Ordinance No…..B

ORDINANCE RELATING TO MASTER IN MEDICAL RADIOLOGY AND IMAGING TECHNOLOGY

1. This ordinance may be called the "**Ordinance relating to Master in Medical Radiology and Imaging Technology (MMRIT) Curriculum and Syllabus**. This ordinance has been drafted in accordance with **National Commission for Allied and Healthcare Professions (NCAHP)** guidelines; all future updates issued by the NCAHP will be strictly implemented.
2. It shall come into force with academic session 2026-27.

Learning Objectives

1. Upon successful completion of the Masters" program, students will
2. Master in Medical Radiology & Imaging Technology is specifically aimed at those candidates pursuing a professional/academic career in Radiology &Imaging Technology.
3. It is designed to provide specialized training in the scientific principles of modern imaging sciences and in the application of these principles in the field of Radiology & Imaging Technology.
4. It is designed as a higher degree course suitable for graduates having experience in the technology of Radiology & Imaging Technology.
5. The objective of the programme is to train students to be qualified, patient focused, compassionate, critical thinkers for the community who are engaged in lifelong learning.
6. Upon successful completion of the Master course, students will have developed a broad knowledge of the principles, technology, instrumentation, recent developments and proper handling of the modern radiological and imaging equipment's and proper execution of the various radiological procedures and be able to embark upon a successful career in their chosen direction of Imaging Science research

PROGRAM OUTCOMES (POs)

Upon successful completion of the MMRIT program, students will be able to: Perform a range of radiographic/radiological examinations on patients to produce high quality images.

1. Verifying informed consent, assuming responsibility for patient needs during procedures.
2. Applying principles of ALARA to minimize exposure to patient, self and others. Starting and maintaining intravenous access as prescribed, Identifying, preparing and/or administering medications as prescribed
3. Evaluating images for technical quality, ensuring proper identification is recorded.
4. Performing diagnostic radiographic/radiological and non-interpretive fluoroscopic procedures
5. Assist radiologists and senior staff in complex radiological examinations.

6. Record imaging identification and patient documentation quickly and accurately and observes protocols.
7. Research and development of new techniques and procedures as assigned.
8. Promotes effective working relationships and works effectively as part of a department / unit / team inter and intra departmentally to facilitate the department/unit's ability to meet its goals and objectives.
9. Follows established safety practices including biohazards, exposure control plan
10. Demonstrates respect and regard for the dignity of all patients, families, visitors and fellow employees to ensure a professional, responsible and courteous environment.
11. Identifying and managing emergency situations.
12. Performing ongoing quality assurance activities.
13. Ensure safe custody of all the accessories of the X-ray/radiological unit of which he/she is in charge. Keeps the X-ray room locked when not in use.
14. Understands and observes health and safety regulations/precautions and instruction for self and others protection. He/she should wear a dosimeter during duty hours.
15. Attends all in service education program required as per hospital policy.
16. Providing education and monitoring students and other health care providers.
17. Orientation and teaching students and new employees.
18. Learns new technologies and technologies as required by the professional bodies.
19. Impart appropriate training to the students and other staff.
20. Should have management and research skills.
21. To exhibit keen interest, initiative & drive in the overall development of the Department and 'Leadership Qualities' for others to follow.
22. He / She is expected to be confident and to perform all the duties diligently with utmost sincerity and honesty.
23. Any other duty/task/work assigned by any higher authority like Director, Dean, Medical Superintendent, Head of the Department from time to time; either in "Public Interest" or in the interest of upkeep / development of the Department / Institutions.

Master in Medical Radiology and Imaging Technology (MMRIT)

Ist SEMESTER

(Common for all specializations)

Radiological and Medical Physics

Theory	Subject Code: MMRIT01
Total Marks for Evaluation-100	No. of Contact Hours-52, Credits:3

RATIONALE

Radiological and Imaging Technology instrumentation and its physics are the primary pillars underlying the practice of radiological and Imaging technology and understanding the principles of radiation physics helps MMRIT to become a qualified MMRIT technologist.

COURSE OUTCOMES

At the end of the course students will be able to...
CO1: Describe general physics related to imaging
CO2: Differentiate between within general radiation
CO3: Identify construction of radiology equipment's
CO4: Interpret quality of control of radiology equipment's
CO5: Differentiate between x-ray equipment's and other radiology related equipment's
CO6: Describe production of x-rays
CO7: Describe circuit system of radiology equipment's
CO8: Describe the structure and working of x-ray tube, production of x-rays
CO9: Describe the types of x-ray tube and heat dissipation methods
CO10:Explain the x-ray generator circuits
CO11: Describe the different circuit types
CO12: Describe the meters and exposure timers
CO13: List the control of scattered radiation
CO14: Describes about the fluoroscopy

Unit	Topic	Hours
I.	**Basic concepts:** Units and measurements-Force, work, power and energy-Temperature and heat-SI units of above parameters. Atomic structure-atom model-Nucleus-electronic configuration-periodic table Isotopes-Ionization-excitation-Binding energy-electron volt Electromagnetic radiation-Quantum nature of radiation-mass energy equivalence-Fluorescence-electromagnetic spectrum.	**4**
II.	**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. Varying currents-Growth and decay of current in LR circuit time constant, charge and discharge of a Capacitor through a resistance and inductance. Oscillations in an LC circuit. Alternating currents: Peak and RMS values and current and voltage, circuit containing LR, CR and LCR-Power factor, series and parallel LCR circuits, DC circuit, Ohm's law, resistivity, series and parallel combination, EMF, Kirchhoff's law, heating effect of current. **Electromagnetic waves:** Introduction, Maxwell's equation, electromagnetic waves, energy density and intensity, momentum, electromagnetic spectrum and radiation in Atmosphere	**4**
III.	**Electronics** Semiconductors; Conduction in crystals, Energy bands. Intrinsic and Extrinsic semiconductors n-type and p-type semiconductors, majority and minority carriers. Semiconductor diodes: p-n junction-properties forward and reverse bias, characteristics of p-n junction Rectifiers-Half-wave and full wave, ripple factor, Efficiency of HW and FW rectifiers. Filter circuits; Zener diode, regulated power supply. Transistors-Symbols, Transistor connections and characteristics, Transistor as an amplifier, load line analysis, operating point, types of amplifiers voltage and power amplifiers. Feedback-negative feedback in amplifiers.	**4**
IV.	**Discovery of x-rays-X-ray production and properties:** Bremsstrahlung radiations-Characteristics X-Rays, factors affecting Xray emission spectra, X-ray quality and quantity, HVL measurements, heel effect, soft and hard X-Rays, added and inherent filtration, reflection and transmission targets.	**4**
V.	**Heat** Definition of heat, temperature, Heat capacity, specific heat capacity, Heat transfer-conduction, convection, radiation, thermal conductivity, equation for thermal conductivity (k), the value of k of various material of interest in radiology, thermal expansion, Newton's law of cooling, Heat radiation, perfect black body, Stefan law, application in Diagnostic Radiology (Heat dissipation	**4**

	in both stationary and rotating X-ray tubes).	
VI.	**Interaction of ionizing radiation with matter**-Types of interactions of X-and gamma radiation, Photoelectric & Compton, Pair production, annihilation radiation. Interaction of X and gamma rays: Transmission through matter, law of exponential attenuation, half value layer, and linear attenuation coefficient-coherent scattering-photonuclear disintegration-Particle interactions. Interactions of X rays and Gamma rays in the body; fatsoft tissue-bone-contrast media-total attenuation coefficient-relative clinical importance.	**4**
VII.	**Exponential attenuation** (linear/mass attenuation coefficients), Half Value Thickness (HVT), Tenth Value Thickness (TVT), dependence on energy and atomic number. Radiation intensity and exposure, photon flux and energy flux density. LET, range of energy relationship for alpha, beta particles with X-Rays. **Physical quantity, its unit and measurement**: Fundamental and derived quantity, SI unit, various physical/radiation quantity used in Diagnostic Radiology and its unit.	**3**
VIII.	**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, Xray 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. **Production of x-rays**: X-ray tube, gas filled x-ray tube, construction working and limitations; stationary anode x - ray tube; construction, working, methods of cooling the anode, rating chart and cooling chart;	**4**
IX.	**Rotating anode x - ray tube:** construction, working rating chart, speed of anode rotation, angle of anode inclination, dual focus and practical consideration in choice of focus, anode heel effect, grid controlled x - ray tube; effect of variation of anode voltage and filament temperature; continuous and characteristics spectrum of x - rays, inherent filter and added filter, their effect on quality of the spectrum**.** **Grid controlled and high-speed tubes,** focal spot size, speed of anode rotation, target angle, inherent filtration, radiation leakage and scattered radiation). Interlocking and X-ray tube overload protection. **Heat dissipation methods,** tube rating, heat units, operating conditions and maintenance and QA procedures.	**4**

X.	**Filament current and voltage,** X-ray circuits (primary circuit, auto transformer), types of exposure switch and timers, principle of automatic exposure control (AEC) and practical operation, filament circuit, high voltage circuits, half wave, full wave rectification, three phase circuits. Types of generators, 3 phase, 6 and 12 pulse circuitshigh frequency generators-falling load generators, Capacitors discharge and grid control systems. **X-ray generator circuits:** Vacuum tube diodes-semi-conductordiodes-transistor-Rectification-half and full wave-self rectification-X-ray generator; filament circuit-kilo Voltage circuit-single phasegenerator-three phase generator-constant potential generator-Fuses,switches and interlocks-Exposure switching and timers-HT cables earthing.	**4**
XI.	**High tension circuits:** H.T. generator for x-ray machines, three phase rectifier circuits, three phase six rectifier circuit, three phase 12 rectifier circuit, high and medium frequency circuits; capacitance filter control and stabilizing equipment; mains voltage compensator, mains resistance compensator, compensation for frequency variation, control of tube voltage, kV compensator; high tension selector switch, filament circuit, control of tube current, space charge compensation.	**2**
XII.	**Meters and exposure timers:** Moving coil galvanometer: construction and working/conversion to millimeter, ammeter and voltmeter, meters commonly used in diagnostic x-ray machines, prereading kV meter and millimeter, digital panel meters. Clockwork timers, synchronous motor timer, electronic timers, photo metric timers (fluorescent and photoelectric effect as applied in timers), ion chamber-based timers, integrated timer.	**3**
XIII.	**Control of scattered radiation and Beam limiting devices:** cones, diaphragms, light beam collimator, beam centering device, methods to verify beam centering and field alignment; Filters-inherent filters, added filters, heavy metal filters, grids; design and control ofscattered radiation, grid ratio, grid cut-off, parallel grid, focused grid, crossed grid, grided cassettes, stationary and moving grid potter bucky diaphragms, various types of grid movements; single stroke movement, oscillatory movement and reciprocatory movement.	**2**
XIV.	**Fluoroscopy:** Fluorescence and phosphorescence - description, fluorescent materials used in fluoroscopic screens, construction of fluoroscopic screen and related accessories, tilting table, dark adaptation. Image intensifier - Construction and working, advantages over fluoroscopic device, principles and methods of visualising intensified image, basic principles of closed circuit television camera and picture tube. Vidicon camera, CCD. Automatic brightness control,	**4**

	automatic exposure control, chamber selection during fluoroscopy. Serial radiography: Manual cassette changer, rapid automatic film changer, basic principles of cine fluoroscopy and angiography use of grid controlled x-ray tube.	
XV.	**Care and Maintenance of X-ray equipment;** General care; functional tests; testing the performance of exposure timers, assessing the MA settings, testing the available KV, measurement of focal spot of an x-ray tube, testing the light beam diaphragm, practical precautions pertaining to Brakes and locks, H.T. cables, meters and controls, tube stands and tracks as well as accessory equipment.	**2**
	Total	**52**

Suggested Practicals/Demonstration

Practical	Subject Code:
Total Marks for Evaluation- 1	No. of Contact Hours- 108, Credits:3

Sr. No	**Radiological physics**	**Hours**
1	Discovery of X-ray production and properties	10
2	Interaction of ionizing radiation with matters	10
3	Exponential attenuation, Physical quantity, its unit and measurement	10
4	Medical Physics	
5	X-ray tube; Production of x-rays	18
6	Rotating anode x - ray tube; Grid controlled and high speed tubes; Heat dissipation methods	10
7	Filament current and voltage; X-ray generator circuits	10
8	High tension circuits; Interlocking circuits; Relay	10
9	Meters and exposure timers	10
10	Fluoroscopy	10
11	Care and Maintenance of X-ray equipment	10
	Total	**108**

Suggested Learning Resources

1. Basic radiologicalphysics ,K. Thayalan ,Jaypee Brothers Medical ,Publishers (P) Limited, 2003
2. Christinsens physics of diagnosticradiology Curry and Dowdey Wolters Kluwer
3. X-Ray Equipment for Student D.N. And M.O. Chesney Blackwell Science Ltd
4. Radiographic Imaging (Cbs)I.C.R.P. D.N. Chesney & M.O Chesney CBS Publishers & Distributors
5. An Introduction Of Physics to Diagnostic Radiography Christensen, Curry &Dowdey Lea&Febiger

6. Radiological Science for technologists Stewart C Bushong Mosby
7. Equipment for Diagnostic Radiography E. Forster Springer Dordrecht
8. A Textbook Of Radiation Physics For Radiologic Technology Surendra Maharjan,Suraj Sah Samiksha Publcation

Clinical Special Radiography Positioning

Theory	Subject Code: MMRIT02
Total Marks for Evaluation-100	No. of Contact Hours-72, Credits:3

RATIONALE

Clinical Radiography Positioning provides the students with knowledge of x-ray imaging, positioning and
all the care that should be taken.

