for a definite training period.

**Unit – II Preparation of patients for general radiological procedures :** Departmental instructions to out-patients or ward staff; use of aperients, enemas and colonic irrigations, flatulence and flatus; causes and methods of relief; principles of catheterization and intubation, pre medication; its uses and methods; anaesthetised patients, nursing care before and after special x-ray examination (for example in neurological, vascular and respiratory conditions); diabetic patients special attention to food; hazards of trauma.

**Unit -III Radiological contrast agents: Opaque agents and gases.** Relationship of x-ray transmission to density and atomic number of the elements of contrast medium.

Types of Barium sulphate solutions, concentration and its uses, flavoring agents.

Iodine preparation: Organic compounds, water - soluble group; significance of iodine content, proprietary preparations, iodized oil, Application of various systems of human body, Volume, contra-indications, methods of administration and route. Sensitivity test, side effects and management, elimination from the body.

Gases: Air, Oxygen and carbon di-oxide application and dangers.

**Unit IV - Emergencies in the x - ray department and management:** External defibrillation, direct cardiac massage, internal defibrillation, complications; cardiac arrest, respiratory arrest. bronchography, local anaesthetics; reactions, treatment.

**Unit – V Special procedures in diagnosis Radiology:** a). The Gastro intestinal tract: Barium meal, Barium swallow, Gastrograffin swallow, enema. The renal tract: Intravenous urography, retrograde pyelography, cysto urethrography. The biliary tract. Oral cholecystography, Intravenous cholangiography, operative and post-operative cholangiography, percutaneous transhepatic cholangiography

The respiratory tract; Bronchography. Gynecology. Hysterosalpingography. Cardio vascular system. Angiography, aortography-cerebral angiography, Spleno-portovenography. The Lymphatic system. Lymphangiography. Central nervous system. Myelography. Sialography; Ultrasound + Guided procedures. General preparation, care and CT scan + guided procedures safety measures.

**Reference books:**

1. Notes on Radiological Emergencies – Ansell and Churchill
2. Care of patient in diagnostic Radiography – Chesney & Chesney.
3. First Aid – Haugher and Gardner.
4. Practical Nursing and First Aid – Ross and Wilson.



## BSC. MRIT-402: CLINICAL RADIOGRAPHY POSITIONING - PART 2

**SUBJECT DESCRIPTION** - The course in clinical radiography- positioning, the student is expected to understand positioning practices related to clinical radiography.

**Unit – I Mammography:** The Mammography as a clinical diagnostic tool- immobilization and identification techniques positioning techniques for various projections, galactography - exposure factors- Conventional & Digital studies- quality and advantage- diagnosis and screening- Characteristics of benign and malignant lesions – patient care – female attendant - interventional procedures - recent advances in mammography techniques –Stereotactic biopsy, wire localization of lesions, specimen radiography. mammo-tomogram & Sono-mammography procedures- advantages & limitations.

**Unit II - Ultrasonography/ Doppler studies:** Techniques of sonography-selection- Preparations - instructions and positioning of patient for TAS, TVS, TRUS, neck USG and extremities- patient care and maintenance protocols clinical applications display methods –quality image reproducible extend -assurance to patients.

### **UNIT III – CT STUDIES**

CT scan studies acquisition/ protocols /techniques: CT of head and neck – thorax – abdomen – pelvis – musculo skeletal system – spine – PNS Anatomy – clinical indications and contraindications – patient preparation – technique –contrast media-types, dose, injection technique; timing, sequence - image display – patient care – utilization of available techniques & image processing facilities to guide the clinician-CT anatomy and pathology of different organ systems.

**Unit – IV MRI Scanners: Methods of MRI imaging methods** – Head and Neck, Thorax, Abdomen, Musculoskeletal System imaging - Clinical indications and contraindications- types of common sequences effects of sequence on imaging - Protocols for various studies- slice section- patient preparation-positioning of the patient -patient care-calibration - paramagnetic agents and dose, additional techniques and recent advances in MRI -image acquisition-modification of procedures in an unconscious or un co-operative patient -plain studies- contrast studies -special procedures- reconstructions- 3D images- MRS blood flow imaging, diffusion/perfusion scans - strength and limitations of MRI- role of radiographer.

