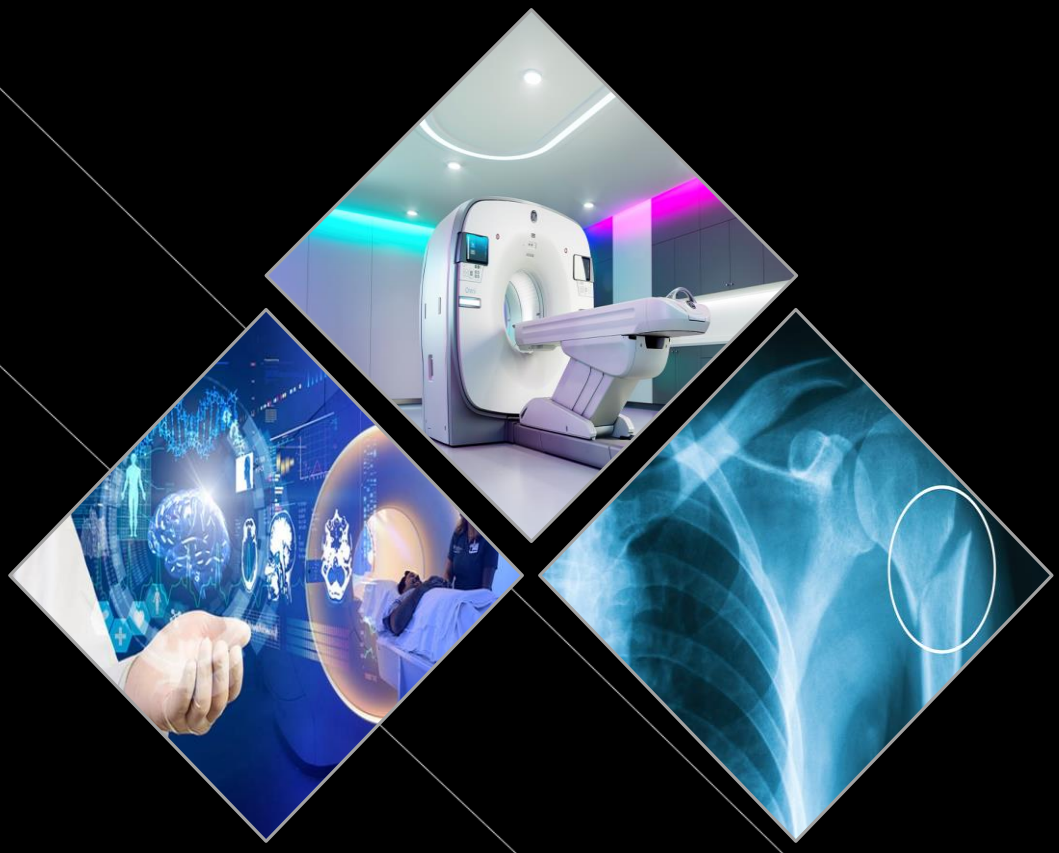
A Textbook For Medical Imaging Technology

Fundamentals of Radiology & Imaging Technology



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-: EDITORS :-

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Invitation to Contribute to our Upcoming Book On Radiology & Imaging Technology

Dear Radiology and Imaging Professionals,

I hope this message finds you well.

We are thrilled to announce the development of an exciting new four volume series titled **"Fundamentals of Radiology and Imaging Technology"**. This comprehensive work aims to provide an in-depth exploration of essential topics in radiology, spanning from basic physics to advanced imaging technologies and professional practices.

Volume 1 will delve into the foundational principles of physics and radiation physics, offering a solid grounding for understanding radiological sciences.

Volume 2 will cover a wide range of medical imaging modalities, including X-ray, CT, MRI, ultrasound, and nuclear medicine, among others, highlighting their principles, applications, and technological advancements.

Volume 3 will focus on practical aspects of radiological procedures, including routine practices, contrast media usage, hospital ethics, and patient safety protocols.

Volume 4 will explore the latest advancements and future directions in the field, examining innovations, ongoing research, and global perspectives.

We are seeking contributions from experts and professionals in the field to share their knowledge and insights. Your expertise in Radiology and imaging would be a valuable addition to this series. We invite you to contribute a chapter that aligns with one of the outlined topics or proposes a new and relevant subject matter.

Your contribution will not only enhance the quality of this comprehensive resource but also support the advancement of knowledge in radiology and imaging technology. We look forward to the opportunity of working with you on this important project.