COURSE OUTCOMES

At the end of the course students will be able to...

CO1: Understand the basic patient positioning during radiographic investigation.
CO2: Apply special positioning skills for different pathological and physical conditions.
CO3: Application of equipments while working in radiology departments.
CO4: Choose proper position during radiography.
CO5: Explain relative positions of x-ray tube and patient relevant exposure factors during radiography.
CO6: Explain the use of accessories.
CO7: Explain the anatomic and physiological basis of the procedure to be undertaken.
CO8: Explain the radiographic appearances of both normal and common abnormal conditions.
CO9: Prepare management and positioning of patients
CO10: Correlate of indications, contraindications of the patient
CO11: Understand the patient preparations needed before any radiological examination.
CO12: Generalize knowledge of post procedural care.
CO13: Students will be able position the patients for radiological procedures.
CO14: Knowledge of image quality in radiological images.
CO15: Management of patients in radiology department for various procedures.
CO16: Ability to handle emergency situations in radiology department.

Unit	Topic	Hours
I.	**Principles of Radiography:** Preparation of the Room, Apparatus and Instruments Positions of the Patient: Erect, Sitting, Supine, Prone, Lateral, Oblique, Decubitus Etc. Relative position of X-Ray tube and patient, relevant exposure factors. Use of accessories such as radiographic cones, grid and positioning aids. Anatomic and Physiological basis	**6**

	of the procedure, Association with theory with practical work. Radiographic appearances, both normal and common abnormal conditions where elementary knowledge of the pathology involved will ensure the application of the appropriate radiographic technique. Modifications in technique for various disabilities and types of subject. Radiation protection, use of gonad shield, practical methods of reducing radiation dose to the patient.	
II.	**Upper limb:** Special projections for the whole hand, fingers, wrist joint, forearm, elbow joint and humerus. Supplementary projections for Scaphoid, Carpal tunnel, Ball Catchers projections, Head of the Radius, Supracondylar fracture and Olecranon process.	**6**
III.	**Lower limb:** Special projections for the whole foot, toes, calcaneum, ankle joint, leg, knee- joint, patella and femurs. Supplementary projections for Talo-Calcaneal joint, Forced projections for torn ligaments, Flat Feet, Club Feet, Intercondylar projections for loose bodies in the knee, Axial projection for Patella.	**6**
IV.	**Shoulder Girdle and Thorax:** Special projections for the shoulder joint, Scapula, Acromio Clavicular joint, Clavicle, Sternoclavicular joint, Sternum and Ribs. Supplementary projections for the axial projection of Clavicle, Bicipital groove, Coracoid process.	**6**
V.	**Vertebral Column:** Special projections for Atlanto -Occipital joint, cervical spine, Cervico- thoracic Junction, thoracic Spine, lumbar Spine, Lumbo Sacral Region, Sacrum and Coccyx. Supplementary projections for the intervertebral foramina, posterior arch of Atlas, Flexion and Extension of Cervical Spine,Scoleosis and Kyphosis, Sacro Ileac Joint.	**6**
VI.	**Skull:** Special projections for cranium and facial bones; Supplementary projections for trauma, Towne's method, Sellaturcica, Optic foramina, Jugular foramina, Temporal bones, Mastoids, Petrous bone, Zygomatic arches, Orbits, Maxillae, Nasal bones, Mandible, Temporomandibular joints. Nasal Sinuses: Techniques for Frontal, Maxillary, Ethmoidal and Sphenoid Sinuses, erect and horizontal projections for fluid levels.	**6**
VII.	**Pelvic girdle and hip region:** Special projections for the whole pelvis, Sacro-Ileac joints, hip joint and Neck of Femur. Supplementary projections for the greater and lesser trochanters of Femur. Frog leg projection, Ischeum, Symphysis Pubis, Ileum, Acetabulum and Congenital Dislocation of Hip, Arthrodesis. **Skeletal survey:** Skeletal survey for metabolic bone disease, metastases, hormonal disorder, renal disorders	**6**

VIII.	**Dental Radiography** Technique for intra oral full mouth.- Occlusal projections Extra oral projections including orthopantomography.- Supplementary techniques. **Upper respiratory system** Technique for postnasal airways, larynx, trachea, thoracic inlet, Valsalva manoeuvre. - Phonation.	**6**
IX.	**Lungs and Mediastinum:** Supplementary projections: Antero-posterior, obliques, lordotic, apical projection, use of penetrated postero-anterior projection. - Expiration technique. - Technique for pleural fluid levels and adhesions. **Abdominal viscera:**Technique for plain film examination. - Projection for acute abdomen patients. - Technique to demonstrate: Foreign bodies, Imperforate anus.	**6**
X.	**Mammography:** Basic views, special views, wire localization	**6**
XI.	**Trauma radiography/Emergency radiography**General precautions, Asepsis in techniques - Checking of mains supply and functions of equipment, selection of exposure factors, explosion risk, radiation protection and rapid processing techniques.	**6**
XII.	**Soft Tissue Radiography:** High and low kilo voltage technique; differential filtration. Non - screen technique - simultaneous screen and non -screen technique. **Multiple radiography.** Uses of soft tissue radiography. **High kV Radiography:** General principles Relation to patient dose Change in radiographic contrast. **Neonatal and Paediatric Radiography** **Forensic Radiography** **Scatter elimination; beam collimation; grid ratio.** **Speed and type of grid movemen**	**6**
	Total	**72**

Suggested Practicals/Demonstration

Theory	Subject Code:
Total Marks for Evaluation-100	No. of Contact Hours-103, Credits:3

Sr. No		Hours
1	Principles of Radiography	5
2	Upper limb	10
3	Lower lim	10
4	Shoulder Girdle and Thorax	10
5	Vertebral Column	10
6	Skull	10
7	Pelvic girdle and hip region, Skeletal survey	5
8	Dental Radiography; Upper respiratory system	5
9	Meters and exposure timers	10
10	Lungs and Mediastinum; Abdominal viscera	13
11	Operation theatre techniques; C-arm	5
12	Soft Tissue Radiography Multiple radiography High kV Radiography Scatter elimination; beam collimation; grid ratio Speed and type of grid movement Radiographic factor; application and uses	5
13	Neonatal and Paediatric Radiography; Forensic Radiography Macroradiography Localization of foreign bodies	5
	Total	**103**

Suggested Learning Resources

1. Atlas of Radiographic Positioning and Radiological Procedures Philip W Ballinger, Eugene D.Frank Mosby.

2. Clarks Positioning In Radiography Ra Swallow, E Naylor Lippincott Williams and Wilkins

3. Merrill's Atlas of Radiographic Positioning and Procedures Bruce W. Long & Jeannean Hall Rollins & Barbara J. Smith Mosby

4.Bontrager'S Textbook Of Radiographic Positioning And Related Anatomy John Lampignano and Leslie E Kendrick Elsevier S

5. Radiology Of Positioning And Applied Anatomy For Students And Practitioners GarkalGs Jaypee Brothers Medical Publishers

Biostatistics and Research Methodology

Theory	Subject Code: MMRIT03
Total Marks for Evaluation-100	No. of Contact Hours-36, Credits:3

RATIONALE:
The application of statistical techniques to scientific research in health-related fields, including medicine, biology, and public health, and the development of new tools to study these areas.

COURSE OUTCOMES
At the end of the course students will be able to...
CO1: Understand the Importance of statistics course in the curriculum
CO2: Understands Statistical Terms
CO3: Possess Knowledge and Skill in the use of Basic Statistics in the analysis and interpretation of data

Unit	Topic	Hours
I.	Introduction: Meaning, Definition, Characteristics of Statistics; Importance of the Study of Statistics. Branches of Statistics; Descriptive and Inferential Statistics; Variables and Their Types. Measurement Scales	**6**
II.	Tabulation of Data: Raw Data, the Array, Frequency Distribution. Basic Principles of Graphical Representation; Types of Diagrams - Histograms, Frequency Polygons, Smooth Frequency Polygon, Commutative Frequency Curve, O give; Normal ProbabilityCurve.	**6**
III.	Measure of Central Tendency: Need For Measures of Central Tendency; Definition and Calculation of Mean; Ungrouped and Grouped Meaning, Interpretation and Calculation of Median Ungrouped and Grouped; Meaning and Calculation of Mode; Comparison of the Mean, and Mode; Guidelines for the Use of Various Measures of Central Tendency.	**6**
IV.	Measure of Variability: Need For Measure of Dispersion. The Range, the Average Deviation, The Variance and Standard Deviation; Calculation of Variance and Standard Deviation, Ungrouped and Grouped.	**6**
V.	Probability and Standard Distributions: Meaning of Probability of Standard Distribution, The Binominal Distribution. The Normal Distribution; Divergence from Normality - Skewness,Kurtosis.	**6**
VI.	Probability and Standard Distributions: Meaning of Probability of Standard Distribution, The Binominal Distribution. The Normal Distribution; Divergence from Normality - Skewness,Kurtosis	**6**
	Total	**36**

Suggested Learning Resources

1. Elements of HealthStatistics , Rao.N.S
2. An introduction ofBiostatistics ,Sunder Rao
3. Methods inBio-Statistics ,B.K. Mahajan
4. Elementary Statistics in MedicalWorkers ,Inderbir Singh
5. An Introduction to. Statistical Methods, Ram Prasad &Sons Gupta C.B

MMRIT Radiological Clinical Education-Part I (studentship): 16 hrs/week
The course may offer hands-on training or practical sessions, allowing participants to enhance their skills in teaching and research.

IInd SEMESTER

Modern Radiological Imaging-Equipment and Physics

Theory	Subject Code: MMRIT04
Total Marks for Evaluation-100	No. of Contact Hours-70, Credits:3

RATIONALE
Modern radiological Imaging Equipment and Physics provides the students knowledge about the modern x-ray equipment and working principle. Modern imaging techniques – including X-rays, ultrasound, CTscans and MRI – can show structures inside your body in great detail. Radiologic Physics is the study ofmedical imaging components, technology, and parameters in an effort to produce optimal imaging results.The goal with studying radiologic physics is to ensure you get clear images while ensuring the patient issafe from radiation.

COURSE OUTCOMES
At the end of the course students will be able to...
CO001: Describe the special radiological equipments
CO002: Describe the digital and computed radiography
CO003: Describe PACS, RIS and HIS

Unit	Topic	Hours
I	Modern x-ray tube: its principle, physics & equipment	**5**
II	Digital Radiography: its principle, physics & equipment. Flat panel digital fluoroscopy and radiography system, Direct and indirect digital radiography and fluoroscopy systems. Digital radiography and Computed radiography its advantages, disadvantages and applications. Digital Portable and mobile x-ray units	**5**
III	Dual energy x-ray absorptionometry (DEXA) scan: its principle, physics & equipment.	**5**
IV	Computed radiography: its principle, physics & equipment	**5**
V	Mammography and Tomosynthesis: its principle, physics & equipment	**5**
VI	Modern dental equipments. Cone beam dental CT	**5**
VII	Bone mineral density test: its principle, physics & equipment	**5**
VIII	Picture archiving and communication system (PACS), RIS, HIS and Teleradiology	**5**
IX	Computed Tomography	**5**
X	Computed TomogrMagnetic Resonance Imagingaphy	**5**
XI	Ultrasound Imaging	**5**

XII	Hybrid Imaging	**5**
XIII	Smart Simulator/virtual imaging	**5**
XIV	Artificial Intelligence in Modern Radiological Imaging	**5**
	Total	**70**

Suggested Practicals/Demonstration

Practical	Subject Code:
Total Marks for Evaluation- 100	No. of Contact Hours- 54, Credits:2

Sr. No	**Radiological physics**	**Hours**
I.	Modern x-ray tube: its principle, physics & equipment	**5**
II.	Digital Radiography	**5**
III.	Dual energy x-ray absorptionometry (DEXA) scan: its principle, physics & equipment	**2**
IV.	Computed radiography	**3**
V.	Mammography and Tomosynthesis: its principle, physics & equipment	**5**
VI.	Modern dental equipments. Cone beam dental CT	**3**
VII.	Bone mineral density test: its principle, physics & equipment	**2**
VIII.	Picture archiving and communication system (PACS), RIS, HIS and Teleradiology	**5**
IX.	Computed Tomography	**5**
X.	Magnetic Resonance Imaging	**5**
XI.	Ultrasound Imaging	**5**
XII.	Hybrid Imaging	**5**
XIII.	Smart Simulator/virtual imaging AI Imaging	**4**
Total		**54**

Suggested Learning Resources

1. Textbook of Radiology: Physics Amol Sasane, Hariqbal Singh , Roshan Lodha Jaypee Brothers Medical Publishers
2. The Physics Of Radiology And Imaging THAYALAN K Jaypee Brothers Medical Publishers
3. Christensen's Physics of Diagnostic Radiology Thomas S. Curry (Author), James E. Dowdey (Author), Robert E. Murry (Author) Lea &Febiger,U.S
4. Textbook Of Radiology For Residents And Technicians BHARGAVA S. K CBS; publishers
5. Ultrasound physics and technology Vivien gibbs, davidcole, Antonio sassano Churchill Livingstone
6. Manual of Diagnostic Ultrasound Philip E. S. Palmer (Author) World Health Organization

Modern Imaging and Special Radiological Procedures

Theory	Subject Code: MMRIT05
Total Marks for Evaluation-100	No. of Contact Hours-54, Credits:3

RATIONALE

Contrast & Special Radiological Procedures are diagnostic procedures usually performed by giving contrast through oral or intravenous to diagnose the disease. These imaging procedures are done under the guided of fluoroscopy or c-ram equipment.