**Unit – IV Angiography and Cine Studies /DSA: Conventional / DSA studies-** Abdominal, visceral, peripheral, cerebral and cardiac angiography - arterial/venous anatomy, physiology-clinical indications and contraindications -patient preparation-positioning of the patient -Sites of puncture, seldinger technique-patient care-contrast media - types of contrast -dosage - accessories catheters,

types and names of catheters, guide wires- pressure injection- control of radiographic and fluoroscopic equipment - exposure factors for serial programmes - programming-injection protocols- outline on each radiological procedure- radiographer's role- patient consent before procedure - patient management before, during and after the procedure - venography- interventional angiography in hepatobiliary, GIT, urology and vascular system- coils/stents etc.- indications and contraindications - role of radiographer-radiation safety.

### **Reference books**

- (a) Diagnostic Radiography, Glenda.J. Bryan ( ELBS )
- (b) Positioning in Radiography" Clarks ( CBS Publishers, New Delhi.)
- (c) Radiographic positions and Radiological procedures" Vinita Merrill ( Jaypee Brothers, New Delhi )
- (d) Manual of Radiographic Technique" T. Holn & P.E.S. Palmer ( World Health Organisation)
- (e) Text book of Radiologic -Technology" Jacoby and Paris ( Mosby )
- (f) Contrast Radiography" Scarrow ( Schering Chemical )
- (g) A manual of Radiographic positioning" Greenfield and Cooper (Lipincott )
- (h) Illustrated guide to X-ray Techniques" Culliman ( Blackwell )
- (i) A Guide to Radiological Procedures" Stephen Chapman & Richard Nakielny. (A Prism books (P) Ltd., Bangalore )
- (j) Applied angiography for Radiographers Paul & Douglas (W.B. Saunder company)

## **SEMESTER-5: 20 CREDITS**

### **BSC. MRIT-403: PHYSICS OF ADVANCED IMAGING MODALITIES**

**SUBJECT DESCRIPTION:** The students should learn and appreciate the physics principles and technology of advanced imaging equipment.

#### **Unit I - Mammography:**

The Mammography as a clinical diagnostic tool - Mammography system, AEC, exposure factors, compression paddles, grids, radiation dose- recent advances in mammography techniques -, biopsy accessories, mammo tomogram & Sono mammography procedures- advantages & limitations.

#### **Unit II - Ultrasonography/Doppler studies:**

Basic Acoustics, Ultrasound terminologies: acoustic pressure, power, intensity, impedance, speed, frequency, dB notation: relative acoustic pressure and relative acoustic intensity.

Interaction of US with matter: reflection, transmission, scattering, refraction and absorption, attenuation and attenuation coefficients, US machine controls, US focusing.

Production of ultrasound: Piezoelectricity, Medical ultrasound transducer: Principle, construction and working, characteristics of US beam.

Ultrasound display modes: A, B, M Resolution of Images: Spatial, temporal and contrast

Real-time ultrasound: Line density and frame rate, Real-time ultrasound transducers: mechanical and electronic arrays, ultrasound artifacts, ultrasound recording devices, and Distance, area & volume measurements.

Techniques for imaging different anatomic areas, ultrasound artifacts, biological effects and safety.

Doppler Ultrasound- Patient preparation for Doppler, Doppler artifacts, vascular sonography,

#### **Unit III - CT scan studies acquisition/protocols/techniques:**

Basic Computed Tomography- Basic principles of CT, generations of CT, CT instrumentation, image formation in CT, CT image reconstruction, Hounsfield unit, CT image quality, CT image display.

Advanced Computed Tomography

Helical CT scan: Slip ring technology, advantages, multi detector array helical CT, cone – beam geometry, reconstruction of helical CT images, CT artifact, CT angiography, CT fluoroscopy, HRCT, post processing techniques: MPR, MIP, Min IP, 3D rendering: SSD and VR, CT Dose, patient preparation, Imaging techniques and protocols for various parts of body, CT contrast

enhanced protocols – CT angiography – (Aortogram, selective angiogram head, neck and peripheral) image documentation and Filing, maintenance of equipment and accessories.

#### **Unit IV - MRI Scanners:**

Magnetic Resonance imaging – Basic principle, Imaging methods, Slice section, Image contrast, Factors affecting Image quality, Difference CT and MRI images, Instrumentation. imaging sequences Bio effects of MRI

Spin – precession – relaxation time – pulse cycle – T1 weighted image – T2 weighted image – proton density image.

