List of Ph.D. Course work subjects that can be offered under Radio Diagnosis Group from 2026

Radio Diagnosis							
Group I		Group II		Group III		Group IV	
Subject Code	Name of the subject	Subject Code	Name of the subject	Subject Code	Name of the subject	Subject Code	Name of the subject
PHRD101	Anatomy & Physiology-Heart/CVS	**PHRD201**	Computed Tomography-Cardiac Studies	**PHRD301**	Anatomy & Physiology of Brain	**PHRD401**	Psychological Considerations-Disease Status
PHRD102	Radiation Protection	**PHRD202**	Basics of CT and Neuroimaging	**PHRD302**	MRI Basics and Spine Imaging	**PHRD402**	MRI Safety
PHRD103	Diagnostic Radiology	**PHRD203**	Computed Tomography	**PHRD303**	CT Thorax	**PHRD403**	Radiation Safety & Thoracic Anatomy & Physiology

PHRD101: ANATOMY AND PHYSIOLOGY- HEART/CVS

Course Objectives:

- To understand the anatomical and physiological principles underlying cardiovascular function.
- To explore advanced mechanisms of cardiovascular control and regulation.
- To analyse the cardiovascular system's response to physiological and pathological conditions.
- To investigate current and emerging research in cardiovascular health.

Unit 1: Introduction to Cardiovascular System

- **Overview**: Structure and function of the cardiovascular system
- **Subtopics**:
  - Cardiovascular system's role in homeostasis
  - Blood circulation types: systemic, pulmonary, and coronary circulation
  - Cardiovascular system organization and evolution in vertebrates
- **Learning Outcomes**:
  - Understand the overall architecture of the cardiovascular system
  - Trace blood flow through different circulatory circuits

Unit 2: Cardiac Anatomy

- **Overview**: Detailed structure of the heart
- **Subtopics**:
  - Gross anatomy of the heart: chambers, valves, and blood vessels
  - Heart wall layers: epicardium, myocardium, endocardium
  - Cardiac skeleton and fibrous structure
  - Embryological development of the heart
- **Learning Outcomes**:
  - Identify and describe the key anatomical structures of the heart
  - Understand how these structures contribute to cardiac function

Unit 3: Cardiovascular Control Mechanisms

- **Overview**: Neural, hormonal, and local regulation of the heart and blood vessels
- **Subtopics**:
  - Autonomic nervous system (ANS) control: sympathetic and parasympathetic influence
  - Baroreceptor reflex and chemoreceptor reflex
  - Hormonal regulation: renin-angiotensin-aldosterone system (RAAS), vasopressin, and atrial natriuretic peptide (ANP)
  - Local regulatory mechanisms: endothelium-derived factors, nitric oxide

- **Learning Outcomes**:
    - Understand the neural and hormonal control of cardiovascular function
    - Explore the interactions between different regulatory mechanisms

Unit 4: Cardiac Electrophysiology

- **Overview**: Electrical conduction system of the heart
- **Subtopics**:
    - Resting membrane potential and action potentials
    - Sinoatrial (SA) node and atrioventricular (AV) node function
    - Cardiac conduction pathway: Bundle of His, Purkinje fibers
    - Electrocardiogram (ECG) principles and interpretation
- **Learning Outcomes**:
    - Analyse the electrical activity of the heart
    - Understand how the electrical system coordinates heartbeats

Unit 5: Cardiac Muscle Physiology

- **Overview**: Properties of myocardial tissue
- **Subtopics**:
    - Structure of cardiac muscle fibres (striations, sarcomeres)
    - Mechanisms of contraction: excitation-contraction coupling
    - Differences between cardiac and skeletal muscle
    - Cardiac muscle energy metabolism
- **Learning Outcomes**:
    - Understand how cardiac muscle generates force and maintains rhythmic contractions
    - Relate structure to function in cardiac muscle fibres

Unit 6: Hemodynamics and Blood Flow

- **Overview**: Principles governing blood circulation and pressure
- **Subtopics**:
    - Poiseuille's Law and laminar vs. turbulent flow
    - Blood pressure regulation: systolic and diastolic pressure
    - Vascular resistance and compliance
    - Arterial, capillary, and venous blood flow characteristics
- **Learning Outcomes**:
    - Understand factors that affect blood flow and pressure
    - Apply hemodynamic principles to real-world cardiovascular scenarios
    -