Submission Guidelines

- **Chapter Proposal**: Authors are invited to submit a 300-500-word abstract of their proposed chapter along with a brief bio.
- **Chapter Length:** Full chapter submissions should be between 5,000-10,000 words.
- **Formatting Requirements**: All submissions must adhere to standard academic formatting.
- **Submission** Deadline for Abstracts: 20/10/2024
- **Submission Deadline for Full Chapters**: 25/12/2024
- **Submission**: Send your abstract and full chapter to ms@spjinternational.co or editor@spjinternational.co
- **Online Submission Link:** https://omp.spjinternational.co/index.php/spjp/about/submissions

Formatting Guidelines

- **Font**: Times New Roman, 12-point
- **Headings**: Bold for Chapter Titles, Italicized for Subheadings
- **Spacing**: Single-spaced for text; Single-spaced for tables and figures
- **Margins**: 1-inch on all sides
- **Page Numbers**: Upper Right side of each page
- **References**: Follow Vancouver style.
- **Figures and Tables**: Numbered and placed within the text

Target Audience

- Undergraduate and postgraduate students (Radiology and Imaging Technology)
- Healthcare professionals and Radiology technicians.
- Educators and trainers in allied health programs.
- Researchers and academicians.

Contact Information: For queries and submissions, please contact:

- **Email**: ms@spjinternational.co
- **WhatsApp**: +91-8017639486
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Author/Contributor/Editor Benefit

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Registration Fee

- The registration fee of USD 40, or INR 2000, covers all associated processing fees along with the comprehensive supporting services mentioned.
- Additionally, it includes the provision of contributing author certificate for all authors and grants one complimentary soft copy of your contributed chapter per registration.

Volume-I: Basic Physics and Radiation Physics

1. **Fundamentals Concept**
   - Introduction to Physics: Definition and scope of physics, Importance in various fields, including radiology.
   - The SI System of Units
   - Precision and Significant Figures
   - Dimensions of Physical Quantities
   - Dimensional Formulas and Equations
   - Applications of Dimensional Analysis
2. **Fundamental concept of atom**
   - Atomic Structure: Atoms, Nuclei, Electron Configurations, Isotopes, Ionization, and Binding Energy.
   - Atomic Masses and Composition of Nucleus
   - Mass-Energy and Nuclear Binding Energy
   - Nuclear Force and Nuclear energy.
   - Atomic Models: Dalton, Thomson, Rutherford, and Bohr's Contributions.
   - Force, Work, Power, and Energy: Concepts and Relevance in Radiology.
   - Heat and Temperature: Heat Capacity, Specific Heat, and Methods of Heat Transfer.
   - Thermal Conductivity: Equations, Material Properties, and Thermal Expansion.
   - Newton’s Law of Cooling and Stefan’s Law: Applications in X-ray Tube Heat Dissipation
3. **Electricity and Magnetism**
   - Fundamental Properties of Electric Charge
   - Electric Charge and Coulomb’s Law: Charge Units, Electric Potential, and Induction Principles
   - Forces Among Multiple Charges
   - Electric Field, Field Lines, Flux, and Dipole
   - Gauss's Law and Its Applications
   - Classification of Metals, Conductors and Semiconductors
   - Intrinsic and extrinsic Semiconductor
   - Capacitance: Understanding Capacitors and Capacitance in Series and Parallel
   - Electric Current: Units, Ohm’s Law, Resistance, Power, and Joule’s Law; Limitations of Ohm’s Law; Resistivity of Materials
   - Time-Varying Currents: Growth and Decay in LR Circuits, Capacitor Charging and Discharging
   - Alternating Currents: Peak and RMS Values, Power Factor, LR, CR, and LCR Circuits, Temperature Effects on Resistivity
   - DC Circuits: Ohm’s Law, Resistivity, Series and Parallel Circuits, EMF, Kirchhoff’s Laws, and Thermal Effects of Current
4. **Moving Charges and Magnetism**
   - Magnetisation and Magnetic Intensity
   - Magnetic Properties of Materials
   - Oersted’s Experiment and Its Significance

- Biot-Savart Law: Magnetic Field Due to a Current Element
- Magnetic Field on the Axis of a Circular Current Loop
- Ampere's Circuital Law
- The Solenoid
- Magnetic Flux & Faraday's Law of Induction
- Magnetic Force on a Moving Charge
- Magnetic Force on a Current-Carrying Conductor
- Torque on a Current Loop in a Uniform Magnetic Field
- Moving Coil Galvanometer: Principle, Construction, and Working
- Cyclotron: Principle, Construction, and Applications
- Motion of a Charged Particle in a Magnetic Field