Pulse sequence: Spin echo pulse sequence – turbo spin echo pulse sequence - Gradient echo sequence – Turbo gradient echo pulse sequence - Inversion recovery sequence – STIR sequence – SPIR sequence – FLAIR sequence – Echo planar imaging – Advanced pulse sequences.

MR Instrumentation: Types of magnets – RF transmitter – RF receiver – Gradient coils – shim coils – RF shielding – computers.

Image formation: 2D Fourier transformation method – K-space representation – 3D Fourier imaging – MIP.

MR contrast media – MR angiography – TOF & PCA – MR Spectroscopy – functional MRI

#### **Unit V - Angiography and Cine Studies /DSA**

Conventional / DSA studies control of radiographic and fluoroscopic equipment - exposure factors for serial programs-programming-injection protocols- outline on each radiological procedure- radiographer's role- patient management before -during and after the procedure-venography-interventional angiography in hepatobiliary, GIT, urology and vascular system-coils/stents etc-indications and contraindications -role of radiographer-radiation safety.

#### **Unit VI: BASICS OF SPECT AND PET CT**

Gamma Camera — Single photon emission computed tomography (SPECT) and Positron emission tomography (PET) and PET-CT, Physics principles and construction.

#### **Reference books:**

- (a) Diagnostic Radiography, Glenda.J. Bryan ( ELBS )
- (b) Positioning in Radiography" Clarks ( CBS Publishers, New Delhi.)
- (c) Radiographic positions and Radiological procedures" Vinita Merrill ( Jaypee Brothers, New Delhi )
- (d) Manual of Radiographic Technique" T. Holn & P.E.S. Palmer ( World Health Organisation)
- (e) Text book of Radiologic -Technology" Jacoby and Paris ( Mosby )
- (f) Contrast Radiography" Scarrow ( Schering Chemical )
- (g) A manual of Radiographic positioning" Greenfield and Cooper (Lipincott )
- (h) Illustrated guide to X-ray Techniques" Culliman ( Blackwell )
- (i) A Guide to Radiological Procedures" Stephen Chapman & Richard Nakielny. (A Prism books (P) Ltd., Bangalore )
- (j) Applied angiography for Radiographers Paul & Douglas (W.B. Saunder company)

## **BSC. MRIT - 501: CROSS SECTIONAL ANATOMY AND PHYSIOLOGY**

**SUBJECT DESCRIPTION** - Radiology has been developing dramatically during the past few years. With enhancements in magnetic resonance imaging (MRI) and computed tomography (CT), the role of the radiologic technologist has also been changing. Skills in cross-sectional anatomy are important to help the technologist in MRI and CT to identify the anatomy being imaged and to communicate effectively with the radiologist and physicians. At the completion of this, candidates will be able to:

### **Unit I - Cross-sectional anatomy in the sagittal, coronal and axial planes on CT and MR images.**

Description of anatomical structural relationships.

Identification of normal anatomy and development of a personal resource system for future study.

Identification of pertinent cerebral, upper thorax, mid-thorax, and abdominal anatomy.

Anatomical structures of the body and of the head on CT and MR images

Distinguishing arterial and venous anatomy of the entire body's vascular system.

Classifying the various sections of anatomical regions and their associated parts.

### **Unit II- Introduction to Sectional Anatomy & Terminology-**

Sectional planes, Anatomical relationships/terminology

Anatomy of the upper thorax- Surface anatomy relationships, Bony structures and muscles, Blood vessels.

**Unit III - Divisions of the mid-thorax, heart and great vessels-** Lungs, heart and great vessels, Esophagus - CT/MRI Images of the Thorax - Normal and pathologic

**Unit IV - Anatomy of the Abdomen-** Major organs and their accessories, Abdominal blood vessels  
CT/MR Images of Abdomen - Normal and pathologic

**Unit V - Anatomy of the Pelvis-** Bony structures and associated muscles, Digestive and urinary systems  
Reproductive Organs - CT/MR Images of the Male/Female Pelvis- Normal and pathologic

**Unit VI - Neuro Anatomy-** Scan planes - **Brain** - Cerebral hemispheres, Sinuses, Ventricles, Brainstem and associated parts, Arterial/venous systems, Basal ganglia, Cranial nerves - **Spine-** Vertebra and disc, Spinal cord and meninges - **Neck-** Arterial/venous systems, Muscles, Glands and pharynx

### **References:**

- (a) Cross Sectional Anatomy CT and MRI - Govind Chavhan
- (b) Pocket Atlas of Sectional Anatomy-T B Moiller,E Reif
- (c) Basic Atlas Of Sectional Anatomy: With Correlated Imaging- J. Jeffrey Carr (Author), Neil T. Wolfman (Author), Walter J. Bo (Author), Wayne A. Krueger
- (d) Human Sectional Anatomy Atlas Of Body Sections Ct And Mri Images 3rd Edition By Ellis

## **BSC. MRIT -502: RESEARCH METHODOLOGY:**

**SUBJECT DESCRIPTION** – The students should learn and appreciate about how to start a research and different steps of research.