Unit 7: Blood Vessels: Structure and Function

- **Overview**: Detailed structure of arterial, venous, and capillary vessels
- **Subtopics**:
    - Types of blood vessels: arteries, veins, arterioles, venules, capillaries
    - Vascular smooth muscle and endothelial cell function
    - Blood vessel remodelling and endothelial dysfunction
    - Mechanisms of nutrient and gas exchange in capillaries

- **Learning Outcomes**:
    - Compare and contrast the structural differences between types of blood vessels
    - Understand how vessel properties contribute to blood flow regulation

Unit 8: Cardiac Cycle and Heart Sounds

- **Overview**: Phases of the cardiac cycle and their physiological significance
- **Subtopics**:
    - Phases: diastole, systole, iso volumetric contraction, and relaxation
    - Heart sounds and their origin (S1, S2, murmurs)
    - Relationship between heart sounds and valve function
- **Learning Outcomes**:
    - Identify the phases of the cardiac cycle
    - Correlate heart sounds with physiological events during the cycle

Unit 9: Cardiovascular Pathophysiology

- **Overview**: Disorders affecting the cardiovascular system
- **Subtopics**:
    - Hypertension: causes, mechanisms, and effects on the heart and vessels
    - Atherosclerosis and coronary artery disease
    - Heart failure: acute vs. chronic, systolic vs. diastolic
    - Arrhythmias: causes and types (e.g., atrial fibrillation, ventricular tachycardia)
- **Learning Outcomes**:
    - Gain in-depth knowledge of common cardiovascular diseases
    - Understand the physiological basis of cardiovascular pathology

Unit 10: Advanced Cardiovascular Topics

- **Overview**: Cutting-edge research and technologies in cardiovascular physiology
- **Subtopics**:
    - Stem cells and regenerative medicine in cardiovascular disease
    - Cardiac biomarkers and their clinical implications
    - Recent advances in cardiovascular imaging techniques
    - Computational modelling of cardiovascular function
- **Learning Outcomes**:
    - Discuss the latest advancements in cardiovascular research and technology
    - Apply new techniques to study cardiovascular health and disease

Recommended Reference Books:

1. Guyton, A. C., & Hall, J. E. (2021). *Textbook of Medical Physiology* (13th ed.). Elsevier.
2. Klabunde, R. E. (2017). *Cardiovascular Physiology Concepts* (2nd ed.). Lippincott Williams & Wilkins.
3. Marieb, E. N., & Hoehn, K. (2018). *Human Anatomy & Physiology* (11th ed.). Pearson.
4. Hille, B. (2001). *Ion Channels of Excitable Membranes* (3rd ed.). Sinauer Associates.
5. Lobo, D. N., & Kinsella, S. (2015). *Textbook of Cardiovascular Medicine* (2nd ed.). Springer.
6. Wiggers, C. J., & West, P. (2020). *Handbook of Cardiovascular Physiology*. Springer.

PHRD102: RADIATION PROTECTION

- **Production of x ray**
  - Thermo ionic emission
  - Excitation and ionisation
  - Characteristic x ray production
  - Bremsstrahlung x ray production

- **Interaction of radiation with matter**
  - Attenuation - absorption, transmission and scattering
  - Coherent scattering
  - Photoelectric effect
  - Compton scattering
  - Pair production
  - Photo disintegration

- **Radiation units and quantities**
  - Exposure
  - Absorbed dose
  - Effective dose
  - Equivalent dose
  - Radioactivity

- **Biological effects of radiation**
  - Maximum permissible dose
  - Stochastic effect
  - Deterministic effect
  - Somatic effect
  - Genetic effect
  - Acute effect
  - Late effect

- **Technical protective consideration in CT**
  - Aim of radiation protection
  - Principles of radiation protection
  - Protection of patient, radiation worker and public from radiation
  - Paediatric and pregnant patient protection

- **Radiation monitoring devices**
  - Ionisation principle
  - Scintillation principle
  - Photographic principle
  - Thermo luminescence
  - Chemical principle
  - Area monitoring devices (GM counter, proportional counter)
  - Personal dosimeters (TLD, OSLD, film badge, pencil dosimeter, frick's dosimeter)

PHRD103: DIAGNOSTIC RADIOLOGY

Introduction to Radiation protection. Need for protection, Aim of radiation protection, Basic radiation units and quantities
_ Exposure
_ Absorbed dose
_ Absorbed dose equivalent
_ Quality factor
_ Tissue weighting factor

Limits for Radiation exposure. Concept of ALARA (or ALARP), Radiation Protection Philosophy, Advanced dose metrics & evaluation tools beyond CTDI & DLP, Automated Dose Tracking & Audit Systems, Advances in CT Dose Reduction.