COURSE OUTCOMES

At the end of the course students will be able to..

CO1: Prepare management and positioning of patients while performing radiological procedures.
CO2: Correlate of indications, contraindications, contrast media, radiation dose, exposure timing and radiation safety measures for different radiological procedures.
CO3: Understand the patient preparations needed before any radiological examination.
CO4: Generalize knowledge of post procedural care.
CO5: Students will be able position the patients for radiological procedures.
CO6: Knowledge of image quality in radiological images.
CO7: Management of patients in radiology department for various procedures.
CO8: Ability to handle emergency situations in radiology department.
CO9: Precautions and care required in interventional suits

Unit	Topic	Hours
I.	Introduction: General approach to Special Radiographic procedures, Responsibility of Radiology Technologist during radiological procedures, Preparation of patient for	**6**

	different procedures, Room layout in interventional radiology and fluoroscopy.	
II.	Basics and modern Emergency Equipment's in the Radiology Department	**4**
III.	Gastrointestinal Tract: Barium Swallow; Barium Meal -Single and Double Contrast; Barium Meal Follow Through; Small Bowel Enema (Enteroclysis); Barium Enema -Gastrograffin Enema; Loopogram Advanced procedures of Gastrointestinal Tract	**10**
IV.	Biliary Tract: Oral & Intravenous Cholecystography; Percutaneous Transhepatic Cholengiography; Percutaneous Transhepatic Biliary Drainage; Endoscopic Retrograde Cholengiopancreatography Advanced procedures ofBiliary Tract	**10**
V.	Urinary System: IVU (Intravenous Urography), Retrograde Pyeloureterography (RGU), Micturating Cysto Urethrography, Ascending Urethrography. Advanced procedures of Urinary System	**10**
VI.	Reproductive System: HysteroSalpingogram, FTR (Fallopian Tube Recanalization) Advanced procedures of Reproductive System	**5**
VII.	Respiratory System: Bronchography, Percutaneous Lung Biopsy Advanced procedures of Respiratory System	**5**
VIII.	Other procedures in radiology: Arthrography, Sialography, Lymphography, Sinography & Fistulography, Dacryocystography, Embolization & embolic agents Related Advanced procedures.	**4**
Total		**54**

Suggested Practicals/Demonstration

Practical	Subject Code:
Total Marks for Evaluation- 100	No. of Contact Hours- 72, Credits:2

Sr. No		**Hours**
I.	General approach to special radiographic procedures, responsibility of radiology technologist during radiological procedures Contrast media and their adverse reactions to contrast media and patient management.	**10**
II.	Procedures for gastrointestinal tract including barium studies Procedures for biliary tract.	**15**
III.	Procedures for urinary system and reproductive system	**15**

IV.	Procedures for central nervous system and respiratory system.	**15**
V.	Other procedures in radiology: Arthrography, Sialography, Lymphography, Sinography & Fistulography, Dacryocystography, Embolization & embolic agents Related Advanced procedures.	**17**
	Total	**72**

Suggested Learning Resources

Radiographic Imaging (Cbs)I.C.R.P. Bhushan and Lakkhar Arya Publications

A guide to radiological procedures Chapman Elsevier

Contrast Media and Interventional Radiology

Theory	Subject Code: MMRIT06
Total Marks for Evaluation-100	No. of Contact Hours-54, Credits:3

RATIONALE

Interventional radiology (IR) helps student MRIT to gain about the basics diagnostics and interventional procedures and to learn procedures in modalities like digital radiography CT and MRI and nuclar medicine and to increase the level of understandings and knowledge required to meet current radiologic procedures and to understand the physical principles of radiography and basic radiography positioning to perform the procedures. it a medical specialty that performs various minimally-invasive procedures using medical imaging guidance, such as x-ray fluoroscopy, computed tomography, magnetic resonance imaging, or ultrasound. IR performs both diagnostic and therapeutic procedures through very small incisions or body orifice.

COURSE OUTCOMES

At the end of the course students will be able to...

CO1: Know the basic principle and physics of interventional equipment.

CO2: Know the management and positioning of patients while performing interventional radiological procedure.

CO3: Have knowledge about the indications, contraindications, contrast media, radiation dose, exposure timing and radiation safety measures for the different interventional radiological procedure.

CO4: Understand the patient preparation needed before any interventional radiological procedures.

CO5: Have knowledge about the post procedural care and safety

Unit	Topic	Hours
I.	Contrast Media: Positive and Negative, Ionic &Non Ionic, Adverse Reactions to contrast media and patient management	**8**
II.	Introduction to interventional procedures **DSA**: principles and types Equipment: Basics of angiographic equipments, single and biplane angiographic equipments, angiographic table, image intensifier, flat panel detectors, recording systems, pulseoximetry, cardiac resuscitation measure-ECG, pressure injector, catheters, needle and other tools, 3D rotational angiography, image processing, patient monitor, CO2 angiography	**8**
III.	Interventional procedures: Catheter- classification, types and applications, Guide wire- classification, types andapplications, Pressure Injector and Accessories,Percutaneous catheterization, Digital Subtraction Angiography, Catheterization Sites, Asepsis	**8**
IV.	Arteriography: Head and Neck Arteriography, Pulmonary Arteriography, Coronary Arteriography, Ascending Aortography, Trans Lumbar Aortography, Renal Arteriography, Trans Femoral Arteriography Venography: Peripheral Venography- Lower Limb, Upper Limb, Central Venography, Superior Venacavography, Inferior Venacavography, Pelvic Venography	**20**
V.	Safety considerations in angiography room; room design, protective devices, radiation monitoring	**5**
VI.	Care and maintenance tests: General care, functional test Quality assurance program: Acceptable limits of variation, corrective action	**5**
Total		**54**

Suggested Practicals/Demonstration

Practical	Subject Code:
Total Marks for Evaluation- 100	No. of Contact Hours- 72, Credits:2

Sr. No		Hours
I.	Contrast Media	**10**

II.	Basics of angiographic equipments	**10**
III.	Catheter and guide wires	**10**
IV.	Arteriography and venography procedures	**20**
V.	Safety considerations in angiography room	**12**
VI.	Care and maintenance tests Quality assurance program:	**10**
	Total	**72**

Suggested Learning Resources

1. The practice of interventional radiology ,Karim valji.
2. Radiologic Procedures Krishna kandarpa (author), lindsay machan (author), janettedurham (author)Lippincott Williams and Wilkins.
3. Interventional radiology: a survival guide EBIR Kessel, David, MB, BS, MA, MRCP, FRCR (Author), FRCR Robertson, Iain, MB, ChB, MRCP Elsevier Health Sciences.

MMRIT Radiological Clinical Education-Part II (studentship): 16 hrs/week

The course may offer hands-on training or practical sessions, allowing participants to enhance their skills in teaching and research.

IIIrd SEMESTER
(Electives of CT Technology)

Principles of CT Imaging Technology

Theory	Subject Code: MMRIT07
Total Marks for Evaluation-100	No. of Contact Hours-54, Credits:3

RATIONALE

It aims to provide knowledge related to the basic working principle and construction of CT scanners and the various hardware and software mechanisms required for obtaining the cross-sectional imaging. It also gives a brief review of the history and evolution of the CT scanners.

COURSE OUTCOMES

At the end of the semester student must be able to:

CO1:Should gain a comprehensive understanding of the principles behind CT imaging, including the physics and technology involved in generating cross-sectional images.
CO2:Will learn the practical aspects of CT scanning such as patient positioning, selection of appropriate protocols and the use of contrast agents.
CO3:Students should be able to explain the process of image reconstruction in CT and understand how raw data is transformed into meaningful images.
CO4:Will learn to assess CT image quality and identify common imaging artefacts, as well as strategies to minimize or correct these artefacts.

Unit	Topic	Hours
I.	Introduction to CT: Basic principle of tomography,definition of terms, Image reconstruction from projections. AI in CT	**7**
II.	Evolution of terms	**3**
III.	**Process**: data acquisition and image reconstruction Image display, Processing, storage, Recording and communications	**6**
IV.	Working of CTBasic principle of CT Instrumentation Reconstruction algorithms AI in CT	**10**
V.	**History of CT:** Early experiments by Godfrey Newbold Hounsfield, Allan Macleod Cormack	**3**
VI.	**Generations of CT** Generation of CT /Geometry	**7**
VII.	**Fast scanner** Helical/ Spiral scanner Applications of volume scanning AI in CT	**7**
VIII.	**Image formation in CT** Hounsfield unit, CT windowing, CT image quality CT artifacts**.** Quality assurance and control in CT AI in CT	**9**
IX.	Merits and demerits of Computed tomography	**2**
Total		**54**

Suggested Practicals/Demonstration

Practical	Subject Code:
Total Marks for Evaluation- 100	No. of Contact Hours- 70, Credits:2

Sr. No		Hours
I.	Introduction and History CT and Evolution of terms.	**6**

II.	Process and Working in CT	**19**
III.	Generations and Image formation in CT.	**25**
IV.	Fast scanner Merits and demerits of Computed tomography	**20**
	Total	**70**

Suggested Learning Resources

1. Principles, Clinical Applications, andQuality ControlEuclid Seeram RT(R) BSc MSc FCAMRT (Author) Saunders
2. Computed Tomography forTechnologists: A Comprehensive Text Lois Romans Lippincott Williams and Wilkins;
3. Computed Tomography: Physics andTechnology. A Self Assessment Guide Euclid Seeram Wiley-Blackwell
4. The CT Handbook: OptimizingProtocols for Today's Feature-Rich Scanners Timothy P.
5. Szczykutowicz Medical Physics Publishing Corporation

CT Imaging Procedures and Scanning Protocols

Theory	Subject Code: MMRIT08
Total Marks for Evaluation-100	No. of Contact Hours-54, Credits:4

RATIONALE

CT Procedures and Scanning Protocol course is to provide participants with a comprehensive understanding of the various procedures involved in computed tomography (CT) imaging and the principles of selecting appropriate scanning protocols for different clinical scenarios.

COURSE OUTCOMES

At the end of the semester student must be able to:

CO1:CT procedures and scanning protocols result in high-quality images that allow radiologists and healthcare professionals to make accurate and precise diagnoses. Clear and detailed CT images aid in identifying and characterizing various medical conditions, such as tumors, fractures, infections, and other abnormalities.

CO2: Will be able to acquire Accurate CT imaging helps healthcare providers create effective treatment plans for patients. The information obtained from CT scans can guide surgical procedures, radiation therapy, and other interventions, leading to improved patient outcomes.

CO3: Must follow appropriate scanning protocols and employ dose reduction techniques to minimize the amount of radiation the patient receives during the scan. This ensures that the benefits of the CT scan outweigh any potential risks associated with radiation exposure.