**Unit I - Accessing research literature:** Use of databases and other sources.

**Unit II - Understanding research design:** Qualitative and quantitative methodologies - their differences and potential integration. Evaluating research and its potential for informing practice. Developing research questions and devising methods for their investigation. Ethical issues in research

**Unit III - Analysis:** Analysis of qualitative and quantitative data. Utilization of appropriate software to assist in the retrieval of information and data analysis.

**Unit IV - Clinical audit:** Distinctiveness of research and audit processes and their function

**Unit V - Research Skills and Management:** The role of evidence-based practice within health and welfare

### **Reference books:**

1. Research Methodology and Biostatistics: A Comprehensive Guide for Health Care Professionals by Sharma Suresh
2. Research Methodology for Health Professionals by R.C. Goyal

## **BSC. MRIT -503: QUALITY CONTROL IN RADIOLOGY**

**SUBJECT DESCRIPTION:** The students should learn and appreciate the need for quality control and different quality control procedures in Radiology.

**Unit I - Objectives of quality Control:** Improve the quality of imaging thereby increasing the diagnostic value; to reduce the radiation exposure; Reduction of film wastage and repeat examination; to maintain the various diagnostic and imaging units at their optimal performance.

**Unit II - Quality assurance activities:** Equipment selection phase; Equipment installation and acceptance phase; Operational phase; Preventive maintenance.

**Unit III - Quality assurance programme at the radiological faculty level:** Responsibility; Purchase; Specifications; Acceptance; Routine testing; Evaluation of results of routine testing; Quality assurance practical exercise in the X ray generator and tube; Image receptors from processing; Radiographic equipment; Fluoroscopic equipment; Mammographic equipment; Conventional tomography; Computed tomography; Film processing, manual and automatic; Consideration for storage of film and chemicals; Faults tracing; Accuracy of imaging- image distortion for digital imaging devices. LASER printer calibration

**Unit IV - Quality assurance program tests:** General principles and preventive maintenance for routine, daily, weekly, monthly, quarterly, annually – machine calibration. Basic concepts of quality assurance – LASER printer - Light beam alignment; X-ray out-put and beam quality check; KVP check; Focal spot size and angle measurement; Timer check; mAs test; Grid alignment test; High and low contrast resolutions; Mechanical and electrical checks; Cassette leak check; Proper screen-film contact test; Safe light test; Radiation proof test; Field alignment test for fluoroscopic device; Resolution test; Phantom measurements - CT, US and MRI.

**Unit V - Quality assurance of film and image recording devices:** Sensitometry; Characteristic curve; Film latitude; Film contrast; Film speed Resolution; Distortion; Artifacts of films and image recording. Monitor calibration. SMPTE pattern

**Unit VI - Maintenance and care of equipment:** Safe operation of equipment; Routine cleaning of equipment and instruments; Cassette, screen maintenance; Maintenance of automatic processor and manual processing units; Routine maintenance of equipment; Record keeping and logbook maintenance; Reject analysis and objectives of reject analysis program.

**Unit VII - Care and maintenance of diagnostic equipment:** General principles and preventive maintenance for routine - daily, Weekly, monthly, quarterly, annually: care in use, special care of mobile equipment.

**Reference Books:**

- 1."Quality assurance in Diagnostic Radiology" By: J.M. Mclemore (Yearbook of Medical publishers)
- 2."Quality Control in diagnostic imaging" By: J.E. GRAY (University Park Press)
- 3."Processing and Quality Control" By: William, E.J. Mckinney (J.B. Lippincott Company)
- 4."Concepts in Medical Radiographic imaging" By: Marianne Tortoise (W.B. Saunders Company)
- 5."Quality assurance Management" By: G.E. Hayes (Charger production)
- 6.Diagnostic Imaging: Quality Assurance By: M.M. Rehani (Jaypee Bros Medical Publishers)



## **SEMESTER-6: 20 CREDITS**

### **BSC. MRIT -601: RADIATION SAFETY IN RADIOLOGY**

**SUBJECT DESCRIPTION:** The students should learn and appreciate the principles and the need for radiation safety in Radiology.