Protection in Diagnostic Radiology. Protection for primary radiation. Work load. Use factor. Occupancy factor. Protection for scatter radiation and leakage radiation. X-Ray room design. Structural shielding. Protective devices. Radiation signages

Technical protective consideration during Radiography. Evaluation of hazards. Effective communication immobilization. Beam limiting devices. Filtration. Exposure factors. Protection in :
- Fluoroscopy
- Mammography,
- Mobile radiography
- CT Scan
- Angiography room

Radiation measuring instruments. Area monitoring. Personnel dosimeters
- Film badge
- Thermo luminescent dosimeter
- Pocket dosimeter

Direct & Indirect actions of radiation. concept of detriment – Deterministic & stochastic effect of radiation – somatic and genetic effects.

Interventional Radiology & Fluoroscopy Protection, Occupational Radiation Protection Advances, Pediatric & Special Population Protection, Education, Training & Safety Culture, International Guidelines & Regulatory Advances

PHRD201: COMPUTED TOMOGRAPHY- CARDIAC STUDIES

Course Objectives:

1. *To understand the fundamental principles of CT technology and cardiac CT imaging.*
2. To analyse coronary artery disease (CAD) using CT angiography.
3. To evaluate the role of CT in diagnosing and assessing heart conditions, including heart function and anatomy.
4. To explore the significance of epicardial fat and its clinical importance in cardiovascular diseases.
5. To critically review the current literature on the use of CT in cardiology and its evolving role in heart disease diagnostics.

Course Topics:

Unit 1: Introduction to Cardiac Imaging

- Overview of cardiac imaging modalities.
- Historical development of CT in cardiology.
- Principles of CT imaging.
- CT scanners: Types (e.g., single-source vs multi-source CT scanners), image acquisition, and reconstruction techniques.
- Basics of radiation dose management in cardiac CT.

Unit 2: Computed Tomography Technology

- Advanced CT technology: Dual-source CT, 256-slice, 320-slice, and photon-counting CT.
- Image acquisition techniques: Temporal resolution, spatial resolution, and contrast optimization.
- Three-dimensional (3D) reconstruction of the heart and vessels.
- Evaluation of coronary arteries using CT angiography (CTA).
- CT in coronary artery disease (CAD) detection and risk stratification.

Unit 3: Cardiac Anatomy and CT Interpretation

- Detailed anatomical structures: Heart chambers, coronary arteries, and great vessels.
- Normal and abnormal findings in CT of the heart.
- Atherosclerotic plaques, stenosis, and coronary artery anomalies.
- Role of CT in pre-surgical planning and post-procedural follow-up.

Unit 4: CT in Coronary Artery Disease (CAD)

- Non-invasive assessment of coronary artery disease.
- Evaluation of coronary artery calcification and plaque burden.
- Detection of coronary artery disease and assessment of severity.
- Comparison of cardiac CT with other diagnostic tools (e.g., coronary angiography, MRI, and echocardiography).
- Use of CT in assessing myocardial ischemia and infarction.

Unit 5: Epicardial Fat and Cardiovascular Health

- Overview of epicardial fat: Definition, physiology, and localization.
- Role of epicardial fat in cardiovascular diseases: Inflammation, metabolic syndrome, and atherosclerosis.
- Imaging of epicardial fat using CT: Measurement techniques, characteristics, and clinical significance.
- Relationship between epicardial fat and coronary artery disease, hypertension, diabetes, and heart failure.
- Impact of epicardial fat on myocardial function and risk stratification.