Unit	Topic	Hours
I.	**CT Head and Neck:** CT Brain, Cerebral Angiography, CT orbit, CT face with 3D post-processing, CT temporal bone, CT PNS, CT neck, neck angiography, Head and neck venography, CT cisternography	**10**
II.	**CT Thorax:** CT thorax (Supine, prone, Expiratory), HRCT thorax, CT pulmonary angiography, CT aortography.	**8**
III.	**CT Abdomen and Pelvis:** CT KUB, CT abdomen (Dual and triple phase), Liver, pancreas and renal protocol, CT enterography, CT pelvis, CT abdominal angiography, CT renal angiography, CT urography, CT cystogram	**12**
IV.	**CT Musculoskeletal System:** CT shoulder, elbow, wrist, hand, hip, femur, knee, tibia & fibula, ankle, foot. CT peripheral angiography/Venography.	**8**
V.	**CT Spine:** CT whole spine, CT cervical, thoracic, lumbar and LS spine, CT sacrum & coccyx, CT Myelography. Lumbar Puncture, CSF Aspiration.	**9**
VI.	**Miscallaneous:** Paediatric CT, Adult Whole-body CT, CT fluoroscopy, Breast CT Imaging	**7**
Total		**54**

Suggested Practicals/Demonstration

Practical	Subject Code:
Total Marks for Evaluation- 100	No. of Contact Hours- 72, Credits:2

Sr. No		Hours
I.	CT Head and Neck	**10**
II.	CT Thorax	**10**
III.	CT Abdomen and Pelvis	**10**
IV.	CT Musculoskeletal System	**10**
V.	CT Musculoskeletal System	**10**
VI.	CT Spine	**10**
VII.	Miscallaneous	**12**

	Total	**72**

Suggested Learning Resources

1. Principles, Clinical Applications, and Quality Control Euclid Seeram RT(R) BSc MSc FCAMRT (Author) Saunders
2. Computed Tomography for Technologists: A Comprehensive Text Lois Romans Lippincott Williams and Wilkins;
3. Computed Tomography: Physics and Technology. A Self Assessment Guide Euclid Seeram Wiley Blackwell
4. The CT Handbook: Optimizing Protocols for Today's Feature-Rich Scanners Timothy P. Szczykutowicz Medical Physics Publishing Corporation.

Basic and Cross-Sectional Anatomy in CT Imaging

Tutorial	Subject Code: MMRIT09
Total Marks for Evaluation-	No. of Contact Hours-18, Credits:1

Practical	Subject Code: MMRIT09
Total Marks for Evaluation-100	No. of Contact Hours-108, Credits:2

RATIONALE

CT Cross Sectional Anatomy course typically aims to provide participants with a comprehensive understanding of the anatomical structures as visualized in computed tomography (CT) images. The course focuses on developing the necessary knowledge and skills to accurately interpret CT cross-sectional images of the human body.

COURSE OUTCOMES

At the end of semester student must be able to:

CO1: Participants should be able to identify and label major anatomical structures in CT cross-sectional images, including organs, bones, blood vessels, nerves, and other relevant tissues.

CO2: Will learn to interpret CT images in different planes (transverse, sagittal, and coronal) to gain a
complete understanding of the spatial relationships and dimensions of anatomical structures.

CO3: Will become proficient in recognizing normal anatomy across various body regions, enabling them to distinguish variations from pathology.

CO4: Will develop the ability to identify and describe common pathological conditions and abnormalities seen in CT cross-sectional images, such as tumors, inflammation, fractures, and vascular anomalies.

Unit	Topic	Hours
I.	Cross Sectional Anatomy of: Head ,Vascular supply of brain Venous supply of brain ,Cranial nerves	**20**
II.	Neck cross sectional anatomy Vascular supply of neck Venous supply of neck	**14**
III.	Thorax cross sectional anatomy Vascular supply of thorax Venous supply of thorax	**18**
IV.	Abdomen cross sectional anatomy Vascular supply of adomen Venous supply of abdomen	**20**
V.	Pelvis cross sectional anatomy (male and female) Vascular supply of pelvis Venous supply of pelvis	**16**
VI.	Vertebral body and extremities	**8**
VII.	Muscles, ligaments and tendons	**6**
VIII.	Upper and lower limb blood supply	**6**
Total		**108**

Suggested Learning Resources

1. Cross Sectional Anatomy CT and MRI Govind Chavhan, Bhavin Jankharia Jaypee Brothers Medical Pub.
2. Cross-Sectional Anatomy for Computed Tomography Michael L. Farkas Springer New York
3. Sectional Anatomy by MRI and CT Mark W. Anderson, Michael G Fox Elsevier Health Sciences
4. Atlas of Human Cross-Sectional Anatomy With CT and MR Images Donald R. Cahill, Matthew J. Orland, Gary M. Miller Wiley

MMRIT Radiological Clinical Education-Part III (studentship): 16 hrs/week

The course may offer hands-on training or practical sessions, allowing participants to enhance their skills in teaching and research.

IVth SEMESTER
(Electives of CT Technology)

Advancements in CT Technology

Theory	Subject Code: MMRIT10
Total Marks for Evaluation- 100	No. of Contact Hours-54, Credits:3

RATIONALE

Advances Techniques in Computed Tomography Technology aims to provide participants with specialized knowledge and skills related to the latest advancements and cutting-edge techniques in the field of Computed Tomography (CT) imaging.

COURSE OUTCOMES

At the end of the semester student must be able to:

CO1: Will gain a comprehensive understanding of the latest advancements and cutting-edge techniques in CT imaging. This knowledge may include advanced imaging protocols, reconstruction methods and clinical applications.

CO2: Will give a deeper understanding of advanced CT techniques, participants can potentially improve diagnostic accuracy, leading to better patient outcomes and more effective treatment planning.

CO3: Involved in research and development, the course may inspire new ideas and insights that contribute to the ongoing advancement of CT technology and medical imaging.

CO4: Completion of this advanced course may provide continuing education credits or professional development recognition for individuals in the medical field.

CO5: Acquiring knowledge and skills in advanced CT techniques could lead to expanded career opportunities or increased responsibilities within their respective workplaces

Unit	Topic	Hours
I.	**Advanced CT Imaging Techniques:** Dual-Energy CT Dynamic CT, and iterative reconstruction algorithms. Role of these techniques enhance image quality and improve diagnostic accuracy	**4**
II.	**CT Angiography (CTA)**: principles and applications of CT angiography, including vascular imaging, cardiac CTA, CTPA and peripheral CTA. Role of CTA in diagnosing vascular diseases and assessing blood flow.	**8**
III.	**CT Perfusion Imaging:** CT perfusion imaging and its use in assessing tissue perfusion, blood flow, and detecting cerebral or abdominal ischemia	**4**
IV.	**Dual-Source CT and Multidetector CT (MDCT):** benefits of dual-source and MDCT scanners, such as reduced scan times, improved spatial resolution, and decreased radiation dose	**4**
V.	**Cardiac CT Imaging**: cardiac CT imaging, including coronary artery assessment, cardiac function evaluation, and the role of CT in cardiac disease diagnosis, Calcium Scoring	**4**

VI.	**Radiation Dose Optimization**: advanced techniques for optimizing CT scanning protocols to reduce radiation dose while maintaining image quality	**2**
VII.	**Advanced Post-processing Techniques**: advanced image post processing techniques, such as 3D volume rendering, maximum intensity projection (MIP), and multiplanar reconstruction (MPR)	**3**
VIII.	**CT-guided Interventions**: CT-guided procedures and interventions, including biopsy, drainage and ablation techniques	**4**
IX.	**Virtual CT**: Colonoscopy: the techniques used in virtual CT colonoscopy, a non-invasive method for imaging the colon and detecting polyps and other abnormalities Bronchoscopy: technique, post processing and applications	**4**
X.	**Advanced Image Reconstruction**: advanced image reconstruction techniques such as iterative reconstruction algorithms which improve image quality while reducing radiation dose.	**3**
XI.	**Artifact Reduction Strategies**: techniques to minimize and correct artifacts that can arise in advanced CT imaging, ensuring accurate diagnosis and interpretation	**4**
XII.	**Radiation Dose Management**: strategies for optimizing CT protocols to reduce radiation dose while maintaining diagnostic image quality.	**2**
XIII.	**Contrast Media Innovations**: new contrast media agents and protocols used in CT imaging to enhance image contrast and visualization of specific tissues or pathologies, automatic contrast tracking techniques.	**2**
XIV.	**Quality Assurance and Image Quality Assessment**: quality assurance protocols specific to advanced CT technology and the assessment of image quality.	**4**
XV.	**Emerging Trends in CT**: latest developments and emerging trends in CT technology, including artificial intelligence applications and new imaging advancements	**2**
Total		**54**

Suggested Practicals/Demonstration

Practical	Subject Code:
Total Marks for Evaluation-	No. of Contact Hours-72, Credits:2

Sr. No		**Hours**
I.	Dual-Source CT and Multidetector CT (MDCT	**8**

	Advanced CT Imaging Techniques	
II.	Radiation Dose Management Radiation Dose Optimization	**6**
III.	Contrast Media Innovations	**4**
IV.	Advanced Post-processing Techniques Advanced Image Reconstruction	**8**
V.	Quality Assurance and Image Quality Assessment	**4**
VI.	Emerging Trends in CT	**4**
VII.	Artifact Reduction Strategies	**8**
VIII.	Virtual CT CT-guided Interventions	**10**
IX.	CT Angiography (CTA) Cardiac CT Imaging	**14**
X.	CT Perfusion Imaging	**6**
	Total	**72**

Suggested Learning Resources

1. Computed Tomography: Physical Principles, Clinical Applications, and Quality Control Euclid Seeram RT(R) BSc MSc FCAMRT (Author) Saunders
2. Computed Tomography for Technologists: A Comprehensive Text Lois Romans Lippincott Williams and Wilkins;
3. Computed Tomography: Physics and Technology. A Self Assessment Guide Euclid Seeram Wiley-Blackwell
4. The CT Handbook: Optimizing Protocols for Today's Feature-Rich Scanners Timothy P.Szczykutowicz Medical Physics Publishing Corporation

Quality Assurance, Radiation Protection and Patient care in CT Imaging

Theory	Subject Code: MMRIT11
Total Marks for Evaluation- 100	No. of Contact Hours- 54, Credits:3

RATIONALE

Radiation Protection and Patient Care in CT course aims to provide participants with essential knowledge and skills related to ensuring patient safety and implementing radiation protection measures during computed tomography (CT) examinations.

COURSE OUTCOME

At the end of semester student must be able to:

CO1: Should gain a comprehensive understanding of the principles of ionizing radiation, its interaction with human tissues, and the potential risks associated with radiation exposure.

CO2: Will be familiarized with the ALARA (As Low As Reasonably Achievable) principle and learn techniques to minimize radiation dose to patients while maintaining image quality.

CO3: Should learn strategies for optimizing CT scanning protocols and adjusting parameters to achieve appropriate image quality with the lowest possible radiation dose.

CO4: Radiation Protection Guidelines: Participants will be introduced to national and international radiation protection guidelines specific to CT imaging.

CO5: Will learn proper patient positioning and centering techniques to ensure accurate imaging and reduce the need for repeat scans.

CO6: Should be aware of the unique considerations and radiation protection protocols when imaging paediatric and pregnant patients.

CO7: Will understand the use of contrast agents in CT imaging, their potential risks, and the importance of proper patient screening for allergies and contraindications.

CO8: Should understand the importance of infection control practices in the CT environment, including equipment cleaning and proper hygiene measures.

CO9: Will become aware of ethical and legal responsibilities in providing radiation protection and patient care in CT imaging.

CO10: Will be educated on safety measures and protocols to protect healthcare professionals and staff working in the CT department.

Unit	Topic	Hours
I.	**Introduction of Radiation Protection**: Principles of radiation protection, ALARA/ALARP, MPD, The Role of the CT Technologist, Radiation in Pregnancy and children.	**10**
II.	**Radiation quantities and units:** Factors Affecting Dose in CT, CT Dosimetry – MSAD, Bed Index, CTDIw, CTDIvol, DLP.	**6**
III.	**Biological units of radiation**: Radiation detection and measurements, LET, OER, survey meters, Geiger muller counter, ionisation chambers.	**6**
IV.	**Radiation Hazard evaluation and control**: Scatter and Leakage radiation, ICRP guidelines for CT room design, Radiation Signage, Protective devices.	**10**
V.	**AERB and ICRP guidelines:** Limits for radiation exposure	**4**
VI.	**Contrast media in CT**: ionic and non-ionic agents, lethal dose, contrast administration techniques, contrast tracking techniques.	**4**
VII.	**Radiation protection**: Radiation protection for patient and staff, personnel protective apparel. AI in radiation safety	**6**
VIII.	**Pre and post-procedural care in CT**:	**8**

	Patient transfer and Restraining techniques, Infection control and sterilization, Medical ethics and records, Patient care in special cases: Spinal injuries, Trauma, Stroke, Burns, Cardiac emergency	
Total		**54**

Suggested Practicals/Demonstration

Practical	Subject Code:
Total Marks for Evaluation- 100	No. of Contact Hours- 60, Credits:2

Sr. No		**Hours**
I.	Introduction of Radiation Protection AERB and ICRP guidelines	**20**
II.	Radiation quantities and units Biological units of radiation	**20**
III.	Pre and post-procedural care in CT	**5**
IV.	Radiation protection	**10**
V.	Radiation Hazard evaluation and control	**12**
VI.	Contrast media in CT	**5**
	Total	**72**

Suggested Learning Resources

1. Computed Tomography: Physical Principles, Clinical Applications, and Quality Control Euclid Seeram RT(R) BSc MSc FCAMRT (Author) Saunders.
2. Computed Tomography for Technologists: A Comprehensive Text Lois Romans Lippincott Williams and Wilkins;
3. Computed Tomography: Physics and Technology. A Self Assessment Guide Euclid Seeram Wiley-Blackwell
4. The CT Handbook: Optimizing Protocols for Today's Feature-Rich Scanners Timothy P. Szczykutowicz Medical Physics Publishing Corporation.

