MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY, WEST BENGAL

(Formerly West Bengal University of Technology)

Syllabus of B. Sc Medical Imaging Technology

(Effective from 2023-24 Academic Sessions)

Semester-VII

Subject Name:	Advanced Imaging techniques and recent trends	**Mode:**	Offline
Code:	BMMIT 7401	**Credit:**	3

Aim of the Course:

To provide students with advanced theoretical knowledge of cutting-edge imaging technologies, including high-end CT systems, functional and metabolic Magnetic Resonance Imaging, molecular imaging modalities, hybrid systems, and state-of-the-art ultrasound variations, preparing them for specialized clinical setups and technological modernizations.

Course Objectives:

- To introduce the working mechanisms and clinical utilities of dual-energy and spectral CT systems.
- To explain functional, perfusion, diffusion, and spectroscopic techniques in Magnetic Resonance Imaging.
- To teach structural setups and functional integration principles within hybrid modalities like PET-CT and PET-MRI.
- To review recent diagnostic advancements in ultrasound, including elastography and contrast-enhanced technologies.
- To evaluate emerging artificial intelligence algorithms and their implementation workflows across medical image reconstructions and processing.

Sl.	Graduate attributes / Course Outcomes (CO)	Mapped Modules
CO1	Comprehend the core physical design and clinical indications of dual-source, multi-slice, and spectral Computed Tomography.	M1
CO2	Analyze and evaluate microstructural and metabolic physiological changes using advanced sequence configurations in MRI.	M2
CO3	Explain and distinguish multi-modality registration frameworks, tracer mechanics, and cross-sectional diagnostic metrics in hybrid systems.	M3
CO4	Differentiate modern mechanical and acoustical characterizations in tissue assessments via elastography and micro-bubble contrast interfaces.	M4

Sl.	Graduate attributes / Course Outcomes (CO)	Mapped Modules
CO5	Assess the performance, workflow adjustments, and automated diagnostic processing steps delivered by AI models.	M5

Learning Outcome/Skills:

- Differentiate advanced multi-detector CT acquisition metrics from traditional scanning workflows.
- Assist in executing dynamic perfusion maps, functional task setups, and localized spectrum assessments during high-field MRI scans.
- Understand scanner geometries, processing steps, and critical radiopharmaceutical guidelines governing PET and SPECT hybrid environments.
- Operate and modify acoustic control parameters for dynamic strain map captures and contrast timing distributions.
- Recognize AI processing modules within diagnostic interfaces and flag systematic artifact outputs.

Module Number	Content	Total Hours	% of Question	Bloom Level	Remarks
M1	**Advanced Computed Tomography** • Multi-slice configuration mechanics (up to 640 slices), ultra-high-resolution CT systems. • Dual-source and dual-energy CT physical design, spectral imaging principles. • Cone Beam CT (CBCT) architectures, cardiac gating techniques, and metal artifact reduction sequences.	8	20	1,2,3	NA
M2	**Advanced Magnetic Resonance Imaging** • Functional MRI (fMRI): BOLD signal physics, paradigm designs, and mapping applications. • Diffusion-Weighted (DWI), Diffusion Tensor Imaging (DTI), and tractography mapping. • MR Perfusion (DSC, DCE, ASL techniques) and localized MR Spectroscopy (MRS).	10	25	1,2,3,4	NA
M3	**Molecular Imaging & Hybrid Systems** • Positron Emission Tomography (PET) system physics, scintillators, and coincidence detection. • PET-CT and SPECT-CT hardware integration, attenuation correction frameworks. • Introduction to PET-MRI architectures, shielding demands, and clinical diagnostic paths.	8	20	1,2,3	NA

Module Number	Content	Total Hours	% of Question	Bloom Level	Remarks
M4	**Recent Trends in Ultrasound** • Ultrasound Elastography: Strain vs. Shear Wave elastography techniques for tissue stiffness metrics. • Contrast-Enhanced Ultrasound (CEUS): Micro-bubble physics, scheduling, and specialized liver/ vascular imaging protocols. • 3D/4D real-time rendering systems, volumetric transducers, and automated fusion with CT/MR images.	8	20	2,3,4	NA
M5	**AI and Future Frameworks** • Deep learning architectures for raw medical image reconstructions and noise attenuation filters. • Computer-Aided Detection (CADe) and Diagnosis (CADx) systems. • Robotic automated scanning positions and emerging photon-counting CT detection frameworks.	6	15	1,2	NA
TOTAL		**40**	**100**		