5. **Electromagnetic Waves**
   - Introduction to Electromagnetic Waves
   - Maxwell's Equations and the Electromagnetic Wave Theory
   - Characteristics of Electromagnetic Waves
   - Wave Propagation: Transverse Nature of Electromagnetic Waves
   - Spectrum of Electromagnetic Waves
   - Energy and Momentum of Electromagnetic Waves
   - Electromagnetic Spectrum: Radio Waves, Microwaves, Infrared, Visible Light, UV, X-rays, and Gamma Rays
   - Applications of Electromagnetic Waves in Communication
   - Electromagnetic Waves in Medical Imaging and Treatment
   - Polarization of Electromagnetic Waves
6. **Electronics**
   - Introduction to Electronics
   - Semiconductors: Intrinsic and Extrinsic
   - PN Junction Diode: Construction, Working, and Applications
   - Zener Diode and Voltage Regulation
   - Transistors: Types, Operation, and Applications
   - Logic Gates: AND, OR, NOT, NAND, NOR, XOR, XNOR
   - Amplifiers: Principles and Types
   - Oscillators: Types and Working Principles
   - Digital Electronics: Binary Systems and Boolean Algebra
   - Integrated Circuits (ICs): Types and Applications
   - Applications of Electronics in Communication and Medicine
7. **Introduction to Radiation Physics**
   - Overview of Radiation Physics
   - Historical Development of Radiation Physics
   - Basic Concepts of Radiation
   - Types of Radiation: Ionizing and Non-Ionizing, Electromagnetic and particulate, etc.
   - Types and Sources of Ionizing Radiation Exposure in Diagnostic Radiology
   - Fundamental Properties of Radiation

- Electromagnetic Spectrum and Radiation
- Sources of Exposure to Ionizing Radiation
- Types of Radiation Exposure, Types of Radiation in Diagnostic Radiology
- Situations of Exposure
- Sources of Radiation: Natural and Man-Made
- Radiation Units and Measurements
- Applications of Radiation in Medicine and Industry
- Importance of Radiation Safety

8. Fundamentals of Radioactivity

- Introduction to Radioactivity
- Discovery of Radioactivity
- Types of Radioactivity: Alpha, Beta, and Gamma Decay
- Radioactive Decay Law
- Half-life and Mean Life
- Radioactive Series and Chain
- Units of Radioactivity: Becquerel, Curie
- Types of Radioactivity: Natural and Artificial Radioactivity
- Radioisotopes: Production, Types and Applications
- Nuclear Reactions: Fission and Fusion
- Interaction of Radioactive Particles with Matter
- Applications of Radioactivity in Medicine, Industry, and Research
- Radioactive Waste Management

9. Radiopharmaceuticals

- Introduction to Radiopharmaceuticals
- Definition and Classification
- Types of Radiopharmaceuticals: Diagnostic Radiopharmaceuticals & Therapeutic Radiopharmaceuticals
- Radioisotopes Used in Radiopharmaceuticals
- Production and Synthesis
- Quality Control and Assurance
- Administration and Dosage
- Applications in Medical Imaging: SPECT Imaging & PET Imaging
- Applications in Therapy: Targeted Radionuclide Therapy Bone Pain Palliation
- Safety and Handling
- Regulatory Guidelines and Standards

10. Interaction of Radiation with Matter

- Introduction to Radiation-Matter Interactions
- Types of Radiation Interactions: Ionizing and Non-Ionizing
- Photoelectric Effect
- Compton Scattering
- Pair Production
- Bremsstrahlung Radiation

- Radiation Absorption and Attenuation
- Linear Energy Transfer (LET)
- Relative Biological Effectiveness (RBE)
- Dose-Effect Relationships
- Energy Deposition Mechanisms
- Interaction of Different Radiation Types with Matter (Alpha, Beta, Gamma, X-rays)
- Attenuation Coefficients: Linear and Mass Attenuation Coefficients, Half-Value Thickness (HVT), and Tenth-Value Thickness (TVT

11. Radiation Detection and Measurement

- Introduction to Radiation Detection
- Types of Radiation Detectors
- Gas-Filled Detectors: Ionization Chambers, Proportional Counters, and Geiger-Müller Counters
- Scintillation Detectors: Principles and Applications
- Semiconductor Detectors: Types and Uses
- Detection Principles: Ionization, Scintillation, and Semiconductor Responses
- Measurement Techniques
- Exposure Measurement
- Absorbed Dose Measurement
- Equivalent Dose Measurement
- Calibration of Radiation Detectors
- Radiation Monitoring and Survey Instruments
- Personnel & Area Monitoring Devices
- Applications in Medical, Environmental, and Industrial Settings
- Safety and Quality Control in Radiation Measurement