Basic Pathology and Image Interpretation in CT Imaging

Practical	Subject Code: MMRIT12

Total Marks for Evaluation- 100	No. of Contact Hours- 108, Credits:2

RATIONALE

Imaging pathology and image interpretation in computed tomography (CT) is to facilitate accurate and early detection, characterization, and evaluation of various medical conditions and abnormalities within the body. CT imaging is a non-invasive, widely available, and valuable medical imaging modality that provides detailed cross-sectional images of the internal structures of the body.

COURSE OUTCOMES

At the end of the semester the student must be:

CO1: To Identify diseases and abnormalities at an early stage often leads to better patient outcomes.

CO2: Learn the extent and location of pathologies, aiding in precise diagnosis and treatment planning.

CO3: Will learn CT guide certain medical procedures such as biopsies, drainages, and needle aspirations

Sr. No		Hours
I.	Basic pathologies and general interpretations of Head, Face&Neck	**15**
II.	Basic pathologies and general interpretations of Vascular imaging	**5**
III.	Basic pathologies and general interpretations of Spine	**15**
IV.	Basic pathologies and general interpretations of Brachial plexus,Chest, Heart and great vessels.	**10**
V.	Basic pathologies and general interpretations of Breast	**5**
VI.	Contrast media in CT	**13**
VII.	Basic pathologies and general interpretations of Abdomen and Pelvis	**10**
VIII.	Basic pathologies and general interpretations of Upper limb	**10**
IX.	Basic pathologies and general interpretations of Lower Limb	**10**
X.	Basic pathologies and general interpretations of Peripheral vascular System	**5**

XI.	Basic pathologies and general interpretations of Pediatric imaging	**10**
	Total	**108**

Suggested Learning Resources

1. CT & MRI Pathology: A Pocket Atlas, Third Edition Michael L. Grey, Jagan Mohan Ailinani Snippet view
2. Normal Findings in CT and MRI Torsten Bert Moeller, Emil Reif
3. Neurological Practice: An Indian Perspective Wadia

Dissertation

Practical	Subject Code: MMRIT13
Total Marks for Evaluation-100	No. of Contact Hours- 108, Credits:2

MMRIT Radiological Clinical Education-Part IV (studentship): 16 hrs/week

The course may offer hands-on training or practical sessions, allowing participants to enhance their skills in teaching and research.

IIIrd SEMESTER
(Electives of MRI Technology)

Principles of MR Imaging Technology

Theory	Subject Code: MMRIT14
Total Marks for Evaluation-100	No. of Contact Hours-54, Credits:3

RATIONALE

The basic working principles of Magnetic resonance imaging along with the construction and equipments necessary for the image formation, processing, encoding, storage and display. To comprehend the image quality parameters, identify artifacts and assure image quality with the aid of quality assurance tests and tolerance limits.

COURSE OUTCOMES

At the end of the course students will be able to...

CO1: Identify the basic physical concepts involved in MRI
CO2: Understand the various imaging parameters that determine image contrast.
CO3: Describe the various image weighting techniques and its application
CO4: To comprehend principles of gradients and spatial encoding.
CO5: Concept of K- space and its traversal involved in MR image formation.

CO6: Knowledge of image quality in MRI images.
CO7: Apply MR imaging parameters in the clinical setting and its trade-off to optimize image quality.
CO8: Ability to minimize image artifacts and understand various Quality assurance tests.
CO9: Precautions and care required during MR Imaging

Unit	Topic	Hours
I.	**Introduction and Basic principles**: Atomic structure and motion, MR active nuclei, Hydrogen MRI, spin precession, Larmor equation, Resonance, Relaxation, T1 and T2 Times.	**8**
II.	**Image contrast and weighting**: Intrinsic and extrinsic parameters of MR Image contrast, T1, T2 and PD weighting and its applications, T2* decay, FID .	**6**
III.	**Spatial Encoding and K-Space**: Gradients, Slice selection, frequency and phase encoding, K space basic concept, its filling and traversal, Fast Fourier transform..	**4**
IV.	**MRI Pulse sequences:** Spin echo sequences, Inversions recovery sequences, Gradient eco sequences, echo planar imaging, Parallel imaging..	**10**
V.	**MR Instrumentation and Safety**: Magnets- types and application, Radio waves, Coils- types and functions, Shielding, Shimming, MR scanner Construction and components, MRI safety considerations, Signage, MR Compatible/conditional/non-compatible devices. AI in MRI.	**10**
VI.	**Image Parameters and quality**: SNR, CNR, Scan time, Spatial Resolution. Trade-offs between parameters.	**4**
VII.	**MRI Contrast Agents**: Mechanism of action, T1 and T2 Agents, classification and applications of contrast agents, doses in adults and pediatrics, Safety considerations in pregnancy and lactation.	**6**
VIII.	**MRI artifacts**: Causes, appearance, remedy. Quality assurance tests and tolerance limits.	**6**
Total		**54**

Suggested Practicals/Demonstration

Practical	Subject Code:
Total Marks for Evaluation-	No. of Contact Hours- 72, Credits:2

Sr. No		Hours
I.	Image contrast and distinction between differently weighted images.	**10**
II.	Manipulating TR and TE for T1, T2 and PD weighted images.	**10**

III.	Identifying and manipulating various image parameters to maintain image quality.	**10**
IV.	Identifying the various types of coils and their uses. Distinction between SE and GRE sequences.	**12**
V.	Understanding MRI safety principles and patient screening.	**10**
VI.	Contrast agents and its uses, dosage and administration process, time-intensity curves.	**10**
VII.	MRI artifacts.	**10**
	Total	**72**

Suggested Learning Resources

1. Fundamentals of MRI Stark &Bradely
2. MRI in practice, 4th edition Catherine Westbrook, Carolyn Kaut Roth, and John Talbot Wiley Blackwell
3. Magnetic Resonance Imaging, Physical and Biological Principles 4th edition. Stewart Bushong and Geoffrey Clarke

MR Imaging Procedures and Scanning Protocols

Theory	Subject Code: MMRIT15
Total Marks for Evaluation-100	No. of Contact Hours-54, Credits:4

RATIONALE

To comprehend the indications, contraindications, patient preparation, positioning, coils used and other specific considerations while performing the different MRI scan Protocols. Basic understanding of Parameter manipulation and post procedural care.

COURSE OUTCOMES

At the end of the course students will be able to...

CO1: Identify the indications and contraindications for various protocols
CO2: Understand the various patient preparation aspects, including history taking and screening.
CO3: Describe the parameters and sequences used to acquire necessary images.
CO4: To comprehend principles of image quality for each type of protocol and the trade-off.
CO5: Types of coils used, positioning and landmark for each anatomical examination.
CO6: Knowledge of Post procedural care.

Unit	Topic	Hours

I.	**MRI Brain:** Routine, stroke, epilepsy, MS, tumour protocols, MR Angiography (COW), MR Venography, CSF Flow analysis.	**10**
II.	**MRI Face:** Orbit, Cochlea, OSA, Pituitary, Neck, Brachial Plexus, Sialography, Dacrocystography.	**7**
III.	**MRI Upper limb protocols:** Shoulder, elbow, wrist, hand. MR Upper limb angiography/venography. Shoulder Arthrography.	**9**
IV.	**MRI Lower limb Protocols:** Pelvis- bony, male and female, hip joint, knee, ankle, foot. MR Cartigram. Lower Limb Angiography/Venograph..	**9**
V.	**MRI Spine:** Cervical, Thoracic, Lumbo-sacral, Flexion Extension, Whole spine screening.Composing. MR Cisternography, Myelography.	**9**
VI.	**MRI Thorax-Abdomen:** Cardiac MR, routine Abdomen, MRCP, Fetal MRI, Fistulography, MR Prostate, MR Placenta, MR Urography, Enteroclysis. Respiratory and ECG Gating techniques	**5**
VII.	**All special MRI procedures** including MRCP, perfusion scan, ASL, FMRI, Cardiac MRI etc. Pediatric scan: Kitten MRI	**5**
Total		**54**

Suggested Practicals/Demonstration

Practical	Subject Code: MMRIT15
Total Marks for Evaluation-100	No. of Contact Hours-72, Credits:2

Sr. No		**Hours**
I.	MRI Brain and special sequences acquired in different pathologic conditions.	**10**
II.	MRI Face and neck region, angiographies and various post processing techniques involved.	**10**
III.	Upper and Lower limb MRI protocols for various anatomical structures.	**10**
IV.	Fistulography, Sialography, Dacrocyctography, MRCP and the various contrasts, techniques and parameters of acquisition.	**12**
V.	Understanding MRI safety principles and patient screening prior to patient position in the clinical setting	**10**
VI.	Contrast agents and its uses, dosage and administration process, time-intensity curves.	**10**

VII.	MR in Pregnancy.	**10**
	Total	**72**

Suggested Learning Resources

1. Musculoskeletal MRI E-Book Major, Nancy M., Anderson, Mark W
2. MRI in practice, 4th edition Catherine Westbrook, Carolyn Kaut Roth, and John Talbot Wiley
   Blackwell.
3. Magnetic Resonance Imaging, Physical and Biological Principles 4th edition. Stewart Bushong and Geoffrey Clarke.

Basic and Cross-Sectional Anatomy in MR Imaging

Practical	Subject Code: MMRIT16
Total Marks for Evaluation- 00	No. of Contact Hours-108, Credits:2

RATIONALE

To identify and understand the various anatomical structures, so that positioning and planning of protocols
is performed proficiently. To also comprehend various pathological conditions and interpret images
efficiently.

COURSE OUTCOMES

At the end of the course students will be able to...

CO1: Identify the cross –sectional anatomical structures with ease
CO2: Understand the various post processing techniques to optimize anatomical visualization. .
CO3: Identify the various blood vessels or nerves and its anatomical correlation.
CO4: To comprehend principles of image quality for each type of protocol based on anatomical structure
CO5: Types of coils used, positioning and landmark for each anatomical examination.
CO6: Knowledge of various pathological conditions and the special sequences used to optimize its visualization.

Unit	Topic	Hours
I.	**Basic Anatomy:** Anatomical Terminologies, Sectional planes, movements, Joints, surface anatomy	**12**
II.	**Brain**: Cross-sectional Anatomy, lobes, ventricles, Brainstem, blood supply, venous sinuses, cranial nerves. Paranasal sinuses, orbits, pituitary gland..	**16**
III.	**Neck:** Major vessels – carotids, aorta, pulmonary vessels, Brachial plexus, Thyroid, cartilages, salivary glands and duct system, muscles of the back..	**14**

IV.	**Upper limb:** Shoulder- rotator cuff, elbow, wrist, hand, metacarpals, carpals,phalangs, related muscles and tendons. Arterial supply and venous drainage.	**14**
V.	**Lower limb:** Pelvis- bony, male and female, hip joint, knee, ankle, foot, metatarsals, tarsals, ligaments, tendons, muscles,popliteal fossa, arterial supply and venous drainage.	**14**
VI.	**Spine:** Cervical, Thoracic, Lumbar, sacrum, coccyx, ribcage, muscles attached. Spinal cord, meninges, nerve roots, vertebral disc.	**12**
VII.	**Thorax:** Lungs, Heart, Mediastinum, Respiratory volumes, Esophagus, Trachea, Bronchial tree, Bronchopulmonary segments, Diaphragm	**12**
VIII.	**Abdomen:** Stomach, Small and Large Intestines, Liver, pancreas, Biliary tree, Spleen, Kidneys and renal vasculature, excretory system, reproductive system (male and female), Aorta and its branches	**14**
Total		**108**

Suggested Learning Resources

1. Cross Sectional Anatomy CT and MRI Govind Chavhan, Bhavin Jankharia Jaypee Brothers Medical Pub.
2. Cross-Sectional Anatomy for Computed Tomography Michael L. Farkas Springer New York
3. Sectional Anatomy by MRI and CT Mark W. Anderson, Michael G Fox Elsevier Health Sciences
4. Atlas of Human Cross-Sectional AnatomyWith CT and MR Images Donald R. Cahill, Matthew J. Orland, Gary M. Miller Wiley

MMRIT Radiological Clinical Education-Part III (studentship): 16 hrs/week

The course may offer hands-on training or practical sessions, allowing participants to enhance their skills in teaching and research.

IVth SEMESTER
(Electives of MRI Technology)

Advancements in MR Imaging Technology

Theory	Subject Code: MMRIT17
Total Marks for Evaluation-100	No. of Contact Hours-54, Credits:3

RATIONALE

To Stay abreast of the advancements and special procedures performed Using MRI in various conditions. The innovation in Hardware, software and post-processing techniques available for advanced image acquisition and diagnosis.

COURSE OUTCOMES

At the end of the course students will be able to...

CO1: Understand the basic principles of advanced techniques of MRI

CO2: To constantly stay abreast of the latest advancements and innovations in the field of MRI

CO3: Identify the various Diffusion related processes and its applications.