Unit 6: Clinical Applications and Research

- Application of CT in the diagnosis and management of arrhythmias.
- CT in heart failure assessment and ventricular remodelling.
- Emerging techniques: CT-based virtual histology, plaque characterization, and risk prediction.
- Research directions: Epicardial fat and cardiovascular risk, artificial intelligence in CT interpretation.
- Challenges in cardiac CT: Artefacts, patient motion, and contrast agents.

Unit 7: Review and Future Trends in Cardiac CT

- Advances in CT imaging technology: Photon-counting CT, artificial intelligence, and machine learning applications.
- Potential future roles of CT in personalized cardiovascular care.
- Ethical considerations and patient safety in cardiac CT imaging.
- Review of the literature on epicardial fat and its role in cardiovascular diseases.

Important Reference Books and Articles:

1. "**Cardiac CT Imaging: Diagnosis of Cardiovascular Disease**" by G. Scott, S. R. Dodd, and J. B. M. Bender.
    - This textbook provides a comprehensive overview of cardiac CT imaging, including coronary artery assessment, cardiac anatomy, and advanced imaging technologies.
2. "**Multidetector-Row CT of the Heart**" by W. J. M. Cademartiri, C. M. K. Nieman, and D. A. Zwerner.
    - A focused resource on multidetector-row CT and its applications in coronary artery disease, as well as detailed imaging techniques and technologies.
3. "**CT Angiography: Principles and Applications**" by M. M. A. S. Joseph.
    - An excellent reference that covers the principles and applications of CT angiography, including CAD diagnosis, coronary artery assessment, and research-related innovations.

4. "**Epicardial Fat: Role in Cardiovascular Diseases**" by A. P. Hekimoglu et al.
    - This research-oriented book addresses the relationship between epicardial fat and cardiovascular diseases, providing valuable insights into its significance and measurement techniques.
5. "**Epicardial Fat and Its Role in Cardiovascular Diseases**" by K. H. T. Kawanishi et al.A detailed analysis of epicardial fat's role in atherosclerosis and its use as a biomarker in cardiovascular disease risk stratification.
6. **Articles in Journals**:
    - "The Role of Epicardial Fat in Cardiovascular Disease" – *Journal of Cardiovascular Imaging*.
    - "Cardiac CT Angiography: Current and Future Applications" – *American Journal of Cardiology*.

PHRD202: BASICS OF CT AND NEUROIMAGING

- **Principles of CT**
  - Detailed analysis of principle of tomography
  - Principle of multiple exposures
  - CT instrumentation

- **Generations of CT**
  - Detailed analysis of 1st to 7th generation of CT
  - Understanding the type of beam, scan geometry
  - Advancements in CT technologies

- **HU value/ CT number**
  - Attenuation in CT
  - Hounsfield scale
  - HU value of different tissues

- **CT artefacts**
  - Causes, appearance and remedy of artefacts
  - Physics-based; beam hardening and partial volume artefact
  - Patient-based; motion and metal artefact
  - Scanner-related; ring and noise artefact
  - Helical/Multi-slice; stair and step artefact

- **CT instrumentation**
  - Gantry
  - CT detector
  - X ray tube
  - DAS
  - Patient couch

- **CT brain protocol**

  Detailed understanding of indication, contra indication, patient preparation, patient positioning, scanning protocol, after care in a CT brain scan

PHRD203: COMPUTED TOMOGRAPHY

Imaging principles in computed tomography. Instrumentation of CT scan. Advances in Detector technology. Slip ring technology. Helical CT, Single slice and Multi slice CT Scan system

Recent advances in CT Dual-Energy & Spectral CT, Photon-Counting CT, AI & Deep Learning in CT, Advanced Iterative & Deep Learning Reconstruction. Ultra-Low-Dose CT Protocols, High-Speed & Wide-Detector CT, CT Perfusion & Functional Imaging, Advanced Cardiac CT.