12. Introduction to Radiation Quantities

- Exposure: Definition and Units. Measurement Techniques.
- Absorbed Dose: Definition and Units. Calculation and Measurement
- Equivalent Dose: Definition and Units
- Radiation Weighting Factors
- Tissue Weighting Factor
- Effective Dose: Definition and Units, Calculation Methods
- Dose Rate: Definition and Units, Measurement and Interpretation
- Exposure Rate: Definition and Units, Measurement and Applications
- Exposure vs. Dose: Key Differences
- Radiation Quantities in Medical and Industrial Applications
- Regulatory Standards and Limits for Radiation Quantities

13. Fundamentals of Radiation Protection

- Overview of Radiation Protection
- Radiation Protection Framework
- Exposure Factors in Diagnostic Radiology
- Patient and Technologist Exposure

- Key Concepts in Radiation Protection
- Understanding the potential risk and benefit of diagnostic exposure
- Radiation Protection standers: Principle of radiation protection (Justification, Optimization, dose limit.
- Inverse square law
- Cardinal principle of radiation protection or radiation protection action.
- Inverse square law

14. Radiation protection for women

- Introduction to Radiation Protection for Women
- Considerations During Pregnancy
- Ten-day rule, 14day rule, 28-day rule.
- LMP and its correlation with radiological investigation.
- Foetal Radiation Exposure
- Safety Measures and Guidelines
- Radiation Protection for Reproductive Health
- Occupational Radiation Exposure and Safety
- Protective Measures in Medical Imaging
- Guidelines for Breast Imaging
- Education and Training for Healthcare Providers
- Diagnosis and medical management of radiation syndromes: LD-50 (lethal dose 50), Radiation syndromes, Medical management of radiation accidents, Methods of triage for treatment after a radiation accident
- Regulatory Standards and Recommendations
- Emergency Protocols and Risk Management

15. Radiation Protection organization

- Overview of radiation protection organization.
- National Organisation: AERB, NCRP, RPB-HC, CRPA, EC, HERCA, PAHO, FORO.
- AERB Code of conduct: Safety and regulatory guidelines, Radiographic room and shielding layout etc.
- International Organisation: ICRP, IAEA, UNSCER, RERF, WHOIRPA, BEIR, ICRU, NEA, ICNIRP, ILO, IACRS, ISO.
- Other Professional Bodies: IOMP, ISRRT, WNA, WNG
- Informal Agencies: EAN, ETRAP, ICPRA, EURADOS, ENETRAP.

16. Factors Affecting X-ray Dose and Techniques for Dose Reduction

- Exposure Time
- X-ray Tube Voltage
- X-ray Tube Current
- Distance from the X-ray Source
- Beam Filtration
- Patient Size and Position
- Type of Imaging Equipment
- Use of Protective Shields

- Technique and Protocol Variations
- Contrast Media Usage
- Optimization of Imaging Protocols
- Use of Appropriate X-ray Techniques
- Beam Collimation and Filtration
- Reduction of Exposure Time
- Adjustment of X-ray Tube Settings
- Implementation of Protective Devices
- Regular Equipment Maintenance and Calibration
- Patient Positioning and Immobilization
- Adherence to ALARA Principle (As Low As Reasonably Achievable)
- Training and Education for Healthcare Professionals

17. Introduction to Protective Shielding

- Categories of protective shielding: Source and structure shielding
- Types of Shielding Materials: Lead Aprons, Lead Shields and Barriers, Thyroid Collars, Gonadal Shields
- Placement and Application of Shielding
- Effectiveness of Different Shielding Techniques
- Shielding for Patients: Use During X-ray Procedures & Special Considerations for Pregnant Patients
- Protective barrier: Primary, secondary
- Factors affecting barrier thickness: Dose limit, Work Load, Occupancy factor, etc.
- Shielding material

18. Introduction to Radiobiology

- Definition and Scope of Radiobiology
- Historical Development of Radiobiology
- Significance in Medicine and Research
- Cellular and Molecular Effects of Radiation
- Interaction of Radiation with Cells
- Cellular Responses to Radiation Exposure
- Radiation Effects on the Cell Cycle
- Molecular Mechanisms of Radiation-Induced Damage
- DNA Damage and Repair Pathways
- Impact of Unrepaired DNA Damage (Chromosomal Damage)
- Apoptosis and Cellular Senescence
- Radiobiological Definition of Cell Death
- Radiation Survival Curve Theory

19. Biological Effects of Radiation

- Acute Radiation Effects
- Chronic Radiation Effects
- Stochastic and Deterministic Effects
- Dose-Response Relationships