CO4: To comprehend principles of magnetic susceptibility and its uses.

CO5: Advancement in the hardware, software and post-processing techniques.

CO6: Knowledge of various pathological conditions and the special sequences or protocols/procedures performed to optimize its visualization.

Unit	Topic	Hours
I.	**Flow Phenomenon:** Types of flow, mechanisms, Compensation, CSF Flow Analysis.	**10**
II.	**MRA:** Conventional Vascular imaging techniques, DSA, TOF MRA, Phase Contrast MRA, Velocity encoding MRA	**10**
III.	**Diffusion and its advancements:** DWI, Diffusion Tensor Imaging, White matter Tractography. Physics, protocol and its applications.	**4**
IV.	**MR Spectroscopy:** Metabolites, hunters angle, CHESS, STEAM, PRESS, MRS in Breast and Prostrate. Related pathologies and protocol.	**10**
V.	**fMRI:** Paradigms, Hemodynamic response function,Perfusion Imaging **-** DSC, DCE, ASL and its types. Protocols, Principles and applications.	**6**
VI.	**Iron and Fat quantification:** Fat suppression techniques, Elastography, Quantification techniques, parameters and Applications.	**6**
VII.	**Miscallaneous advancements**: Sodium MRI, Portable MRI Systems, Ultra-high Magnetic field systems, MR Mammography, Synthetic MRI, Interventional MRI techniques.	**6**
Total		**54**

Suggested Practicals/Demonstration

Practical	Subject Code:
Total Marks for Evaluation-	No. of Contact Hours-72, Credits:2

Sr. No		Hours
I.	Flow Phenomenon and MRA	**20**
II.	Diffusion and its advancements .	**12**

III.	MR Spectroscopy and fMRI	**20**
IV.	Iron and Fat quantification.	**10**
V.	Miscallaneous advancements	**10**
	Total	**72**

Suggested Learning Resources

1. Tomography and Magnetic Resonance Imaging of the Whole Body (Vol.1&II) (Saunders) John R. Haaga (Author), Daniel Boll (Author) Elsevier.
2. MRI inPractice Catherine Westbrook &CaralynKaut Wiley–Blackwell
3. Protocols inMRI Catherine Westbrook Wiley-Blackwell

Planning, Safety and Patient care in MR Imaging

Theory	Subject Code: MMRIT18
Total Marks for Evaluation-100	No. of Contact Hours-54, Credits- 3

RATIONALE

Students comprehend the effects of MRI on the human body, learn the safety aspects to prevent accidents and maintain high image quality while ensuring patient compliance and pleasant patient experience

COURSE OUTCOMES

At the end of the course students will be able to...

CO1: Understand the basic safety measures to be taken while performing MRI

CO2: To Ensure optimum patient care

CO3: Identify the various MRI compatible/conditional and non compatible devices and warn patients accordingly.

CO4: To comprehend the various hazards involved in MRI and to know how to prevent Accidents.

CO5: To learn the various MRI facility zones and other MRI Safety considerations.

Unit	Topic	Hours
I.	**Bioeffects of MRI:** Bio-effects of static and gradient magnetic fields, Acoustic noise, Bio-effects of radiofrequency power deposition and induced heating during MRI, SAR, Claustrophobia, anxiety and emotional distress in the MR	**14**
II.	**MRI facility design:** Site selection, MRI safety zones, Scanner room layout. Shielding techniques, Faraday Cage.	**10**
III.	**Implants:** Materials used as implants and prosthesis,cardiac devices, Patient monitoring in the MRI environment, Managing Acute situations, Screening, History, Metal Detection.	**10**

Sr. No		Hours
I.	Bioeffects of MRI	**14**
II.	MRI facility design	**12**
III.	MRI Contrast Safety	**12**
IV.	Miscallaneous Safety aspects.	**16**
V.	Implants	**18**
	Total	**72**
IV.	**MRI Contrast Safety:** Identification and management of acute reactions related to gadolinium based contrast agents, Contrast safety in pregnancy and lactation, nephrogenic systemic fibrosis, Extravasation.	**10**
V.	**Miscallaneous Safety aspects:** Quenching, Ambient temperature, cryogen levels,Safety issues for interventional MR Systems, MRI safety guidelines, policies and procedures.	**10**
Total		**54**

Suggested Practicals/Demonstration

Practical	Subject Code:
Total Marks for Evaluation-100	No. of Contact Hours-72, Credits:2

Suggested Learning Resources

1. Tomography and Magnetic Resonance Imaging of the Whole Body (Vol.1&II) (Saunders) John R. Haaga (Author), Daniel Boll (Author) Elsevier
2. MRI inPractice Catherine Westbrook &Caralyn Kaut Wiley–Blackwell
3. Protocols inMRI Catherine Westbrook Wiley-Blackwell
4. An Introduction to the Physics and Function of Magnetic Resonance Imaging Dominik Weishaupt , Victor D. Koechli , Borut Marincek , J.M. Froehlich Springer

Basics Pathology and Image Interpretation in MR Imaging

Practical	Subject Code: MMRIT19
Total Marks for Evaluation-100	No. of Contact Hours-108, Credits:2

RATIONALE

Students comprehend the effects of MRI on the human body, learn the safety aspects to prevent accidents and maintain high image quality while ensuring patient compliance and pleasant patient experience.

COURSE OUTCOMES

At the end of the course students will be able to

- To Identify diseases and abnormalities at an early stage often leads to better patient outcomes.
- Learn the extent and location of pathologies, aiding in precise diagnosis and treatment planning.
- Will learn MR guide certain medical procedures such as biopsies, drainages, and needle aspirations.

Image-guided procedures improve accuracy, minimize risks, and reduce the need for exploratory surgeries.

Sr. No		Hours
I.	Basic pathologies and general interpretations of Head, Face&Neck	**15**
II.	Basic pathologies and general interpretations of Vascular imaging.	**5**
III.	Basic pathologies and general interpretations of Spine	**15**
IV.	Basic pathologies and general interpretations of Brachial plexus, Chest, Heart and great vessels	**10**
V.	Basic pathologies and general interpretations of Breast	**5**
VI.	Basic pathologies and general interpretations of Kidney, Pancreas, Liver and biliary system	**13**
VII.	Basic pathologies and general interpretations of Abdomen and Pelvis	**10**
VIII.	Basic pathologies and general interpretations of Upper limb	**10**
IX.	Basic pathologies and general interpretations of Lower Limb	**10**
X.	Basic pathologies and general interpretations of Peripheral vascular System	**5**
XI.	Basic pathologies and general interpretations of Pediatric imaging	**10**
	Total	**108**

Suggested Learning Resources

1. CT & MRI Pathology: A Pocket Atlas, Third Edition Michael L. Grey, Jagan Mohan Ailinani Snippet view

2. Normal Findings in CT and MRI Torsten Bert Moeller, Emil Reif
3. Neurological Practice: An Indian Perspective Wadia

Dissertation

Practical	Subject Code: MMRIT20
Total Marks for Evaluation-100	No. of Contact Hours-108, Credits:2

MMRIT Radiological Clinical Education-Part IV (studentship): 16 hrs/week

The course may offer hands-on training or practical sessions, allowing participants to enhance their skills in teaching and research.

IIIrd SEMESTER
(Electives of Breast Imaging Technology)

Principle of Breast Imaging Technology

Theory	Subject Code: MMRIT21
Total Marks for Evaluation-100	No. of Contact Hours-54, Credits:3

RATIONALE

Mammography is a specialized imaging technique that uses low-dose X-rays to visualize and assess breast
tissue.The role of imaging technologist specializing in mammography is crucial in the early detection and
diagnosis of breast abnormalities, including breast cancer.

COURSE OUTCOMES

At the end of the course students will be able to...

C01: Understand the various components of the mammographic equipment, properly operate it and demonstrate thecorrect use of compression devices, filtration devices, the magnification setup, exposure controls etc.

C02: State the specifications and parameters of physical principles related to mammography (eg. Half valuelayer, focal spot size, heel effect, source-to-image distance and the minimum requirements).

C03: Explain the significance of target/filtercombinations.

C04: Differentiate between the various types of x-ray generators used inmammography.

C05: Discuss and define digitalmammography.

C06: Define compression, its usefulness and minimum and maximum requirements.
C07: State the purpose ofmagnification.
C08: Process digital images if available.
C09: Describe a picture archiving and communications system (PACS) and itsfunction.
C010: Define digital imaging and communications in medicine (DICOM).
C011: Discuss the image storage and viewing capabilities related to digital mammography.

Unit	Topic	Hours
I.	**Basic Principles:** History, Xero-mammography, Screen film mammography**,** Physics of image formation, Mammography Instrumentation, Mammographic cassettes, X-ray tube, Filters, AEC & Console	**6**
II.	**Conventional Mammography Equipment:** C-arm x-ray tube stand**,** Mammography tube: Rotating vs. stationary anodes**,** Tube design, Anode design and configuration, Biangular targets, Focal spot: Standard sizes, Magnification size, Effective target angle, Filtration, Beam geometry, Heel effect.	**8**
III.	**Beam limiting devices:** Collimation, SID, OID, Generators: Three-phase, High-frequency and Constant potential, Homogenous x-ray beam**,** Ripple factor**,** Tube capacity (Ma output)**,** Automatic exposure control(AEC), Grids, Compression devices, Magnification	**8**
IV.	**Digital mammography:** Detectors, Types of digital mammography systems, Image processing, CAD for mammography**,** technical considerations: Charged coupled device (CCD), Matrix/pixels, FOV, Resolution, SNR, CNR, AEC, Single-and Multiple exposure approach, Tele mammography.	**8**
V.	**Other aspects of digital technology:** Expense**,** Additional equipment**,** Review workstation**,** PACS**,** Laser printer**,** Computer aided detection (CAD)**,** Connectivity, Compatibility & Computer literacy of technologist**,** Digital imaging and communications in medicine (DICOM), HIS, RIS, EMR and HL7.	**10**
VI.	**Sonomammography:** Physics of USG, Instrumentation & equipment, Image quality, Breast density and influencing factors	**7**
VII.	**Mammographic compression:** Rationale for breast compression, Clinical image assessment for proper breast positioning, exposure, contrast, sharpness, and noise	**7**
Total		**54**

Suggested Practicals/Demonstration

Practical	Subject Code:
Total Marks for Evaluation-	No. of Contact Hours- 72, Credits:2

Sr. No		Hours
I.	Basic Principles	**10**
II.	Conventional Mammography Equipment.	**10**
III.	Beam limiting devices	**10**
IV.	Digital mammography	**10**
V.	Other aspects of digital technology	**10**
VI.	Sonomammography	**12**
VII.	Mammographic compression	**10**
	Total	**72**

Suggested Learning Resources

Basic radiological physics K. Thayalan Jaypee Brothers Medical Publishers (P) Limited, 2003
Christinsens physics of diagnosticradiology Curry and Dowdey Wolters Kluwer
X-Ray Equipment for Student D.N. And M.O. Chesney Blackwell Science
Digital Mammography Ulrich Bick, Felix Diekman

Breast Imaging Procedures and Scanning Protocols

Theory	Subject Code: MMRIT22
Total Marks for Evaluation- 100	No. of Contact Hours-54, Credits:4

RATIONALE

Breast Imaging Procedures and Scanning Protocols provide the knowledge base in the type and application of interventional procedures involving breast imaging modalities.