Recommended Books:

1. Bushong, S.C. - Radiologic Science for Technologists: Physics, Biology, and Protection.
2. Grainger & Allison's Diagnostic Radiology - Advanced Modalities Volume.
3. Westbrook, C. - MRI in Practice, Wiley-Blackwell.
4. Saha, G.B. - Fundamentals of Nuclear Medicine Physics and Instrumentation, Springer.

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Semester-VII

Subject Name:	Lab on Advanced Imaging techniques and recent trends	**Mode:**	Offline
Code:	BMMIT 7491	**Credit:**	2

Practical Protocols:

1. Demonstration and workflow observation of spectral and dual-energy dataset reconstructions on advanced CT workstations.
2. Processing of Diffusion-Weighted Imaging (DWI) datasets, generating Apparent Diffusion Coefficient (ADC) maps, and observing brain fiber tractography tracks.
3. Processing and interpretation workflow of MR Spectroscopy data, evaluating metabolite ratios (Cho/Cr, NAA/Cr).
4. Demonstration of cross-modality registration, image fusion steps, and attenuation updates on clinical PET-CT workstation interfaces.
5. Practical hands-on adjustment of elastography window sizing, region-of-interest placements, and shear wave velocity velocity readings on ultrasound systems.
6. Simulation or workstation tracking of contrast-enhanced ultrasound distributions across focal anatomical models.
7. Observation of artificial-intelligence-driven diagnostic enhancement modules, segmentations, and structural detection marks inside modern picture systems.

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Semester-VII

Subject Name:	Quality control, Radiobiology, and Radiation safety in Radiodiagnosis and imaging other than x-ray related	**Mode:**	Offline
Code:	BMMIT 7402	**Credit:**	3

Aim of the Course:

To provide specialized knowledge on systemic quality validation structures, biological consequences of radiation, and comprehensive safety parameters within non-X-ray imaging environments, focusing on Magnetic Resonance Imaging, Ultrasound systems, and Nuclear Medicine frameworks.

Course Objectives:

- To build competency in identifying and verifying standardized performance specifications for MRI and Ultrasound systems via phantoms.
- To detail specific risk mechanisms, mechanical hazards, and protection methods matching high magnetic fields and RF exposures.
- To explain structural radiobiology frameworks, internal dosimetry definitions, and tracking responses concerning internal radionuclide depositions.
- To review legislative protocols, shielding setups, and response rules mandated by regulatory bodies like AERB.

Sl.	Graduate attributes / Course Outcomes (CO)	Mapped Modules
CO1	Execute standard quality metrics on MRI installations using ACR phantom methods.	M1
CO2	Analyze structural ultrasound properties and verify transducer performance parameters via multi-tissue mimicking phantoms.	M2
CO3	Differentiate system validations, source handling risks, and instrumentation tests inside Gamma Camera and PET infrastructures.	M3
CO4	Evaluate specific cellular damage risks, internal absorption rates, and tissue dependencies in isotope administrations.	M4
CO5	Implement statutory decontamination exercises, personal safety limits, and waste workflows fulfilling state safety certifications.	M5

Learning Outcome/Skills:

- Perform geometric linearity, slice thickness, and signal-to-noise ratio quality reviews across clinical MRI scanners.
- Check axial/lateral resolution accuracy, dead zones, and geometric caliper errors on ultrasound systems.
- Calibrate and run daily constancy checks on dose calibrators and diagnostic scintillation cameras.
- Manage area screening tools, compute dose levels, and arrange standard emergency setups during isotope spills.
- Document site approvals and structure temporary storage cells matching isotope regulatory expectations.