#### **Unit I - Radiation safety in diagnostic Radiology**

Radiation Quantities and Units: Radiation- Radioactivity- Sources of radiation - natural radioactive sources -cosmic rays - terrestrial radiation - - man made radiation sources. Units of radiation - Quality factor - Flux- Fluence-Kerma- Exposure- Absorbed dose- Equivalent Dose- Weighting Factors-Effective Dose - Occupational Exposure Limits - Dose limits to public.

**Unit II - Biological Effects of radiation:** Ionization, excitation and free radical formation, hydrolysis of water, action of radiation on cell-Chromosomal aberration and its application for the biological dosimetry- Effects of whole body and acute irradiation, dose fractionation, effects of ionizing radiation on each of major organ system including fetus -Somatic effects and hereditary effects- stochastic and deterministic effects-Acute exposure and chronic exposure-LD50 - factors affecting radio sensitivity. Biological effects of non-ionizing radiation like ultrasound, lasers, IR, UV and magnetic fields.

**Unit III - Radiation detection and Measurements:** Ionization of gases- Fluorescence and Phosphorescence -Effects on photographic emulsion. Ionization Chambers – proportional counters- G.M counters- scintillation detectors – liquid semiconductor detectors – Gamma ray spectrometer. Measuring systems – free air ionization chamber – thimble ion chamber – condenser chamber – Secondary standard dosimeters – film dosimeter – chemical dosimeter- Thermoluminescent Dosimeter. -Pocket dosimeter- Radiation survey meter- wide range survey meter -zone monitor-contamination monitor -their principle function and uses. Advantages & disadvantages of various detectors & its appropriateness of different detectors for different type of radiation measurement. Dose and Dosimetry, CT Dose Index (CTDI, etc.), Multiple Scan Average Dose (MSAD), Dose Length Product (DLP), Dose Profile, Effective Dose, Phantom Measurement Methods, Dose for Different Application Protocols, Technique Optimization. Dose area product in fluoroscopy and angiography systems, AGD in mammography.

#### **Reference books:**

- (a) Radiation Protection in Hospitals. Richard F.Mould
- (b) Basic radiological physics. Jaypee bothers pvt ltd, New delhi
- (c) An Introduction to Radiation Protection. Allen Martin & Samuel
- (d) Radiation safety in Medical practice. M.M. Rchami.
- (e) Radiation Protection. Ronald L. Kathren
- (f) AERB safety code and manuals,

## BSC. MRIT-602: ADVANCED IMAGING TECHNIQUES

**SUBJECT DESCRIPTION** - The students should learn and appreciate the principles of advanced imaging technology.

### **Unit I - Interventional Radiography:**

Basic angiography and DSA:

- Abdominal, visceral, peripheral, cerebral and cardiac angiography - arterial/venous anatomy, physiology-clinical indications and contraindications - patient preparation-positioning of the patient -patient care- contrast media - types of contrast - dosage - accessories catheters, guide wires- pressure injection-

History, technique, patient care -Percutaneous catheterization, catheterization sites, Asepsis - Guidewire, catheters, pressure injectors, accessories -Use of digital subtraction- single plane and bi-plane - All forms of diagnostic procedures including angiography, angioplasty, biliary examination, renal evaluation and drainage procedure.

Central Nervous System:

Myelography - Cerebral studies - Ventriculography

Arthrography: Shoulder, Hip, Knee, Elbow

Angiography:

Carotid Angiography (4 Vessel angiography) - Thoracic and Arch Aortography - Selective studies: Renal, SMA, Coeliac axis - Vertebral angiography - Femoral arteriography - Angiocardiography

Venography:

Peripheral venography - Cerebral venography - Inferior and superior venocavography

Relevant visceral phlebography

Cardiac catheterization procedures: PTCA, BMV, CAG, Pacemaker, Electrophysiology,

### **Unit II - Mammography**

The Mammography as a clinical diagnostic tool - immobilization and identification techniques- positioning techniques for various projections - exposure factors- Conventional & Digital studies- quality and advantage- diagnosis and screening- Characteristics of benign and malignant lesions-patientcare-female attendant- interventional procedures.