CT angiography. CT fluoroscopy. Multidimensional reformations. MPR, Curved MPR, MIP 3D imaging & 4D CT

CT coronary angiography. CT calcium scoring Myocardial Imaging

CT Artefacts and remedies, Protocols for adult KUB. Protocols Phases of CT Urography / Nephrographic phase and delay phase.Protocols for HCC & RCC KUB with different delayed imaging in CT

Kidney, ureter urinary bladder, Male and female urethra. Histology of kidney, ureter and urinary bladder. Types of Contrast media used in CT – Imaging

PHRD301: ANATOMY AND PHYSIOLOGY OF BRAIN

Unit 1: **Introduction to Neuroscience and Brain Structure**

- **Overview of the Central Nervous System (CNS)**
  - The role of the brain in the nervous system.
  - Basic divisions of the CNS: Brain and spinal cord.
  - Overview of the peripheral nervous system (PNS) and its relationship with the brain.
- **Gross Anatomy of the Brain**
  - Development of the brain: Embryology of the nervous system.
  - Major structures: Cerebrum, cerebellum, brainstem, diencephalon.
  - Anatomical landmarks: Gyri, sulci, ventricles, etc.
  - Functional divisions: Frontal, parietal, temporal, occipital lobes.
- **Histology of the Brain**
  - Types of neurons and glial cells.
  - Synapses, neurotransmitters, and receptor systems.
  - Blood-brain barrier.

Unit 2: Neural Circuits and Pathways

- **Neural Signalling and Transmission**
  - Resting membrane potential and action potential.
  - Synaptic transmission and neurotransmitters.
  - Electrical properties of neurons.
- **Descending and Ascending Pathways**
  - Motor pathways: Corticospinal tract, basal ganglia circuit.
  - Sensory pathways: Dorsal column-medial lemniscal pathway, spinothalamic tract.
- **Cerebrospinal Fluid (CSF) and Blood Supply**
  - Production, circulation, and function of CSF.
  - Blood supply to the brain: Circle of Willis, carotid and vertebral arteries.
  - Ischemia and its impact on brain function.

Unit 3: **Functional Neuro-Anatomy**

- **Cerebral Cortex and Higher Functions**
  - Motor and sensory cortex functions.
  - Association areas: Language, memory, and cognition.
  - Role of the prefrontal cortex in decision-making and behaviour.
- **Limbic System and Emotions**
  - Anatomy of the limbic system: Hippocampus, amygdala, cingulate gyrus.
  - Emotional regulation and memory formation.
- **Basal Ganglia and Movement Disorders**
  - Role in motor control and coordination.
  - Disorders: Parkinson's disease, Huntington's disease.

Unit 4: Autonomic Nervous System and Brainstem

- **Autonomic Nervous System (ANS)**
  - Sympathetic vs. parasympathetic nervous systems.
  - Brain centres controlling autonomic functions.
  - Autonomic regulation of cardiovascular, respiratory, and digestive systems.
- **Brainstem and Cranial Nerves**
  - Structure and function of the brainstem: Midbrain, pons, medulla.
  - Cranial nerves and their functions.
  - Brainstem reflexes: Pupil reflex, cough reflex, etc.

Unit 5: Neurophysiology of Sensory and Motor Systems

- **Sensory Systems**
  - Visual system: Anatomy of the eye and the visual pathways.
  - Auditory system: Anatomy of the ear and auditory pathways.
  - Somatosensory system: Touch, temperature, pain, and proprioception.
- **Motor Systems**
  - Mechanisms of voluntary movement.
  - Role of the cerebellum in motor control and coordination.
  - Integration of sensory and motor systems.

Unit 6: Pathophysiology and Clinical Aspects

- **Neurological Disorders**
  - Stroke: Mechanisms, clinical signs, and management.

    - Neurodegenerative diseases: Alzheimer's, Parkinson's, Multiple sclerosis.
    - Traumatic brain injury: Mechanisms and outcomes.
- **Neuroplasticity and Brain Repair**
    - Mechanisms of brain adaptation and recovery after injury.
    - Brain’s ability to reorganize and compensate for damage.
- **Psychiatric Disorders and Brain Function**
    - Neuroanatomical and neurochemical bases of depression, schizophrenia, and anxiety disorders.

Unit 7: Experimental Techniques in Brain Research

- **Imaging Techniques**
    - MRI, CT, PET, and fMRI: Principles and applications in brain research.
- **Electrophysiological Techniques**
    - EEG, EMG, and evoked potentials.
    - Techniques for studying brain activity.