- Radiation Sensitivity and Radio resistance
- Factors Affecting Radio-sensitivity (Cell Cycle, Oxygen Effect)
- Variation in Sensitivity Among Different Tissues and Organs
- Radio-sensitivity of Tumour vs. Normal Tissue

20. Radiation Carcinogenesis

- Mechanisms of Carcinogenesis
- Epidemiological Evidence for Radiation Carcinogenesis
- The A-Bomb Survivor Life-Span Study
- Cancer Mortality and Cancer Incidence
- Case Study (The Chernobyl Accident)
- Patients Treated for Benign Diseases
- Radon Exposure in Hard Rock Miners and Homes

21. Heritable Radiation Effects

- Effects on the Developing Embryo
- Radiation Effects on Fertility (Target Cells for Infertility)
- Doses Necessary for Temporary and Permanent Sterility
- Genetic Effects
- What to Do When the Foetus Has Been Exposed to Radiation

22. Radiation Pathology

- Introduction to radiation pathology
- Acute radiation syndrome (ars)
- Radiation effects on tissues and organs
- Skin and soft tissue damage
- Radiation effects on the hematopoietic system
- Gastrointestinal radiation damage
- Central nervous system and radiation exposure
- Late effects of radiation
- Radiation-induced carcinogenesis
- Radiation-induced fibrosis
- Cardiovascular effects of radiation
- Radiation effects on foetal development
- Pathophysiology of radiation sickness
- Radiation dose thresholds for pathological effects
- Management and treatment of radiation injuries
- Protective measures in radiation therapy

Volume-2. Medical Imaging Modalities

1. **Fundamental of Medical Imaging**
    - Overview of Medical Imaging
    - Types of Medical Imaging Techniques/Medical imaging modalities
    - Understanding the Contrast: Definition, Types & Greyscale characteristics
    - Unsharpness: Quantifying unsharpness, Measuring unsharpness,
    - Noise in Imaging: Poisson nature of photons, Measures of variance and correlation/covariance, Noise power spectra, Noise power spectra of a cascaded imaging system.
    - Signal and Noise Analysis: Quantum signal to noise ratio, Detective quantum efficiency, Signal to noise ratio, SNR /dose
    - DICOM & PACS
2. **Conventional Radiographic technique**
    - Dark room: definition, structure
    - Dark room equipment
    - Radiography cassette
    - Radiographic film
    - Intensifying screen
    - Radiograph Processing technique
    - Image characteristics & silver recovery
3. **X-ray Imaging**
    - Introduction to X-Ray Imaging: Definition and Key Characteristics
    - X-Ray Production Mechanisms: Bremsstrahlung and Characteristic Radiation, X-Ray Spectrum
    - X-Ray Generator Technology: Electromagnetic Induction and Voltage Transformation, Transformer Operation, Modules, Operator Console, Generator Types, Efficiency, Power Ratings, Heat Dissipation and Cooling, Filament Circuit, Rectification, etc.
    - Construction of X-Ray Tubes: Components of the X-Ray Tube, Tube Envelope, Cathode, Anode, Protective Housing, etc.
    - Various types of X-Ray Tubes
    - Collimation and Filtration in X-Ray Imaging
    - Factors Affecting X-Ray Spectrum and Output
4. **CR System**
    - Introduction to Computed Radiography (CR)
    - Principle of CR system
    - Components of a CR System
    - Advantages and Limitations of CR Systems
    - Clinical Applications of CR Imaging
    - Future Trends in CR Technology
5. **Fluoroscopy: A Real Time Scanning**
    - Overview of fluoroscopy: Historical development & Principle

- Fluoroscopy Equipment: X-ray tube, image intensifier, detector, automatic exposure control, etc.
- Types of Fluoroscopy: Conventional, IITV, etc.
- Fluoroscopic Techniques
- Clinical Applications of Fluoroscopy
- Radiation Safety in Fluoroscopy

6. Introduction to Computed Tomography

- Overview of CT Scan
- History and Development
- Principles of CT Imaging
- Advantage, Disadvantages,
- Application and Limitation
- Importance of CT in Modern Medicine

7. Generation of CT Scan

8. Physics of Computed Tomography

- CT Equipment: Gantry, X-Ray generator and its type, Detector, Filter, Collimator, Patient Table,
- Console: Image Display, Storage, Recording, and Communications
- HU/CT Number, Pitch, Slip ring Technology
- CT Detector Technology: Feature, Types, Detector Electronics, etc.
- Data Acquisition and Sampling
- Scanning Mode: Sequential, Spiral/Helical, HRCT

9. CT Image quality

- Overview of Image Quality
- Spatial Resolution
- Contrast Resolution
- Temporal Resolution
- Low-Contrast Resolution
- Accuracy and Uniformity of CT Numbers
- Noise Levels
- CT Artifacts and Solutions