### **Unit III - CT scan studies acquisition/ protocols /techniques:**

CT of head and neck – thorax – abdomen – pelvis – Musculo skeletal system – spine – PNS. Anatomy – clinical indications and contraindications – patient preparation – technique – contrast media-types, dose, injection technique; timing, sequence - image display – patient care – utilization of available techniques & image processing facilities to guide the clinician-CT anatomy and pathology of different organ systems.

**Unit IV - Methods of MRI imaging methods** – Head and Neck ,Thorax, Abdomen, Musculoskeletal System imaging - Clinical indications and contraindications- types of common sequences-effects of sequence on imaging - Protocols for various studies- slice section- patient preparation-positioning of the patient -patient care calibration - paramagnetic agents and dose, additional techniques and recent advances in MRI -image acquisition-modification of procedures in an unconscious or un co-operative patient - plain studies- contrast studies -special procedures reconstructions - 3D images- MRS blood flow imaging, diffusion/perfusion scans - strength and limitations of MRI- role of radiographer.

**Unit V - Nuclear Medicine procedures:**

SPECT-CT & PET-CT studies, protocols, Basics of common clinical Nuclear Medicine procedures/techniques–comparison with different structural imaging studies- advantages and limitations.

**Unit V - Recent Advances in imaging**

Dynamic CT&MRI studies preoperative application of various imaging systems including detector probes application in Nuclear Medicine Imaging guidance in therapeutic procedures-IGRT, TACE & TARE etc.

**Reference books:**

1. "Recent advances in Radiology and Medical Imaging" Lodge & Steiner (Churchill Livingstone)
2. "MRI for Technologists" Peggy Woodward & Roger F. Freimark (McGraw Hill)
3. "Imaging for Students" David A. Lisle (Arnold)
4. "Digittal subtraction ateriography" Charles, Andrew, Joseph (Yearbook Medical Publishers)
5. "Atlas of Interventional Radiology" Constantin Cope ( J.P. Lipincott.)
6. "Principles of Radiographic Imaging" Richard R. Carlton (Arlene M. Alder)
7. "Radiologic Science for Technologist" Stewart C. Bushong (Mosby)

**BSC. MRIT-603: QUALITY ASSURANCE, RADIOBIOLOGY & RADIATION SAFETY  
(AERB GUIDELINES) IN DIAGNOSTIC RADIOLOGY**

**SUBJECT DESCRIPTION** - The students should learn and appreciate the quality assurance methods, radiobiology and AERB guideline for radiology equipment and procedures.

**Unit I - QA in Diagnostic Radiology:**

Quality assurance (Q.A), acceptance testing and quality control tests in Radiology-

Meaning of the terms used and aspects of a QA programme, equipment and staff requirements, benefits of QA procedures in an imaging department –NABH guidelines. Verification of Optical & Radiation field congruence, Beam alignment, Focal spot size, Linearity of tube current mA and Timer, applied potential, HVT and total tube filter, Contact between film and intensifying screen, contrast resolution, Grid alignment, Special techniques like mammography, CT - CT Dose Modulation- Patient dose management.

**Unit II - Radiation Hazard evaluation and control**

Philosophy of Radiation protection, effects of time, Distance & Shielding. Calculation of Workload, weekly calculated dose to radiation worker & General public Good work practice in Diagnostic Radiology. Planning consideration for radiology, including Use factor, occupancy factors, and different shielding material.

**Unit III - Regulatory Bodies & regulatory Requirements:**

International Commission Radiation Protection (ICRP)/National Regularity body (AERB - Atomic Energy Regulatory Board) - Responsibilities, organization, Safety Standard, Codes and Guides, Responsibilities of licenses, registrants & employers and Enforcement of Regulatory requirements.

**Unit IV - Role of Radiographer in Planning, QA & Radiation Protection:**

Radiation protection of self and patient- Principles of radiation protection, time - distance and shielding, shielding - calculation and radiation survey –ALARA- personnel dosimeters (TLD and film batches) - occupational exposure

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, darkrooms–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. Guidance level for patient's dose reduction in radio-diagnosis. Dose constrains for comforters of patients. Radiation incidents involving X-Ray equipment, over exposure investigations and case studies.

**Reference books:**

1. Radiobiology for the Radiologist, 8e – Eric J Hall
2. Handbook of Radiobiology – Thayalan Kuppusamy
3. Radiation Protection. Ronald L. Kathren
4. AERB safety code and manuals,