Semester-V

Subject Name-Digital Imaging & Image processing methods

Mode-Offline

Code-5301
Credit-3

Aim of the Course:

To impart knowledge on the principles and practical aspects of digital imaging and image processing in radiology, covering image acquisition, enhancement, restoration, and reconstruction techniques used in diagnostic and therapeutic imaging.

Course Objectives:

- To introduce the fundamentals of digital radiographic imaging.
- To explain digital image formation, characteristics, and enhancement.
- To train students in artifact correction and 3D reconstruction techniques.

SI	Graduate attributes	Mapped modules
CO1	Understand fundamentals of digital radiography and PACS/DICOM standards.	M1
CO2	Explain the characteristics of medical images and acquisition methods.	M2
CO3	Apply noise reduction and contrast enhancement techniques.	M3
CO4	Identify and correct artifacts in digital imaging.	M4
CO5	Analyze and interpret 3D reconstruction and volume rendering techniques.	M5

Learning Outcome/Skills:

- Understand digital image formats, PACS, and DICOM usage.
- Evaluate medical image parameters: noise, contrast, resolution.
- Enhance diagnostic image quality using digital processing tools.
- Correct common artifacts in digital imaging systems.
- Apply 3D reconstruction methods in clinical and surgical planning.

Module Number	Content	Total Hours	% of Question	Bloom Level (applicable)	Remarks, if any
M1	**Introduction to Digital Imaging in Radiology** • History: Film to Digital • Basics of Digital Radiography • PACS (Picture Archiving and Communication System) • DICOM (Digital Imaging and Communication in Medicine) Standards	6	15	1,2	NA
M2	**Fundamentals of Medical Image Processing** • Image Acquisition (X-ray, CT, MRI, USG) • Image Characteristics • Sampling, Quantization, Resolution • Image Quality: Contrast, Noise, Resolution, Artifacts	8	20	1,2,3	NA
M3	**Image Enhancement in Radiology** • Noise Reduction (CT, MRI) • Contrast & Edge Enhancement	8	20	2,3	NA
M4	**Image Restoration and Artifact Correction**	10	20	2,3	NA

	• Types of Artifacts (X-ray, CT, MRI) • Artifact Removal • Motion Correction • Noise Suppression				
M5	**3D Image Processing and Reconstruction** • 3D Acquisition (CT, MRI) • MPR, MIP, Volume Rendering Oncology Applications	8	25	2,3,4	NA
	TOTAL	**40**	**100**		

Module 1: Introduction to Digital Imaging in Radiology

History of Imaging: From Film to Digital

Basics of Digital Radiography

PACS (Picture Archiving and Communication Systems)

DICOM (Digital Imaging and Communications in Medicine) Standards

Module 2: Fundamentals of Medical Image Processing

Image Acquisition in Radiology Modalities (X-ray, CT, MRI, US,)

Characteristics of Medical Images

Sampling, Quantization, and Resolution in Medical Imaging

Image Quality Parameters: Contrast, Noise, Spatial Resolution, Artifacts

Module 3: Image Enhancement in Radiology

Noise Reduction Techniques (Filtering in CT, MRI)

Contrast Enhancement in Radiographic Images

Edge Enhancement and Sharpening (Bone vs. Soft Tissue Visualization)

Module 4: Image Restoration and Artifact Correction

Types of Artifacts in X-ray, CT, and MRI

Techniques for Artifact Removal

Motion Correction in MRI and CT

De-blurring and Noise Suppression

Module 5: 3D Image Processing and Reconstruction

Basics of 3D Image Acquisition (CT, MRI,)

3D Reconstruction Techniques: MPR (Multi-Planar Reconstruction), MIP (Maximum Intensity Projection)

Volume Rendering in CT and MRI Applications in Surgical Planning and Oncology.