COURSE OUTCOMES

At the end of the course students will be able to...
C01 Illustrate the sterile technique.
C02 Describe localization techniques.
C03 Describe biopsy techniques.
C04 Delineate galactography.
C05 Describe specimen imaging guidelines.
C06 Describe specimen handling and record keeping for pathologic analysis.
C07 Describe continuous patient care from pre-biopsy topostbiopsy.
C08 Define patient transport requirements pre and post biopsy

Unit	Topic	Hours
I.	**Sterile Techniques:** Spread of infection: Exogenous, Endogenous, Iatrogenic and Nosocomial**,** Preparation of local anesthetics, contrast media, Patient allergies and alternative options. Proper glove use, hand washing technique, Skin preparation Sterile tray preparation, Disposal of items	**8**
II.	**Localization Modalities** Mammography localization: Stereotactic biopsy : Definition, Application & Technique Wire localization: Definition, Application &Technique Ultrasound Guidance: Definition, Application &Technique MR localization: Definition, Application, Technique	**8**
III.	**Interventional Procedures:** Cyst aspirations, Fine-needle aspiration or biopsies, Core biopsy,Vacuum-assisted breast biopsy, Galactography, Specimen Imaging: Imaging Guidelines- Core Specimen and Surgical specimens	**6**
IV.	**Patient Positioning:** Foot Placement, Arm placement, Degree of obliquity- Size of breast, Lesion location, Patient comfort.	**10**
V.	Contrast, Sharpness, Noise, Artifacts, Motion, Labeling, Collimation .	**6**
VI.	Males, Transgender patients, Kyphotic patients, Large breasts, Small breasts, Encapsulated implants, Pectus excavatum, Pectus carinatum, Protruding abdomens, Pacemaker, Wheelchair, Infuse port (Port-A-Cath), Physically disabled, Mentally disabled, Frozen shoulder, Barrel chest, Thick axilla, Irradiated breast, Reduction mammoplasty, Postsurgical breast, Loop recorde	**10**
VII.	**Image Quality Problems and remedy**: Nipple not in profile, Skin folds or wrinkling, Difficulty compressing due to patient body habitus, Incorrect or uneven compression, Superimposition of extra anatomy, Drooping of breast, Motion, Artifact	**6**
Total		**54**

Suggested Practicals/Demonstration

Practical	Subject Code:
Total Marks for Evaluation- 100	No. of Contact Hours- 72, Credits:2

Sr. No		Hours
I.	Sterile Techniques	**10**
II.	Localization Modalities .	**12**
III.	Interventional Procedures	**14**
IV.	Patient Positioning and Evaluation of Images	**12**

V.	Patients requiring modification of positioning techniques	**14**
VI.	Image Quality Problems and remedy	**10**
	Total	**72**

Suggested Learning Resources

1. Clarks Positioning In Radiography Ra Swallow, E Naylor Lippincott William and Wilkins
2. Merrill's Atlas of Radiographic Positioning and Procedures Bruce W. Long & Jeannean Hall Rollins & Barbara J. Smith Mosby

Basics and Cross-Sectional anatomy of Breast

Practical	Subject Code: MMRIT23
Total Marks for Evaluation-100	No. of Contact Hours-108, Credits:2

RATIONALE

The knowledge of breast anatomy is of paramount importance for Imaging technology students, especially those specializing in mammography or breast imaging. Understanding breast anatomy is crucial for several reasons like proper positioning, differentiating normal and abnormal structure and image interpretation.

COURSE OUTCOMES

At the end of the course students will be able to...

CO1: Describe breast structure, developmental stages, and the differences between the male and female breast.

CO2: Identify and label external and internal anatomy of the breast.

CO3: Identify and label the breakdown of the single lobe.

CO4: Identify the three arterial branches supplying the breast and the three venous drainage channels.

CO5: Describe the lymphatic system and lymphatic drainage.

CO6: Correlate breast anatomical structures to mammographic anatomical structures.

Sr. No		Hours
I.	**Definition of the Breast:** Male vs female**,** breast developmental stages: Fetal, Puberty, Menstruation, Pregnancy, Lactation, Menopause, Post menopause**,** Breast landmarks: Quadrants, Clock face references.	**20**
II.	Gross Anatomy of the Normal Breast, Nipple, Areola, Montgomery's glands, Morgagni's tubercles, Skin: Sebaceous glands, Sweat glands, Hair follicles, Axillary tail, Breast margins, Inframammary fold, Axilla, Internal Anatomy: Fascia, Layers, Retromammary(fat)space. Breast parenchymal components, Lobes and ducts, Cooper's	**40**

	ligaments, stroma, Lymphatic drainage, Breast Vasculature, Pectoral muscle.	
III.	**Histology of the breast:** Terminal ductal lobular unit**,** Extra lobular terminal duct, Intra-lobular terminal duct, Ductal sinus(acinus)**,** Cellular components: Epithelial cells, Myoepithelial cells, Basement membrane	**20**
IV.	**Mammographic Appearance of Breast:** Density variations, BIRADS, Variances, Life cycle changes, lesions and characteristic features, lesion measuremen	**28**
	Total	**108**

Suggested Learning Resources

1. Cross Sectional Anatomy CT and MRI Govind Chavhan, Bhavin Jankharia Jaypee Brothers Medical Pub.
2. Cross-Sectional Anatomy for Computed Tomography Michael L. Farkas Springer New York
3. Sectional Anatomy by MRI and CT Mark W. Anderson, Michael G Fox Elsevier Health Sciences
4. Atlas of Human Cross-Sectional Anatomy With CT and MR Images Donald R. Cahill, Matthew J. Orland, Gary M. Miller Wiley

MMRIT Radiological Clinical Education-Part III (studentship): 16 hrs/week

The course may offer hands-on training or practical sessions, allowing participants to enhance their skills in teaching and research.

IVth SEMESTER

(Electives of Breast Imaging Technology)

Advancements in Breast Imaging Technology

Theory	Subject Code: MMRIT24
Total Marks for Evaluation-100	No. of Contact Hours-54, Credits:3

RATIONALE

Advances in breast imaging techniques have been instrumental in improving the early detection, diagnosis,
and management of breast conditions, especially breast cancer. These advanced techniques offer several
key benefits and rationale for their adoption

COURSE OUTCOMES

At the end of the course students will be able to...

CO1: Describe the uses of computer-aided detection for mammography images.

CO2: Describe the basic theory of digital breast tomosynthesis including appropriate use.

CO3: Identify the value of biomarkers and those specific to breast imaging modalities.
CO4: Discuss dual energy contrast digital mammography and its appropriate use.
CO5: Describe the potential benefits and use of breast elastography.
CO6: Discuss the potential benefits and use of nuclear medicine studies.
CO7: Describe the use of 3-Dsonography.
CO8: Discuss the potential benefits and use of abbreviated breast MRI.
CO9: Discuss the use of computed tomography laser mammography (CTLM) and thermography

Unit	Topic	Hours
I.	**Computer-Aided Detection** Define, Proper protocol for use, Tool for mammography Interpretation	**4**
II.	**Digital Breast Tomosynthesis (DBT):** Define, physical principle and components of DBT, Personnel training requirements (MQSA), Potential benefits, Types of images: Projection images &Reconstruction images.	**8**
III.	**Breast Imaging Biomarkers:** Breast Density assessment: Breast arterial calcification scoring, Cancer markers, MRM	**4**
IV.	**Dual Energy Contrast-enhanced Mammography** Define, Theory, Potential benefits	**4**
V.	**Breast Elastography:** Ultrasound Imaging, Basic principle, types, advantages, image interpretation.	**4**
VI.	**Nuclear Medicine Studies**: Define, basic principle, Potential benefits, Types: Scintimammography, Lympho-scintigraphy, Positron emission tomography	**10**
VII.	**3-D Ultrasound Imaging**: Concept, mechanism of action, advantages, indications	**8**
VIII.	**Abbreviated Breast MRI:** Define, Theory, Potential benefits	**6**
IX.	**Non-ionizing techniques:** CTML, Thermal Imaging, Breast Imaging with EIS, Breast Photo Imaging	**4**
X.	**Dedicated Breast CT:** Fundamental principle, dose estimation, indications, pros and cons, protective apparel.	**2**
Total		**54**

Suggested Practicals/Demonstration

Practical	Subject Code:
Total Marks for Evaluation-	No. of Contact Hours- 72, Credits:2

Sr. No		Hours
I.	Computer-Aided Detection.	**8**

II.	Digital Breast Tomosynthesis (DBT)	**6**
III.	Breast Imaging Biomarkers	**8**
IV.	Non-ionizing techniques	**8**
V.	Dedicated Breast CT	**8**
VI.	3-D Ultrasound Imaging	**8**
VII.	Dual Energy Contrast-enhanced Mammography Breast Elastography	**10**
VIII.	Abbreviated Breast MRI	**6**
IX.	Nuclear Medicine Studies	**10**
	Total	**72**

Suggested Learning Resources

1. Basic radiological physics K. Thayalan Jaypee Brothers Medical Publishers (P) Limited, 2003
2. Christinsens physics of diagnostic radiology Curry and Dowdey Wolters Kluwer
3. X-Ray Equipment for Student D.N. And M.O. Chesney Blackwell Science
4. Digital Mammography Ulrich Bick, Felix Diekmann

Quality Assurance, Radiation Protection and Patient care in Breast Imaging

Theory	Subject Code: MMRIT25
Total Marks for Evaluation-100	No. of Contact Hours-54, Credits:3

RATIONALE

Radiation Protection and Patient care provides an overview of the principles of radiation protection, including the responsibilities of the radiographer for patients, personnel and the public. This content provides the concepts of optimal patient care, including consideration for the physical and psychological needs of the patient and family. Routine and emergency patient care procedures are described, as well as infection control procedures using standard precautions. The role of the Imaging Technologist in patient education is identified.

COURSE OUTCOMES

C01: Identify and justify the need to minimize unnecessary radiation exposure of humans.
C02: Explain the objectives of a radiation protection program.
C03: Define radiation and radioactivity units of measurement.
C04: Identify effective dose limits (EDL) for occupational and non-occupational radiation exposure.
C05: Describe the ALARA concept.
C06: Identify ionizing radiation sources from natural and man-made sources.

C07: Comply with legal and ethical radiation protection responsibilities of radiation workers.
C08: Identify appropriate applications and limitations for each radiation detection device.
C09: Describe how iso-exposure curves are used for radiation protection.
C010: Identify performance standards for beam-limiting devices.
C011: Distinguish between controlled and non-controlled areas and list acceptable exposure levels.
C012: Describe the function of federal, state and local regulations governing radiation protection practices.
C013: Role of Radiation safety officer
C014: Describe personnel monitoring devices, including applications, advantages and limitations for each device.
C015: Compare values for individual effective dose limits for occupational radiation exposures (annual and lifetime).
C016: Identify effective dose limits for the embryo and fetus in occupationally exposed women.
C017: Distinguish between primary and secondary radiation barriers.
C018: Demonstrate how the operation of various x-ray and ancillary equipment influences radiation safety and describe the potential consequences of equipment failure

Unit	Topic	Hours
I.	**ALARA Principle:** Optimizing imaging techniques and using the lowest possible radiation dose are essential components of ALARA.	**10**
II.	**Appropriate Indications and contraindications.** **Technique Optimization:** Patient education, consent and preparation, history taking, exposure factors and compression settings based on the patient's breast size and density.	**10**
III.	**Mammographic Procedure:** Collimation and Field Size, Compression, Receptor Sensitivity (reduction of patient dose), Use of AEC, Patient Comfort.	**8**
IV.	Regular continuing education and training about latest	**8**
	techniques and guidelines. **Quality Assurance and Audits:** Implement quality assurance programs to monitor and assess radiation dose levels, image quality, and compliance with radiation safety protocols.	
V.	**Patient Care in Interventional Mammographic procedures:** **Pre-procedural care:** Knowledge of informed consent, Use of 2 patient identifiers, Hard stop process, Vital signs, Explanation of procedure, Proper documentation **During procedure:** Patient awareness, Signs of vasovagal reaction and syncope, Signs of allergic reactions to anesthesia, Anxiety, patient compliance. **Post-procedural care:** Post-procedure imaging for clip placement, compression and wound dressing, instructions and medications prescribed, Follow-up.	**18**
Total		**54**

Suggested Practicals/Demonstration

Practical	Subject Code:
Total Marks for Evaluation-100	No. of Contact Hours-72, Credits:2

Sr. No		Hours
I.	ALARA Principle	**15**
II.	Appropriate Indications and contraindications. Technique Optimization	**10**
III.	Mammographic Procedure	**6**
IV.	Staff Education and Training Quality Assurance and Audits	**20**
V.	Patient Care in Interventional Mammographic procedures: Pre-procedural care During procedure Post-procedural care	**21**
	Total	**72**

Suggested Learning Resources

1. Ultrasound physics and technology Vivien gibbs, davidcole, Antonio sassano Churchill Livingstone;
2. Manual of Diagnostic Ultrasound Philip E. S. Palmer (Author) World Health Organization
3. Physics and Technical Aspects Diagnostic Ultrasound DINESH K BAGHEL (Author AITBS PUBLISHERS
4. Patient care in radiography : with an introduction to medical imaging Ehrlich, Ruth Ann and joanA.daly St. Louis, Mo. : Mosby Elsevier

Basics Pathology and Image Interpretation in Breast Imaging

Practical	Subject Code: MMRIT26
Total Marks for Evaluation-100	No. of Contact Hours-108, Credits:3

RATIONALE

Imaging Pathology and image Interpretation provides the knowledge about the concepts of breast pathology detection and diagnosis. This section presents characteristics of benign and cancerous pathologies and their mammographic appearance.

COURSE OUTCOMES

At the end of the course students will be able to...

CO1: Discuss the factors and physiologic changes that will affect breast tissue composition.

CO2: Identify physical changes of the breast.
CO4: Correlate clinical breast changes with imaging findings, and comparison with previous mammograms.
CO5: Identify the mammographic appearance of pathologies.
CO6: Describe assessment categories and the recommended clinical follow up.
CO7: Identify the high risk and low risk factors limited to breast cancer.
CO8: Describe the etiology, mammographic appearance, diagnosis and treatment of benign breast pathologies.
CO9: Describe the etiology, mammographic appearance, diagnosis and treatment of malignant breast pathology.
CO10: Identify the procedures used to diagnosis breast cancer.
CO11: Describe treatment options for breast cancer.
CO12: Explain breast cancer stages 0 to IV and stage characteristics.
CO13: Explain tumor node metastasis (TNM) classifications of breast cancer.
CO14: Identify the significance of breast cancer detection through patient screening and diagnostic mammograms.
CO15: Discuss the practice of clinical breast examinations and breast self-examinations, and current evidence-based data about them.
CO16: Identify the risk factors associated with breast cancer.