Reference Books:

1. "**Neuroanatomy through Clinical Cases**" by Hal Blumenfeld.
2. "**Clinical Neuroanatomy**" by Snell.
3. **Neurophysiology: A Conceptual Approach**" by Edmund A. C. C. L. Barajas.
4. "**Neuroscience: Exploring the Brain**" by Mark F. Bear, Barry W. Connors, Michael A. Paradiso.
5. **The Human Brain Book**" by Rita Carter.
6. "**Neuroanatomy: An Atlas of Structures, Sections, and Systems**" by Duane E. Haines.
7. **Human Physiology: An Integrated Approach**" by Dee Unglaub Silverthorn.
8. "**Neuroanatomy: A Review**" by Joseph F. L. Pardo.
9. "**Principles of Neural Science**" by Eric R. Kandel, James H. Schwartz, Thomas M. Jessell.
10. "**Neurophysiology: A Functional Approach**" by Steven P. Gilbert.
11. "**Neurology and Neurosurgery at a Glance**" by Geraint Fuller, Oliver J. K. R. Manji, and Mark S. McNally.
12. "**Clinical Neurology**" by David A. Greenberg, Roger P. Simon.
13. **Neuroimaging: A Clinical Atlas**" by John C. Mazziotta.
14. "**Fundamentals of Neuroimaging**" by K. M. Z. Shahid.

PHRD302: MRI BASIC AND SPINE IMAGING

I. Principles of MRI and NMR

1. Basic concepts of Nuclear Magnetic Resonance
2. Nuclear spin and magnetic moment
3. Proton behaviour in a magnetic field
4. Precession and Larmor Frequency
5. Alignment of protons in external magnetic field
6. Excitation and relaxation processes
7. Signal formation in MRI

II. MRI Signal and Relaxation

1. Magnetization (longitudinal and transverse)
2. Free Induction Decay (FID)
3. Relaxation mechanisms:
   - T1 Relaxation (longitudinal recovery)
   - T2 Relaxation (transverse decay)
   - T2* effects (magnetic field inhomogeneity)
1. Spin echo and gradient echo signal formation
2. Contrast generation through TR and TE
3. Factors affecting relaxation times

III. MRI System Components

1. Main magnet system-Function and field strength
2. Gradient system -X, Y, Z gradient coils
3. -Spatial encoding
4. RF system -RF transmit coil
5. -RF receive coils
6. Computer system and image reconstruction
7. Shielding: RF shielding
8. Magnetic shielding
9. Patient table and accessories

IV. Types of MRI Magnets and Sequences

1. Types of Magnets
   - Permanent magnets
   - Resistive magnets
   - Superconducting magnets
   - Open vs closed MRI systems
   - Field strengths (low field vs high field)

2. Pulse Sequences
   - Spin Echo (SE)

- Fast Spin Echo (FSE)
- Gradient Echo (GRE)
- Inversion Recovery (IR)
- Echo Planar Imaging (EPI)
- Diffusion sequences
- Perfusion sequences

V. Image Weighting and Artifacts

Image Weighting

1. T1-weighted imaging
2. T2-weighted imaging
3. Proton density weighting
4. Role of TR and TE in image contrast
5. Common MRI Artifacts
6. Motion artifacts
7. Aliasing (wrap-around)
8. Chemical shift
9. Susceptibility artifacts
10. Ghosting
11. Truncation artifacts
12. Flow artifacts
13. Metal artifacts

VI. Advantages and Limitations of MRI

Advantages

1. Excellent soft tissue contrast
2. No ionizing radiation
3. Multiplanar imaging capability
4. Functional imaging (fMRI, diffusion, perfusion)
5. High spatial resolution
6. Limitations
7. High cost and maintenance
8. Long scan times
9. Contraindications (metal implants, pacemakers)
10. Claustrophobia issues
11. Motion sensitivity
12. Acoustic noise

PHRD303: CT THORAX

Principles of CT Image Formation

1. Physics of CT image acquisition
2. Detector technology and MDCT systems
3. Factors affecting image quality in chest CT (Spatial, contrast, and temporal resolution
4. Noise, signal-to-noise ratio (SNR), and contrast-to-noise ratio (CNR)

Chest CT Protocols and Techniques

1. Routine chest CT protocols
2. High-Resolution CT (HRCT): indications, technique, and limitations
3. Low-dose CT protocols for chest imaging
4. Paediatric and special population protocols