Recommended Books:

1. Dougherty, G. – *Digital Image Processing for Medical Applications*
2. Jan, Jiri – *Medical Image Processing, Reconstruction and Analysis*
3. Shung, K.K. – *Principles of Medical Imaging*
4. Online Standards: *PACS and DICOM Tutorials*

Subject Name: Lab on Digital Imaging & Image Processing Methods

Subject code- 5391

Credit-02

1. Demonstration of PACS and DICOM workflow in digital imaging systems.
2. Handling digital radiographs: Identifying parameters (contrast, resolution, noise) using sample datasets.
3. Applying noise reduction filters on sample CT/MRI images.
4. Identification and simulation of common artifacts in CT/MRI/X-ray images.
5. Demonstration of 3D reconstruction using MPR and MIP techniques from DICOM datasets.
6. Clinical interpretation demo: Surgical planning using 3D reconstructed images.

Subject Name-Dark Room Techniques

Mode-Offline

Code-5302
Credit-3

Aim of the Course:

To impart comprehensive knowledge of darkroom setup, processing techniques, image formation, intensifying screens, and film handling in conventional radiography.

Course Objectives:

- Understand the construction and functional requirements of a darkroom in medical imaging.
- Learn the principles of photographic film, image formation, and spectral response.
- Gain knowledge about intensifying screens, cassettes, and film-screen contact.
- Acquire hands-on understanding of manual and automatic film processing.
- Understand modern methods like daylight film handling, xeroradiography, and stereoscopy.

SI	Graduate attributes	Mapped modules
CO1	Understand darkroom construction and essential safety features	M1
CO2	Explain photographic principles and film characteristics	M2
CO3	Evaluate intensifying screen and cassette technologies	M3
C04	Demonstrate film processing using manual and automatic methods	M4
C05	Discuss daylight film handling and related advanced methods	M5

Learning Outcome/Skills:

- Understand darkroom design, safety, and layout in radiology departments.
- Explain radiographic film structure, types, and image formation.
- Identify film faults and image artifacts.
- Handle and maintain cassettes and intensifying screens.

- Perform manual and automatic film processing techniques.
- Operate daylight film systems and understand xeroradiography and stereoscopy basics.

Module Number	Content	Total Hours	% of question	Bloom Level(if applicable)	Remarks, if any
M1	**Dark Room Planning & Construction** - Small vs. large hospital setup - Construction, ventilation, wall protection - Entrance types: single, double, labyrinth - Accessories: dry/wet bench, hangers, sinks, safelights, viewing room.	8	20	1,2	NA
M2	**Photographic Principles** - Radiographic film: construction, types - Latent image, density, exposure, characteristic curve - Spectral response, film faults, artifacts - Luminescence, fluorescence, phosphorescence	8	20	1,2,3	NA
M3	**Cassettes & Intensifying Screens** - Types and construction - Intensification factor, screen speed, film-screen matching - Screen-film contact tests - Advantages and maintenance	8	20	2,3	NA
M4	**Film Processing Techniques** - Developer, fixer, washing, drying - Manual vs. automatic processing - Thermal regulation, solution preparation	8	25	2,3,4	NA
M5	**Daylight Film Handling & Advanced Techniques** - Daylight film system - Xeroradiography - Stereoscopy	8	15	2,3	NA

Module -1

Dark Room – Planning & Construction:

Planning for a small & large Hospital; Location of Dark Room; Construction of Dark Room; Ventilation; Wall

Protection; Entrance to Dark Room - Single Door, Double Door, Labyrinth
Dark Room Accessories: Dry bench; Hopper, Drawer,
Cupboard; Loading and unloading cassettes; Hangers, types
of hangers and storage of hangers; Wet bench; Cleanliness,
control of dust, dark room sinks; Hatches; Drier; Safe Lights-types and uses, factors affecting safelight
performance, safelight Tests; Viewing room, Film dispensing.

Module-2

Photographic Principles:

Radiographic film- construction and types;
Photographic effect and latent image formation; Film density and log
relative exposure; Characteristic curve – its formation and features
Spectral response; Film faults and Artifacts
Intensifying Screens: Luminescence-fluorescence
and phosphorescence.