10. CT Image Reconstruction

- Fundamental Principles: Algorithms, Fourier Transform, Convolution, Interpolation
- Image Reconstruction from Projections
- Reconstruction Algorithms
- Data Types
- Single-Slice Image Reconstruction
- Dual/Multi-Slice Image Reconstruction
- Post processing Technique: Three-Dimensional Reconstruction, VR/MIP^{Max}/MIP^{Min}
- Windowing: Window Width and Window Level

11. Radiation Dose in Computed Tomography

- CT Scanner X-Ray Beam Geometry,

- Factors Affecting Dose in CT
- Automatic Tube Current Modulation
- CT Dose Optimization
- Radiation Protection Considerations
- CTDI & DLP

12. Multi Slice scanning

- SSCT: Historical Overview
- Limitations of SSCT Scanners
- MSCT: History and Assessment
- Physical Principles of MSCT
- Instrumentation
- Four-Dimensional Imaging
- Single and Dual Source Imaging

13. Introduction to Magnetic Resonance Imaging (MRI)

- History of MRI
- Principles of MRI
- Advantages, Disadvantage and limitation of MRI over Other Imaging Modalities

14. Fundamental Physics of MRI

- Magnetism and electromagnetism
- Magnetic Fields and field strength
- Atomic structure
- Alignment and precession
- Radiofrequency Pulses
- Excitation
- Relaxation Times (T1 and T2)
- Signal Detection and Processing
- T1 weighting
- T2 weighting
- Proton density weighting
- MRI Equipment and Technology
- Scanning room: Magnets and its type
- Cryogens:
- Radio-frequency coils and its type
- Gradients Coil: Definition
- Other hardware
- Ramping, Quenching, Trade-off
- Type of MRI Scanner: Closed, Open, Upright, Portable etc.

15. MRI Sequences

- Overview of MRI Pulse sequences
- Fundamentals of pulse sequence including parameter
- Pulse sequence mechanisms
- Conventional spin echo

- Fast or turbo spin echo
- Inversion recovery
- Gradient echo mechanisms
- Coherent gradient echo
- Incoherent sequences
- Steady state free precession
- Ultrafast sequences
- Others

16. MRI Image Acquisition Techniques & Image quality

- Overview of Image acquisition in MRI
- K-Space
- Data acquisition
- Encoding: Phase, Frequency, Slice
- Signal-to-noise ratio
- Contrast-to-noise ratio
- Spatial resolution

17. MRI Artefact & Remedial Measures

- Motion Artifacts: Phase-Encoded Motion Artifact, Ventricular CSF Pulsation Artifact, Entry Slice Phenomenon, Transient Arterial Phase Respiratory Motion-Related Artifact
- Tissue and Material Artifacts**:** Black Boundary Artifact, Magic Angle Effect, Magnetic Susceptibility Artifact, Blooming Artifact, Chemical Shift Artifact, Dielectric Effect Artifact.
- Sampling and Reconstruction Artifacts: Gibbs Artifact/Truncation Artifact, Zero-Fill Artifact, Aliasing Artifact (also known as Wrap Around Artifact)

18. MRI Contrast Media

- Overview of MRI CM
- Working Principle and effect on image
- Gadolinium-based contrast agent
- Manganese-based contrast agents: paramagnetic
- Iron oxide contrast agents: superparamagnetic
- Iron platinum contrast agents
- Chemical composition and the presence or absence of metal atoms
- Route of administration
- Bio distribution and applications
- Classification of contrast media: Tissue specific and non-tissue specific contrast

19. MRI Safety

- MRI Hazards: Various Magnetic Field, Acoustic Noise, Pregnancy and Exposure, Cryogens,
- MRI Room Shielding
- Exposure limits and guidelines
- The pressure system safety and regulation
- Quenching related guidelines and vent installation

- Role and responsibility: Organization, Technologist.
- MRI Zone and Access
- MRI personnel
- Patient screening protocols
- Case study

20. Ultrasonography

- Overview of Ultrasound: Advantage, Disadvantage, limitation.
- Fundamental physics of Ultrasound and ultrasonography
- History and development
- Basic Principle of ultrasonography
- Advantage, disadvantage and Importance of Ultrasound in Medicine.
- Sound Waves and Frequencies
- Interaction with Tissue
- Transducer Technology

21. Types of Ultrasound Imaging

- A-Mode ultrasound
- B-Mode Ultrasound
- M-Mode ultrasound
- Doppler Ultrasound
- Continuous-Wave Doppler
- Pulsed-Wave Doppler
- Colour Doppler Imaging
- 3D and 4D Ultrasound
- Contrast-Enhanced Ultrasound