Module Number	Content	Total Hours	% of Question	Bloom Level	Remarks
M1	**MRI Quality Control & Safety** • American College of Radiology (ACR) phantom frameworks: signal-to-noise ratio (SNR) evaluations, image uniformity, geometric accuracy, and slice profiles. • Static magnetic field safety: projectile hazards, fringe field mappings, zone classifications (Zones I-IV). • Time-varying field risks: peripheral nerve stimulation, acoustic noise regulations, Specific Absorption Rate (SAR) metrics, and implant safety classification guidelines (MR Safe/Conditional).	10	25	2,3,4	NA
M2	**Ultrasound Quality Control & Safety** • Evaluation with multi-tissue mimicking phantoms: axial/lateral resolution limits, depth of penetration, functional dead zone tracking, and distance measurement accuracy. • Bioeffects of ultrasound energy: Thermal Index (TI: TIS, TIB, TIC) and Mechanical Index (MI) physics and definitions. • Electrical safety checks for multi-frequency transducers, cleaning, and disinfection methods.	8	20	1,2,3	NA
M3	**Nuclear Medicine Quality Control** • Quality control protocols for dose calibrators: geometry tests, linearity validation, accuracy, and daily constancy evaluations. • Scintillation camera and SPECT validations: intrinsic/extrinsic floods, spatial resolution, and center-of-rotation parameters. • PET system quality checks: coincidence timing maps, normalization, and uniform cylinder calibrations.	8	20	2,3,5	NA

Module Number	Content	Total Hours	% of Question	Bloom Level	Remarks
M4	**Radiobiology in Unsealed Source Administrations** • Cellular tracking of radionuclide exposures: direct vs. indirect action models, stochastic vs. deterministic hazards. • Internal radiation dosimetry models (MIRD schema): calculation paths for absorbed organ estimations. • Specific radiobiological traits of therapeutic emitters (I-131, Y-90, Lu-177) and targeted diagnostic tracers.	8	20	1,2,4	NA
M5	**Radiation Safety Regulations & Waste Workflows** • Statutory legal bodies (AERB, ICRP): licensing rules, facility shielding criteria, and design templates for nuclear clinics. • Operational containment rules: personal monitoring devices (TLD badges for Beta/Gamma), survey meter audits. • Management of radioactive waste: classification systems, decay-in-storage setups, disposal paths for liquid and solid wastes, and decontamination steps for laboratory spills.	6	15	2,3,4	NA
TOTAL		**40**	**100**		

Recommended Books:

1. Saha, G.B. - Physics and Radiobiology of Nuclear Medicine, Springer.
2. Price, R.R. & Panych, L.P. - Whitaker's Quality Control in Diagnostic Imaging.
3. AERB Safety Codes and Guidelines for Nuclear Medicine Facilities, India.
4. Hall, E.J. & Giaccia, A.J. - Radiobiology for the Radiologist, Lippincott Williams & Wilkins.

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Semester-VII

Subject Name:	Lab on Quality control, Radiobiology, and Radiation safety in Radiodiagnosis and imaging other than x-ray related	**Mode:**	Offline
Code:	BMMIT 7492	**Credit:**	2

Practical Protocols:

1. Conducting daily and weekly uniformity checks on clinical MRI systems using specialized phantom kits.
2. Measurement and computation of MRI Signal-to-Noise Ratio (SNR) and spatial linearity checks across multi-channel head coils.
3. Practical assessment of an ultrasound unit using a standard multi-tissue phantom to evaluate vertical/horizontal calibration, dead zone, and axial resolution boundaries.
4. Performance testing of radioisotope dose calibrators, including daily constancy and background radiation tracking logs.
5. Executing intrinsic flood uniformity assessments and checking center-of-rotation records on a Gamma Camera system.
6. Demonstration of radiation area monitoring techniques using Geiger-Muller counters and ionization chambers within unsealed isotope labs.
7. Simulated exercises on package logging, wipe tests, and emergency containment/decontamination setups for a mock radioisotope liquid spill.

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Semester-VII

Subject Name:	Research Methodology	**Mode:**	Offline
Code:	BMMIT 7403	**Credit:**	4

Aim of the Course:

To equip undergraduate students with structured competencies required to design, conduct, analyze, and communicate clinical and technical research in the field of medical imaging technology, adhering to standard scientific and bioethical frameworks.