Module-3

Cassettes and intensifying screen

Construction and types of
Intensifying Screens; Intensification Factor
Film screen matching;
Resolving power of Intensifying Screens; Speed of intensifying screen
Screen film contact tests
Advantages and limitations of Intensifying Screens
X-ray Cassette: Construction of X-ray cassettes;
Types of cassettes; Mounting Intensifying Screens on cassettes;
Care and maintenance of cassettes

Module-4

Film Processing: Photochemistry

Developer; Rinsing; Fixer; Washing and drying;
Preparation of processing solutions; Manual processing
apparatus; Effect of temperature in processing; Rapid processing

Automatic processor: Principle of working and features, thermal regulation and replenishment system; maintenance of automatic processor; Advantages and limitations of automatic processor

Module-5

Day Light Film handling

Xeroradiography, Stereoscopy

Recommended Books

1. **Bushong, Stewart C.** – *Radiologic Science for Technologists: Physics, Biology, and Protection*
2. **Ballinger, Philip W.** – *Manual of Radiographic Positioning and Procedures*
3. **Christensen's Physics of Diagnostic Radiology** – *Thomas S. Curry, James E. Dowdey*
4. **S. M. Bhargava** – *Basic Radiological Physics* (for Indian context and manual processing focus)

Practical

Subject Name-Dark Room Techniques

Subject Code-5392

Credit -02

1. Demonstration of dark room setup and layout planning for small & large hospitals
2. Identification and use of dark room accessories: dry/wet bench, safelights, sinks, hatches
3. Safelight testing and performance evaluation
4. Study of radiographic film types and construction
5. Handling and maintenance of cassettes
6. Identification of different types of intensifying screens
7. Screen-film contact testing
8. Manual film processing steps: developer, rinsing, fixer, washing, drying
9. Demonstration of automatic processor operation and maintenance
10. Observation of temperature effect on film quality

Semester-VI

Subject Name-Orthopaedics in Radiology

Subject Code- BMMIT-6301

Credit-03

Course Aim:

To provide students with in-depth knowledge and skill in identifying, evaluating, and assisting in the radiologic diagnosis of orthopedic conditions using various imaging modalities.

Course Objectives:

- Understand the anatomy and pathology of the musculoskeletal system.
- Learn imaging protocols specific to orthopaedic cases.
- Identify common and uncommon orthopaedic conditions in radiological images.
- Correlate clinical symptoms with radiological findings.
- Assist in trauma and post-operative imaging evaluations.

SI	**Graduate attributes**	**Mapped modules**
CO1	Core understanding of musculoskeletal imaging, including anatomy, pathology, and trauma imaging.	M1
CO2	Ability to analyse and differentiate between fractures, joint disorders, tumors, and infections.	M2
CO3	Identify and differentiate joint diseases through imaging, including arthritis and spondylosis, and understand the role of MRI in evaluating degenerative and inflammatory conditions.	M3
CO4	Ability to identify and differentiate bone infections and tumors using radiological features,	M4
CO5	Students learn to evaluate orthopaedic implants, detect post-surgical complications, and use CT/MRI for accurate assessment.	M5

Learning Outcome/Skills**:**

Understand the role of radiology in orthopaedic diagnosis and treatment.
• Identify and interpret normal and abnormal bone and joint anatomy.
• Classify and analyze fractures, joint diseases, infections, and tumors.
• Evaluate post-operative and implant imaging for complications.