22. Ultrasound Equipment and Technology

- Components of Ultrasound Systems
- Image Processing Techniques
- Quality Control in Ultrasound Imaging
- Advances in Ultrasound Technology

23. Interaction of Ultrasound-Matter Interaction

- Overview of interaction
- Importance of Understanding Interactions
- Physical Properties of Ultrasound
- Mechanisms of Interaction
- Reflection
- Absorption
- Refraction
- Scattering
- Tissue Characteristics and Their Influence
- Acoustic Impedance

24. Clinical Implications of Ultrasound Interactions

- Diagnostic Imaging

- Image Artifacts Related to Interactions
- Therapeutic Applications
- Ultrasound in Physiotherapy
- High-Intensity Focused Ultrasound (HIFU)
- Ultrasound-Guided Procedures: Biopsy Techniques. 6.2 Drainage Procedures 6.3 Catheter Placement
- Regional Anaesthesia

25. Artifacts in Ultrasound Imaging

- Types of Ultrasound Artifacts
- Acoustic Shadowing\Reverberation Artifacts
- Enhancement Artifacts
- Minimizing Artifacts

26. Introduction and basic principle of nuclear Medicine

- Definition and Scope
- Historical Development
- Importance in Modern Medicine
- Radioactivity and Radiopharmaceuticals
- Mechanism of Action
- Types of Radiation: Alpha, Beta, Gamma

27. Radiopharmaceuticals

- Classification of Radiopharmaceuticals
- Production and Quality Control
- Administration Routes and Dosage Forms
- Safety and Regulatory Considerations

28. Imaging Techniques in Nuclear Medicine

- Single Photon Emission Computed Tomography (SPECT)
- Positron Emission Tomography (PET)
- Hybrid Imaging Techniques (PET/CT, SPECT/CT)
- Comparison of Imaging Modalities

29. Clinical Applications of Nuclear Medicine

- Oncology: Tumor Detection and Staging, Treatment Planning
- Cardiology: Myocardial Perfusion Imaging, Viability Assessment
- Neurology: Brain Imaging in Dementia and Movement Disorders
- Endocrinology: Thyroid Imaging and Treatment
- Infection and Inflammation Imaging
- **Therapeutic Applications**
- Radioiodine Therapy for Hyperthyroidism and Thyroid Cancer
- Radiolabelled Antibodies in Cancer Treatment
- Pain Management in Palliative Care
- Emerging Therapies and Clinical Trials

30. Dosimetry and Safety in Nuclear Medicine

- Radiation Dose Measurement and Calculation

- Patient and Staff Safety Protocols
- Risk Management Strategies
- Emergency Procedures in Nuclear Medicine

31. Other Imaging Technologies

- DEXA: Bone density measurement.
- Mammography: Breast imaging techniques.
- Dental Radiology: Imaging techniques for dental diagnostics.
- Portable/Mobile Equipment: Uses of mobile imaging technologies.
- Interventional Radiology: Techniques and equipment for minimally invasive procedures.

32. Quality Assurance and Quality control

- Care and Maintenance of Equipment
- Conventional radiography equipment
- X-Ray Equipment
- CT Scan
- NRI
- Ultrasound equipment
- Dental
- Mammography
- Fluoroscopy
- DEXA
- CR & DR System

Volume-3 Radiographic Procedures

Part-1: Routine Radiographic Procedure

1. Fundamental Radiographic Terminology
2. Skull and Facial Anatomy: Includes Skull, Facial Bones, Optic Foramina, Zygomatic Arches, Nasal Bones, Mandible, Temporomandibular Joints (TMJs), and Paranasal Sinuses.
3. Upper Extremity Imaging: Covers Fingers, Thumb, Hand, Wrist, Forearm, Elbow, and Pediatric Upper Limbs.
4. Lower Extremity Imaging: Includes Toes, Foot, Heel (Calcaneus), Ankle, Tibia-Fibula (Leg), Knee, Patella, and Pediatric Lower Limbs.
5. Femur and Pelvic Region: Imaging of the Femur, Hips, Pelvis, and Pediatric Hip and Pelvis.
6. Thoracic Imaging: Adult and Pediatric Chest Radiography.
7. Bony Thorax Imaging: Covers Sternum, Sternoclavicular (SC) Joints, and Ribs.
8. Humerus and Shoulder Area: Imaging of the Humerus, Shoulder, Clavicle, Scapula, and Acromioclavicular (AC) Joints.
9. Spinal Column Imaging: Cervical, Thoracic, Lumbar Spine, Sacrum, Coccyx, and Sacroiliac Joints.
10. Abdominal Radiography
11. Ward Radiography
12. Theatre Radiography
13. Paediatric Radiography