Image Reconstruction Algorithms

1. Filtered back projection (FBP)
2. Iterative reconstruction (IR): statistical and model-based techniques
3. Impact of reconstruction algorithms on image noise and resolution

Image Quality Assessment in Chest CT

1. Objective and Subjective image quality parameters
2. Quantitative analysis of noise and resolution
3. Role of reconstruction algorithms in dose reduction

Pulmonary Nodule Detection and Characterization

1. CT appearance of pulmonary nodules
2. Solid, subsolid, and ground-glass nodules
3. Factors influencing nodule detectability
4. Effect of dose reduction and reconstruction methods on nodule detection

HRCT versus Routine Chest CT

1. Technical differences between HRCT and routine CT
2. Diagnostic performance of HRCT in diffuse lung diseases
3. Comparative role in pulmonary nodule evaluation
4. Image quality and radiation dose considerations
5. Indications and limitations of each technique

Research Methodology in Chest CT

1. Study design for dose and image quality optimization

2. Statistical methods for image quality and diagnostic performance
3. ROC analysis and observer performance studies
4. Ethical considerations in CT-based research

PHRD401: PSYCHOLOGICAL CONSIDERATION- DISEASE STATUS.

Course Objectives:

- Understand the mechanisms of brain plasticity in response to various types of injuries.
- Evaluate the role of psychological factors in neuroplasticity and recovery processes.
- Analyse the impact of neurological diseases (such as stroke, TBI, neurodegenerative disorders) on brain plasticity.
- Critically assess experimental and clinical studies in brain plasticity, particularly in the context of recovery post-injury.
- Apply knowledge of brain plasticity to psychological interventions and rehabilitation strategies.

UNIT: 1 Introduction to Brain Plasticity

- Overview of neuroplasticity: Definitions, history, and significance.
- Mechanisms of neuroplasticity: Synaptic plasticity, structural plasticity, and functional plasticity.
- Types of brain injuries: Traumatic brain injury (TBI), stroke, neurodegenerative diseases**.**

UNIT 2: Neuro-anatomy of Brain Injuries

- Brain structure and function: Cerebral cortex, subcortical structures, hippocampus, and more.
- Impact of injury on the brain: Structural and functional consequences.
- Case studies: TBI and stroke-related structural changes.

UNIT 3: Psychological Considerations in Brain Injury

- Cognitive and emotional consequences of brain injury.
- Psychological effects of TBI, stroke.
- The role of cognitive rehabilitation in neuroplasticity.

UNIT 4: Neuroplasticity Following Traumatic Brain Injury (TBI)

- Pathophysiology of TBI and subsequent neuroplasticity.
- Mechanisms of recovery and reorganization after TBI.
- Case studies of recovery in TBI patients.

UNIT 5: Stroke and Neuroplasticity

- The effect of stroke on brain regions: Hemispheric dominance, motor and sensory deficits.
- Mechanisms of plasticity in stroke rehabilitation.
- Behavioural therapies and their impact on brain reorganization

UNIT 6: Neuroplasticity in Children and Aging Populations

- Brain plasticity in children: Higher potential for recovery.
- Aging and its impact on neuroplasticity.
- Developmental vs. age-related neuroplasticity differences.

UNIT 7: The Role of Environmental Factors in Neuroplasticity

- Impact of environment on brain injury recovery: Enriched environments vs. standard care.
- Psychological aspects of environmental influence: Motivation, support systems, and cognitive stimulation.
- Social and emotional aspects in rehabilitation.

UNIT 8: Psychological Interventions for Enhancing Neuroplasticity

- Cognitive therapies: Neuro-feedback, cognitive behavioural therapy (CBT), and their role in recovery.
- Role of motivation and self-efficacy in brain injury rehabilitation.
- Case studies and clinical practices in neuroplasticity-based psychological interventions.

UNIT 9: Mechanisms of Neurogenesis and Synaptic Plasticity

- Neurogenesis in response to injury and repair.
- Synaptic plasticity mechanisms: Long-term potentiation (LTP) and long-term depression (LTD).
- Experimental models and findings in neurogenesis.

UNIT 10: Integrative Case Studies and Clinical Applications

- □ examining real-world case studies of patients with brain injuries and neurological diseases.
- □ Applying principles of brain plasticity to rehabilitation and therapy.
- □ integrating psychological considerations in treatment protocols.