Module Number	Content	Total Hours	% of Question	Bloom Level (applicable)	Remarks, if any
M1	**Introduction to Orthopedic Imaging** • Role of radiology in orthopedics • Imaging modalities: X-ray, CT, MRI,	8	15	1,2	NA
M2	**fractures and Trauma Imaging** • Types and classification: simple, compound, etc. • Common fractures: upper limb, lower limb, spine • Emergency trauma imaging: protocols and patient positioning.	7	25	2,3,4	NA
M3	**Joint Disorders and Degeneration** • Radiological signs of osteoarthritis, rheumatoid arthritis, gout • Spondylosis and ankylosing spondylitis • Differences in degenerative vs inflammatory arthritis • MRI role in joint imaging • Soft tissue changes in arthritis	8	20	2,4	NA
M4	**Infections and Tumors** • Osteomyelitis and septic arthritis – radiological appearance • Benign tumors: osteochondroma, bone cysts • Malignant tumors: osteosarcoma, Ewing's sarcoma • Tumor-like lesions and mimickers • CT and MRI in tumor staging and evaluation	8	20	4,5	NA
M5	**Post-operative and Implant Imaging** • Imaging after orthopaedic surgery • Fracture fixation: plates, screws, nails • Joint replacements: hip and knee prosthesis • Types of orthopaedic implants and their materials • Complications: loosening, infection,	9	20	3,5	NA

	implant failure • Role of CT/MRI in post-operative assessment.				
	Total	**40**	**100**		

Module 1 – Introduction to Orthopedic Imaging

• Role of radiology in orthopedics
• Imaging techniques used in orthopedics: X-ray, CT, MRI, Ultrasound, Bone Scan
• Normal radiographic anatomy of bones and joints
• Importance of selecting proper modality for diagnosis
• Indications for musculoskeletal imaging

Module 2 – Fractures and Trauma Imaging

• Types and classification of fractures (simple, compound, greenstick, comminuted, etc.)
• Common fractures: Upper limb (humerus, radius, ulna), Lower limb (femur, tibia, fibula), Spine fractures
• Radiological signs of fracture healing and non-union
• Complications of fractures: delayed union, avascular necrosis
• Emergency trauma imaging: protocols and positioning

Module 3 – Joint Disorders and Degeneration

• Radiological appearance of joint diseases:
  - Osteoarthritis
  - Rheumatoid arthritis
  - Gout
• Spondylosis and ankylosing spondylitis
• Differences in imaging features between degenerative and inflammatory arthritis
• Use of MRI in joint disorders
• Soft tissue involvement in arthritis

Module 4 – Infections and Tumors

• Radiological signs of Osteomyelitis and Septic Arthritis
• Imaging of Benign bone tumors: osteochondroma, bone cysts
• Imaging of Malignant bone tumors: osteosarcoma, Ewing’s sarcoma

• Tumor mimicking lesions
• CT and MRI roles in tumor staging and evaluation

Module 5 – Post-operative and Implant Imaging

• Radiological evaluation after orthopaedic surgeries
• Imaging of fracture fixation (nails, plates, screws)
• Joint replacement imaging (hip, knee prosthesis)
• Types of orthopaedic implants and materials
• Detection of complications: loosening, infection, implant failure
• Role of CT/MRI in implant assessment

Practical

Subject name- Orthopaedics in Radiology

Subject code- BMMIT-6391

Credit-02

1. Identification of normal bones and joints on X-ray
2. Interpretation of common fractures (upper/lower limb, spine)
3. Classification of fracture types on radiographs
4. Radiographic positioning for trauma imaging
5. Radiographic analysis of osteoarthritis, rheumatoid arthritis, gout
6. Imaging of spondylosis and ankylosing spondylitis
7. Identification of osteomyelitis and septic arthritis
8. Detection of benign and malignant bone tumors
9. Differentiation between tumors and tumor-like lesions
10. Evaluation of post-operative images (implants, joint replacement)
11. Identification of implant complications (loosening, infection)
12. Viewing CT and MRI images for orthopaedic applications

Recommended Books**:**

• *Grainger & Allison's Diagnostic Radiology* (Musculoskeletal Section)
• *Orthopaedic Imaging: A Practical Approach* by Adam Greenspan
• *Essentials of Musculoskeletal Imaging* by M.A. Reinus
• *Bone and Joint Imaging* by Donald Resnick

Subject name- Dental Radiography

Subject code- 6302

Credit-03

Course Aim:

To provide foundational knowledge and skills in dental imaging techniques, radiographic anatomy, patient positioning, and safety in dental radiography.