Course Objectives:

- To build comprehension of standard research structures, systematic data exploration paths, and hypothesis formatting.
- To analyze distinct clinical observation strategies, sampling distributions, and structural research variables.
- To detail primary inferential biostatistical tools and software processing frameworks used for medical image evaluations.
- To review core clinical trial ethical structures, patient protection mandates, and plagiarism rules.
- To teach formal structures for medical article formatting, abstract compositions, and academic references.

Sl.	Graduate attributes / Course Outcomes (CO)	Mapped Modules
CO1	Identify scientific gaps, construct testable clinical hypotheses, and perform systematic literature searches across medical databases.	M1
CO2	Select and establish proper experimental or observational research designs while managing sample selection biases.	M2
CO3	Apply relevant biostatistical calculations to validate the significance of diagnostic and experimental datasets.	M3
CO4	Formulate clinical protocols that fully comply with institutional ethics committee expectations and international patient data privacy rules.	M4
CO5	Draft well-structured scientific abstracts, methods descriptions, and accurate reference lists for scientific publications.	M5

Learning Outcome/Skills:

- Formulate logical research questions and map existing evidence using index tools like PubMed and Embase.
- Design structured clinical tracking models, define cohort metrics, and determine minimum sample size limits.
- Execute basic t-tests, ANOVA, and non-parametric tests using tools like SPSS, Excel, or open statistical environments.
- Draft informed consent documentation and compile baseline research dossiers for ethical committee reviews.
- Format bibliography listings accurately according to Vancouver, Harvard, or AMA reference standards.

Module Number	Content	Total Hours	% of Question	Bloom Level	Remarks
M1	**Foundations of Research & Problem Definition** • Definition, objectives, and classifications of research (pure, applied, descriptive, analytical, and clinical). • Identifying research gaps in medical imaging, formulating research questions, and defining clear study objectives. • Literature review strategies: accessing digital databases (PubMed, Scopus, Google Scholar), tracking index metrics, and managing bibliography tools.	8	20	1,2	NA
M2	**Research Design & Sampling Methods** • Observational studies (case-control, cohort, cross-sectional designs) and experimental tracks (Randomized Controlled Trials). • Classification of operational variables: independent, dependent, confounding variables, and methods to minimize systemic bias. • Sampling strategies: probability vs. non-probability sampling frameworks, defining target groups, and determining sample sizes for clinical validation.	8	20	2,3,4	NA
M3	**Data Management & Biostatistics** • Processing metrics: data collection methods, verifying accuracy, and structured data entry layouts. • Descriptive statistical analysis: measuring central tendencies (mean, median, mode) and dispersion markers (variance, standard deviation). • Inferential biostatistics: hypothesis testing, p-values, parametric tests (Student's t-test, ANOVA) and non-parametric evaluations (Chi-Square test).	10	25	2,3,4	NA

Module Number	Content	Total Hours	% of Question	Bloom Level	Remarks
M4	**Ethics in Medical Research** • Core historical ethical declarations (Declaration of Helsinki, ICMR guidelines), responsibilities of Institutional Review Boards (IRB/IEC). • Informed consent processes: drafting participant information sheets, handling vulnerable populations, and maintaining data anonymity. • Professional research integrity: preventing plagiarism, understanding data fabrication/ falsification risks, and authorship guidelines.	8	20	2,3,5	NA
M5	**Scientific Writing & Dissemination** • Structural organization of a scientific manuscript: the IMRAD format (Introduction, Methods, Results, and Discussion). • Formatting abstracts, compiling data tables, and designing clear clinical charts. • Referencing standards (Vancouver, Harvard, APA styles) and understanding journal metrics like impact factors and peer-review workflows.	6	15	1,2,3	NA
TOTAL		**40**	**100**		

Recommended Books:

1. Kothari, C.R. - Research Methodology: Methods and Techniques, New Age International.
2. Mahon, K. & Rao, S. - Biostatistics for Clinical and Medical Research.
3. ICMR Ethical Guidelines for Biomedical Research on Human Participants, New Delhi.
4. Day, R.A. & Gastel, B. - How to Write and Publish a Scientific Paper, Cambridge University Press.