Key References:

1) "Principles of Neural Science" by Eric Kandel, James Schwartz, and Thomas Jessell
2) "Neuroplasticity: New Approaches in Neuroscience" by Moheb Costandi
3) Cognitive Rehabilitation of Brain Injury: A Practitioner's Handbook" by Robert S. McMillan
4) Psychological Aspects of Brain Injury" by Wayne A. Oakes and Timothy J. Doyle
5) Neuroplasticity and Brain Repair: From Bench to Bedside" by Masato T. Tominari
6) "Neurodegenerative Diseases and Brain Injury: Mechanisms and Therapies" by Barbara J. Stricker
7) Brain Injury: A Clinical Approach" by M. G. Feeney and A. W. Tham
8) "Principles of Functional MRI" by Peter Jezzard, Peter Matthews, and Stephen M. Smith
9) The Handbook of Rehabilitation Psychology" by Patricia A. Fitts and Wayne L. Forreste
10) Brain-Computer Interfacing: An Introduction" by Rajesh P. N. Rao

PHRD402: MRI SAFETY

I. **Introduction to MRI Safety**
- Basic principles of MRI
- Importance of safety in MRI environment
- International safety standards

II. **Static Magnetic Field Hazards**
- Nature and strength of static magnetic field
- Projectile effect
- Biological effects
- Safety measures

III. **Gradient Magnetic Field Effects**
- Function of gradient coils in spatial encoding
- Time-varying magnetic fields
- Biological effects
- Acoustic noise
- Regulatory limits and safety thresholds

IV. **Radiofrequency (RF) Heating and SAR**
- RF energy deposition in tissues
- Concept of Specific Absorption Rate (SAR)
- Factors affecting SAR
- Thermal effects and tissue heating
- Monitoring and safety limits

V. **Safety of Implants and Medical Devices in MRI**

VI. **MRI Contrast Agent Safety**
- Types of contrast agents
- Pharmacokinetics and mechanism
- Type of reactions
- Gadolinium deposition concerns
- Contraindications and precautions
- Patient consent and emergency preparedness

VII. **MRI Safety Zones and Guidelines**
- Four-zone concept.
- Signage and labeling standards

VIII. **Recent Advances and Research in MRI Safety**
- High-field MRI (7 Tesla and above)
- AI in safety monitoring
- New implant technologies

PHRD403: RADIATION SAFETY AND THORACIC ANATOMY & PHYSIOLOGY

Unit I: Radiation Physics Relevant to Chest CT

- X-ray production and interaction with tissues
- Radiation dose units and measurements
- CT dose indices: CTDIvol, DLP, effective dose
- Factors affecting patient dose in chest CT

Unit II: Radiation Biology and Risk Assessment

- Cellular effects of ionizing radiation
- Deterministic and stochastic effects
- Organ-specific radiation sensitivity (lung, breast, thyroid)
- Radiation risk in repeated chest CT examinations

Unit III: Dose Optimization in Chest CT

- ALARA principle
- Automatic exposure control (AEC)
- Tube current and voltage modulation
- Iterative reconstruction and dose reduction
- Dose optimization strategies in HRCT and routine CT

Unit IV: Dose Audit and Quality Assurance

- Concepts of dose audit in CT
- Diagnostic reference levels (DRLs)
- Dose tracking and monitoring systems
- National and international guidelines (ICRP, AERB)
- Quality assurance programs in CT practice

Unit V: Thoracic Anatomy Relevant to CT

- Bronchopulmonary segments
- Secondary pulmonary lobule anatomy
- Mediastinal anatomy and lymph node stations
- Pleura and interstitial
- Vascular anatomy relevant to chest CT

Unit VI: Cross-Sectional and Radiological Anatomy

- CT anatomy of lungs, airways, and mediastinum
- Anatomical basis of HRCT findings

Unit VII: Physiology of Respiration

- Lung volumes and mechanics
- Ventilation and perfusion
- Gas exchange
- Physiological basis of CT imaging appearances

Unit VIII: Clinic radiological and Pathophysiological Correlation

- Anatomical basis of pulmonary nodules
- Physiological correlates of diffuse lung disease
- Imaging correlation with pulmonary function tests
- Functional implications of CT findings