Course Objectives:

• Understand the principles and techniques of dental radiography
• Learn intraoral and extraoral imaging procedures
• Identify normal and pathological findings in dental X-rays
• Ensure radiation protection for dental imaging
• Assist dental professionals with high-quality radiographs

SI	Graduate attributes	Mapped modules
CO1	Understands the principles, techniques, equipment, and anatomy involved in dental radiographic imaging.	M1
CO2	Develop skills in performing intraoral radiographs and identifying dental structures accurately.	M2
CO3	Learn to conduct and interpret panoramic and cephalometric radiographs for dental assessment.	M3
C04	Apply safety principles to protect patients and operators from unnecessary radiation exposure.	M4
CO5	Ability to interpret dental pathologies and ensure image quality through proper evaluation and documentation.	M5

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Module Number	Content	Total Hours	% of Question	Bloom Level (applicable)	Remarks, if any
M1	Introduction to Dental Radiography: • History and importance • Types (intraoral, extraoral) • X-ray generation principles • Equipment	7	15	1,2	NA
M2	Intraoral Techniques: • Periapical, bitewing, occlusal radiographs • Film placement • Exposure & errors • Dental anatomy	8	25	2,3	NA
M3	Extraoral Techniques: • Panoramic and cephalometric imaging • Indications, positioning, interpretation basics	9	20	2,3	NA
M4	Radiation Protection: • ALARA • Safety tools (apron, collimator) • Legal & operator safety guidelines	8	15	2,3	NA
M5	Image Interpretation & Quality Control: • Diagnosis of caries, periodontal disease • Artifacts • QA • Legal record-keeping	8	25	3,4,5	NA
	Total	**40**	**100**		

Module 1: Introduction to Dental Radiography

• History and importance of dental radiology

• Types of dental radiographs: intraoral, extraoral

• Principles of X-ray generation in dentistry

• Structure and function of dental X-ray equipment

Module 2: Intraoral Radiographic Techniques

• Periapical, bitewing, and occlusal radiography

• Film placement and patient positioning

• Exposure parameters and technique errors

• Radiographic anatomy of teeth and supporting structures

Module 3: Extraoral Radiographic Techniques

• Panoramic (OPG) and lateral cephalometric imaging

• Indications and patient preparation

• Technique, positioning, and interpretation basics

Module 4: Radiation Protection in Dental Imaging

• ALARA principle

• Use of lead apron, thyroid collar, and collimators

• Operator safety measures and legal guidelines

Module 5: Image Interpretation and Quality Control

• Identification of dental caries, periodontal disease, periapical lesions

• Quality assurance in dental radiography

• Common artifacts and corrective actions

• Record keeping and legal documentation

Practical

Subject name- Dental Radiography

Subject code- BMMIT6392

Credit-02

1. Identification of dental radiographic equipment
2. Performing periapical, bitewing, and occlusal radiographs
3. Film placement and patient positioning for intraoral imaging
4. Demonstration of panoramic (OPG) imaging technique
5. Positioning for lateral cephalometric radiography
6. Interpretation of normal dental radiographic anatomy
7. Identification of common dental pathologies (caries, periodontal disease, periapical lesions)
8. Detection and correction of common radiographic errors and artifacts
9. Radiation protection practices during dental imaging
10. Quality assurance procedures in dental radiography

Recommended Books

1. **Essentials of Dental Radiography** – Evelyn M. Thomson
2. **Dental Radiography: Principles and Techniques** – Joen Iannucci, Laura Howerton
3. **Textbook of Dental Radiology** – Ghom A
4. **White & Pharoah's Oral Radiology** – Stuart C. White, Michael J. Pharoah

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Subject Name: Medical Ethics, Biosafety and IPR

Mode: Offline **Credits: 4**

BMMIT 6303

AIM OF THE COURSE:

To provide foundational knowledge of medical ethics, bioethics, biosafety, and intellectual property rights (IPR) for safe, ethical, and legally compliant healthcare and biomedical practices.