Part-2: Special Radiographic Procedure

1. Special procedure and related Contrast Media,
    - Contrast Media, Types, Risk Factor, Reaction & Management
2. Emergency in Radiology Department
3. Fistulogram
4. Urinary system imaging
    - IVU,
    - MCU,
    - RGU)
5. G.I. Tract
    - Barium studies, Barium Swallow b) Barium Meal Series c) Barium Meal Follow Through d) Barium Enema
    - Distal colography,
    - Defaecography
6. Biliary system (PTC, ERCP, T-TUBE Cholangiography, Pre- operative Cholangiography)
7. Sialography and Sinography,
8. DCG
9. HSG
10. Pelvimetry
11. Oral cholecystography/ intravenous cholangiography
12. Arthrography, Discography, etc.

Part-3: CT Protocols

1. Fundamental Terminology: NCCT, CECT, Bolus Tracking, Scout/Topogram, Pressure Injector, Angiography, Arteriography, Venography, etc.
2. CT Contrast media: Definition, Types, & Application.
3. NCCT & CECT Brain
4. HRCT, Temporal
5. Brain Angiography
6. NCCT & CECT Neck
7. Neck Angiography
8. Head & Neck Angiography
9. NCCT & CECT Face
10. NCCT Thorax
11. HRCT Chest
12. Pulmonary Angiography
13. Calcium Scoring
14. Coronary Angiography
15. NCCT Abdomen
16. CECT Abdomen
17. LAI Protocols
18. CT Enterography
19. CT Urography
20. Abdominal Angiography/Dual Phase Angiography
21. Triple Phase Angiography
22. NCCT & CECT Pelvis
23. NCCT Upper Limb (All)
24. NCCT Lower Limb (All)
25. Upper Limb Angiography
26. Lower Limb Angiography
27. CT Guided Procedure

Part-4: MRI Protocols

1. Head and Neck: Brain, Temporal lobes, Posterior fossa and internal auditory meatus, Pituitary fossa, etc
2. Orbits, Paranasal sinuses
3. Face
4. Pharynx, Larynx
5. Thyroid and parathyroid glands
6. Salivary glands
7. Temporomandibular joints
8. Spine: Cervical spine, Thoracic spine, Lumbar spine, Whole spine imaging
9. Chest: Lungs and mediastinum
10. Heart and great vessels
11. Breast
12. Brachial plexus
13. Liver and biliary system
14. Kidneys and adrenal glands

15. Pancreas
16. Male pelvis, Female pelvis
17. Upper limb: Shoulder, Humerus, Elbow, Forearm, Wrist and hand,
18. Lower limb, Hips, Femur, Knee, Tibia and fibula, Ankle, Foot
19. MRCP
20. F-MRI
21. DWI
22. DTI
23. Spectroscopy: Single & Multi-voxel
24. Cardiac MRI
25. Defecography
26. PLACENTAL MRI
27. FRTAL MRI
28. Fistulogram
29. Dynamic Scan
30. Magnetic Resonance Angiography : BRAIN, NECK, Abdomen, Upper Limb, Lowe Limb, Thorax, Cardiac, Renal

Note Elaborate all special/Additional protocols associate with concern topic including planning, technical factors.

Volume-4. Recent Advancements & Patient Care in Radiology

Part-A: Recent Advancement

1. Overview of Radiology Advancements
2. Innovations in Imaging Technology
3. Enhancing Diagnostic Precision
4. Patient-Focused Practices in Radiology
5. Ensuring Safety and Quality
6. Tele-radiology and Remote Patient Care
7. Collaborative Approaches in Healthcare
8. Emerging Trends in Radiology
9. Ethical Challenges in Radiology

Part-II: Patient Care in Radiology

1. Introduction to Patient Care in Radiology
2. Understanding Radiology's Role
3. Enhancing Patient Experience & Patient Safety
4. Effective Communication in Radiology
5. Reducing Patient Anxiety
6. Patient Transport Mechanism
7. Safety Protocols in Imaging & Patient Education Strategies
8. Tele-radiology and Accessibility
9. Medical Record & Informed Consent in Imaging
10. Staffing & Organisation: Managing Patient Expectations
11. Feedback Mechanisms for Improvement
12. Ethical Considerations in Radiology
13. Medical Record
14. Hospital Accreditation
15. Patient Support Services
16. First Aid
17. ALS.BLS/ACLS
18. ABCD
19. Vital Signs
20. Glasgow Coma Scale (GCS)