Sr. No		Hours
I.	**Breast Anomalies** Asymmetry Inverted nipples Accessory nipples Accessory breast tissue Other (e.g. congenital)	**8**
II.	**Clinical Breast Changes** Lumps: Location, Size, Pain, Mobility, Duration and Other associated indications (e.g. trauma, fever, antibiotics) Thickening: Location, Size and Duration Swelling: Location, Size and Duration Dimpling: Location, Size and Duration Skin irritation and lesions (e.g. moles, keratosis, cysts, ulcers, blisters, scaling): Location, Size and Duration Pain: Location, Duration and New Onset Discharge: Duration, New onset, Color of discharge, Ipsilateral or bilateral, Single duct or multiple ducts and Spontaneous vs. Expressed Nipple retraction, inversion, and areolar changes: Location, Duration and New Onset Edema Erythema Mammoplasty Breast Augmentation: Types: Silicone, Saline Location: Sub-glandular & Subpectoral	**20**

	Breast lift, Breast reduction & Other Reconstructive surgery: Autologous (e.g. TRAM flap, DIEP flap, latissimus dorsi flap), Tissue expander, Implant & Other Post surgical excision Radiation changes	
III.	**Mammographic Appearance of Pathology** Masses: Definition, Location & Margins Circumscribed Ill-defined(indistinct) Lobulated Spiculated Asymmetric density: Definition & Location Focal asymmetry: Definition & Location Calcifications: Location- Dermal and Internal Causes: Cystic changes, Sutural, Vascular, Malignancy, Characteristics, Number(quantity), Size & Shape **Distribution:** Clustered or grouped, Segmental, Regional, Diffuse(scattered), Multiplegroups Margins Benign characteristics(typical) Coarse Rim or eggshell Milk of calcium(teacup-like) Dystrophic Vascular Skin(superficial) Secretory Fat necrosis Punctate Suspicious morphology (nondeterminate characteristics) Indistinct(amorphous) Pleomorphic, granular (clustered) Irregular Linear Casting	**20**
IV.	Reporting Terminology (e.g.BI-RADS) Assessment categories Recommendations Interpretation of imaging Density Score, BIRADS, Comparison of mammographic images with other modalities.	**10**
V.	Benign Breast Pathology Cyst, Galactocele, Fibroadenoma, Lipoma, Hamartoma(fibroadenolipoma), Papilloma, Ductal ectasia, Breast infection/abscess, Hematoma, Fat Necrosis, Radial Scar,	**10**

	Lymph node & Gynecomastia Etiology, Mammographic appearance, Diagnosis and Treatment	
VI.	Breast Cancer Classification Stage Characteristics Description Size Invasive vs. Noninvasive Lymph node involvement Spread beyond the breast Stages Stage 0 Stage I Stage II Stage III Stage IV TNM classification characteristics TNM description Size Lymph node involvement Metastasis T –size TX T0 Tis T1, T2, T3,T4 N – lymph node involvement NX N0 N1, N2,N3 M –metastasis MX, M0, M1 Cell grade Definition Grade1 Grade2 Grade3 Multifocal Multicentric Hormone receptors andHER2 Importance oftests Estrogen Progesterone HER2	**15**
VII.	**Risk Factors Associated with Breast Cancer** Gender Age Breast density and breast composition Personal history of breast cancer Family history of breast cancer	**15**

	Personal history of female cancer Genetic predisposition Menses: Early age at menarche Late age at menopause Parity: Nulliparity, Primiparity Hormone replacement therapy Obesity Ethnicity Risk assessment models (e.g. Gail, Tyrer Cuzick)	
VIII.	**Breast Cancer Detection Methods** Screening mammograms ACS and ACR guidelines Diagnostic mammograms: Clinical findings & Recall from screening Clinical examinations Women aged 20 to 40 years, every 3years Women older than 40 years, every year Breast self-examinations	**10**
	Total	**108**

Suggested Learning Resources

1. Clinical Breast Imaging: A Patient Focused Teaching File Gilda Cardenosa
2. Interventional Breast Procedures: A Practical Approach Cherie M. Kuzmiak
3. Diagnostic Ultrasound Carol M. Rumack (Author), Deborah Levine (Author) Elsevier;

Dissertation

Practical	Subject Code: MMRIT27
Total Marks for Evaluation-100	No. of Contact Hours-108, Credits:2

MMRIT Radiological Clinical Education-Part IV (studentship): 16 hrs/week

The course may offer hands-on training or practical sessions, allowing participants to enhance their skills in teaching and research.

Annexures

MONITORING LEARNING PROGRESS

It is essential to monitor the learning progress of each candidate through continuous appraisal and regular assessment. It not only helps teachers to evaluate students, but also students to evaluate themselves. The monitoring be done by staff of the department based on participation of students in various teaching/ learning activities. It may be structured and assessment shall be

done using checklists that assess various aspects. Model checklists are given which may be copied and used.

The learning out comes to be assessed should include:

a. Acquisition of knowledge: the methods used comprise of 'Log Book' which records participation in various teaching/ learning activities and mentoring of students. The number of activities attended and the number in which presentations are made are to be recorded. The log bookshouldperiodicallybe validated by the supervisors. Some of the activities are listed.
b. Journal Review Meeting (Journal Club): the ability to do literature search, in depth study, presentation skills, and use of audio- visual aids are to be assessed. The assessment is made by faculty members and peers attending the meeting using a checklist ***(see Model ChecklistI)***.
c. Seminars/ symposia: the topics should be assigned to the student well in advance to facilitate in depth study. The ability to do literature search, in depth study, presentation skills and use of audio- visual aids are to be assessed using a checklist ***(see Model Checklist II).***
d. Teaching skills: candidates should be encouraged to teach undergraduate students. This performance should be based on assessment by the faculty members of the department and from feedback from the undergraduate students ***(see Model Checklist III).***
e. Work diary/ Log Book- every candidate shall maintain a work diary and record his participation in the training programs conducted by the department such as journal reviews,seminars, etc. Special mention may be made of the presentations by the candidate as well as details of experiments or procedures, if any conducted by the candidate.
f. Records: records, log books and marks obtained in tests will be maintained by the Head of the Department and will be made available to the University.

Log Book

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

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

Format of Model Checklists

Checklist- I: Model checklist for evaluation of journal review presentations

Name of the student: Date:

Name of the faculty/ observer:

Title of the paper:

Journal detail:

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

Name and Signature of the Faculty ……..

Checklist- II: model checklist for the evaluation of the Seminar presentations

Name ofthe student: Date:
Name of the faculty/ observer:
Title of the semina

S. No.	**Items of observation during Presentation**	**Poor 0**	**Below average 1**	**Average 2**	**Good 3**	**Very good 4**
1	Topic chosen was					
2	Extent of understanding of scope & objectives of the paper by the candidate					
3	Whether cross- references have been Consulted					
4	Whether other relevant references have been consulted					
5	Ability to respond to questions on the paper/ subject					
6	Audio- visual aids used					
7	Ability to defend the paper					
8	Clarity of presentation					
9	Any other observation					
	Total score					
	Remarks					

Name and Signature of the Faculty ……

Checklist – III: model checklist for evaluation of teaching Skill

Name of the student: Date:

Name of the faculty/ observer:

Topic:

Under Graduate batch

S.No.	**Items to be observed during teaching**	**Strong Point**	**Weak Point**
1	Communication of the purpose of the talk		
2	Evokes audience interest in the subject		
3	The introduction		
4	The sequence of ideas		
5	T he use of practical examples and/or illustrations		
6	Speaking style (enjoyable, monotonous, etc., specify)		
7	Summary of the main points at the end		
8	Ask questions		
9	Answer questions asked by the audience		
10	Rapport of speaker with the audience		
11	Effectiveness of the talk		
12	Uses of AV aids appropriately		
	Remarks		

Name and Signature of the Faculty…….

Checklist- IV: Continuous Evaluation Of Dissertation Work
BY GUIDE/ CO- GUIDE

Name ofthe student: Date:
Name of the faculty/
observer: Topic:

S. No.	Items of observation during Presentation	Poor 0	Below average 1	Average 2	Good 3	Very good 4
1	Periodic consultation with guide/ co-guide					
2	Depth of Analysis/ Discussion					
3	Department presentation of findings					
4	Quality of Final Output					
5	Others					
	Total score					
	Remarks					

Name and Signature of the Faculty

……

……...

Master in Medical Radiology and Imaging Technology
(MMRIT)
Log Book

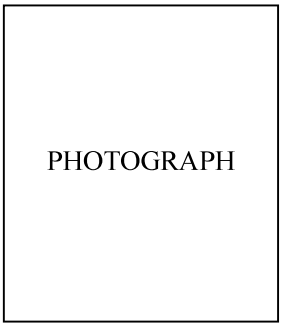
Name of the Student:

Name of the Post Graduate degree:

USN:

Batch:

PARTICULARS OF STUDENT



Name of the student:

Reg no:

Year of admission:

Year of completion:

Address :

Contact details:

Email id :

Signature of the student:

DISSERTATION DETAILS

Title of Dissertation :

Name of the Guide :

Designation of the Guide :

Name of the Co-guide :

Designation of the Co-guide :

Synopsis Presentation date :

IEC Approval :

Completion and Submission date :

CERTIFICATE

This is to certify that Mr/Ms……has completed the training requirements for for the programme Master in Medical Radiology and Imaging Technology (MMRIT) of (name of the Institute/University & address). She/He has completed all the clinical responsibilities during her/his Post-graduation

training from…….to…….....

Signature

Head/Programme Co-ordinator

Signature

Principal/Dean

Signature
Head/Programme Co-ordinator

Signature
Principal/Dean

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SECTION I: CLINICAL/AREA/FIELD POSTINGS

Date.	Clinical/Dept/ Area/Field	Particulars	Name & Signature of the staff/mentor /supervisor

SECTION II. SEMINARS PRESENTED/ATTENDED

Sl.No.	Date	Topic	Signature of the Moderator

SEMINAR EVALUATION FORM
Evaluation of Seminar

S. No.	Criteria	5 Excellent	4 Good	3 Average	2 Below Average	1 Poor
1	Content of the Presentation					
2	Aesthetic of slides preparation					
3	Oratory & Presentation Skills					
4	Audio- visual aids used					
5	Clarity of presentation					
6	Critical Analysis, ,					
7	Ability to respond to questions on the subject					
8	Ability to defend the topic					
9	Referencing					
10	Implementation recent advancement on the topic					
Total Marks: 50						

SEMINAR SCORE SHEET

Sl.No.	Date	Topic	Total Marks (Max.50)	Evaluations Signature	Coordinator Signature

SECTION III. JOURNAL PRESENTED/ATTENDED

Sl.No.	Date	Title	Signature Of The Faculty

JOURNAL CLUB EVALUATION

S. No.	Criteria	5 Excellent	4 Good	3 Average	2 Below Average	1 Poor
1	Paper Selection(importance, interest, general appeal)					
2	Background Knowledge & Introduction of Topic, Questions, and Experimental System					
3	Critical Analysis of Results, Concise and Accurate Conclusions, and Future Experiments or Implications:					
4	Slides / Visual aids: (organization, number, clarity) , Oral Presentation & Delivery: (Confidence, eye contact, rate of speech, enunciation, appropriate use of pauses					
5	Ability to Answer Questions from the Audience. Overall Performance and Contribution toOthers Journal					
Total Marks: 25						

JOURNAL CLUB SCORE SHEET

Sl.No.	Date	Topic	Total Marks (Max.50)	Evaluations Signature	Coordinator Signature

SECTION IV: Seminar taken for UG students

Sl.No.	Date	Topic Taught	UG Batch	Signature of the Moderator

Review of Dissertation

Sl.No.	Date	Activity	Remarks	Signature of the Co-Guide	Signature of the Guide

SECTION V. Extension/Extra Curricular activities
(CONFERENCES/CME/WORKSHOP/TRAININGS)

Sl.No.	Date	Event	Achievements	Signature Of The Faculty

DETAILS OF ABSENCE

Sl.No.	Date Event		Achievements	Signature Of The Faculty
	From	To		

EVALUATION OF THE LOGBOOK

S. No.	Items of observation during presentation	I semester	II semester	III semester	IV semester
1	Organization of the log book				
2	Adequacy of Content/ Information in the log book				
3	Punctuality				
4	Relevance of Content/ Information in the log book				
5	Shows professional conduct during the Teaching Learning session				
6	Timely submissions of Projects/Synopsis/Seminare ffectively				
7	Work Relationship & Frequency of consulting faculty				
8	Overall quality of department work				
9	Total Score				
Signature of the Co-ordinator					

Scoring:
1 Poor
2 Below Average
3 Average
4 Good
5 Excellent

IMMUNIZATION FORM

SL.NO.	Vaccination	Date of vaccination	Dose