COURSE OBJECTIVES:

- Understand the basic principles and importance of medical ethics in healthcare delivery.
- Apply ethical principles to real-life clinical and laboratory scenarios.
- Understand and implement biosafety protocols and biomedical waste management in healthcare settings.
- Gain awareness of legal frameworks, especially PCPNDT Act, governing medical practices.
- Understand the role and process of intellectual property rights (IPR) in protecting innovations in the biomedical field.
- Analyze ethical and legal dilemmas through relevant case studies.

Sl	Graduate attributes	Mapped Modules
CO1	Explain core principles of medical and bioethics	M1
CO2	Interpret ethical and legal issues in clinical practice	M2
CO3	Implement biosafety and biomedical waste guidelines	M3
CO4	Describe the scope and types of IPR in healthcare	M4
CO5	Analyze legal frameworks like PCPNDT and case studies	M5

Learning Outcome / Skills:

- Understand and apply ethical principles in healthcare settings.
- Follow biosafety practices and ensure safe lab handling.
- Manage biomedical waste according to standard procedures.
- Explain legal implications of the PCPNDT Act in medical practice.
- Understand and respect IPR in medical innovations and research.
- Analyze and respond to ethical dilemmas in healthcare.

Module Number	Content	Total Hours	% of Questions	Bloom Level	Remarks
M1	Principles of Medical Ethics, Professionalism	10	20	1,2	NA
M2	Bioethics, Consent, PCPNDT Act	10	20	2,3	NA
M3	Biosafety & Biomedical Waste Management	10	20	2,3	NA
M4	Introduction to IPR and its application	10	20	1,2	NA
M5	Case studies, Legal Issues, Biosecurity	10	20	3,4	NA
Total		**50**	**100**		

Detailed Syllabus

Module I: Introduction to Medical Ethics

- Definition, Scope
- Principles of Medical Ethics – Autonomy, Beneficence, Non-maleficence, Justice
- Doctor–Patient Relationship
- Informed Consent and Confidentiality
- Professional Misconduct and Medical Negligence
- Role of Hospital Ethics Committees

Module II: Bioethics and Legal Framework

- Bioethics in Research and Clinical Practice
- Guidelines by ICMR and WHO
- Organ Donation Ethics
- Legal Responsibilities of Healthcare Providers
- Overview and Importance of the PCPNDT Act

Module III: Biosafety and Biomedical Waste

- Biosafety Concepts and Levels (BSL-1 to BSL-4)
- PPE Usage and Laboratory Safety
- Laboratory Safety Rules
- Biomedical Waste Segregation, Colour Coding
- Safe Handling of Sharps and Needle-stick Injury Management
- Role of Biosafety Committees

Module IV: Intellectual Property Rights (IPR)

- Definition and Importance of IPR
- Types: Patent, Copyright, Trademark, Trade Secret
- Patent Filing – Basics
- IPR in Healthcare and Biotechnology
- WIPO & TRIPS Agreement Overview

Module V: Contemporary Issues & Case Studies

- Ethical Case Studies in Patient Care
- Legal Cases in Medical Negligence
- Ethical Concerns in Artificial Intelligence, Genetic Engineering
- Biosafety Incidents and Responses
- Critical Review of PCPNDT Act Implementation

Reference Books:

1. Beauchamp, T.L. and Childress, J.F. – Principles of Biomedical Ethics.
2. Indian Council of Medical Research (ICMR) – Ethical Guidelines for Biomedical Research.
3. Park's Textbook of Preventive and Social Medicine – K. Park.
4. Medical Ethics Manual – World Medical Association.