GURU KASHI UNIVERSITY

Masters of Science in Radiology and Imaging Technology

PG Curriculum (Appendix-III)

Session: 2025-26

Faculty of Health & Allied Sciences

Graduate Attributes of the Programme: -Masters of Science in Radiology and Imaging Technology

Type of learning outcomes	**The Learning Outcomes Descriptors**
Graduates should be able to demonstrate the acquisition of:	
Learning outcomes that are specific to disciplinary/inter disciplinary areas of learning	Demonstrate in-depth understanding of various radiological imaging techniques, including X-ray, CT, MRI, ultrasound, nuclear medicine, and interventional radiology.
	Explain the principles of radiation physics, image acquisition, reconstruction, and quality assessment.
	Understand contrast media and their applications in enhancing imaging diagnostics.
	Apply advanced knowledge of radiological anatomy and pathology for accurate diagnosis.
Generic learning outcomes	Critical Thinking & Problem-Solving Skills Apply analytical skills to interpret complex medical images and detect abnormalities.
	Develop decision-making abilities in radiology-based clinical scenarios.
	Troubleshoot technical and operational challenges in imaging systems.
	Demonstrate effective communication with radiologists, physicians, and healthcare teams.
	Educate patients about imaging procedures, risks, and safety measures.
	Present research findings and clinical cases in academic and professional settings.
	Operate advanced imaging software and PACS systems for digital radiology.
	Utilize AI-based tools for image enhancement and analysis.
	Adapt to new advancements in radiology technology through continuous learning.

Programme learning outcomes: A post graduate degree is awarded to students who have demonstrated the achievement of the outcomes located at level 6:

Element of the Descriptor	**Programme learning out comes relating to Post graduate degree (2years)**
The Post graduates should be able to demonstrate the acquisition of:	
Knowledge and understanding	Demonstrate advanced theoretical and practical knowledge in radiological imaging technology, including X-ray, CT, MRI, ultrasound, nuclear medicine, and interventional radiology.
	Understand the principles of radiation physics, image acquisition, and quality control.
	Explain human anatomy, physiology, and pathology, with a focus on diagnostic and interventional imaging applications.
	Interpret biomedical signals and digital image processing techniques to enhance image accuracy and diagnostics.
General, technical and professional skills required to perform and accomplish tasks	Operate and troubleshoot advanced imaging modalities, ensuring optimal performance and accuracy.
	Implement radiation safety protocols and follow international guidelines (ICRP, AERB, NCRP) to minimize risks to patients and staff.
	Demonstrate proficiency in contrast media usage, image enhancement techniques, and post-processing methods.
	Perform image-guided interventional procedures and assist radiologists in diagnostic and therapeutic applications.
Application of knowledge and skills	Apply evidence-based practices to diagnose and manage diseases using medical imaging techniques. Integrate clinical, anatomical, and pathological knowledge for accurate radiological interpretation. Utilize machine learning and artificial intelligence (AI) algorithms to enhance imaging diagnostics. Conduct independent research to develop new imaging techniques and optimize existing ones. Implement quality assurance programs in radiology departments to maintain imaging efficiency and compliance.
Generic learning outcomes	Exhibit critical thinking and problem-solving skills in radiology-based clinical scenarios. Demonstrate effective communication with radiologists,

	clinicians, and patients regarding imaging procedures and findings. Work in multidisciplinary teams, contributing to collaborative healthcare solutions. Adapt to technological advancements in radiology and engage in continuous professional development. Develop leadership qualities to manage radiology departments, imaging centers, and research teams.
Constitutional, humanistic, ethical, and moral values	hold ethical standards in radiology practice, including patient confidentiality, informed consent, and radiation ethics. Adhere to legal and regulatory frameworks governing medical imaging and radiation safety. Respect cultural and social diversity in healthcare delivery and patient interactions. Practice compassion and empathy while handling patients undergoing diagnostic procedures.
Employability and job-ready skills, and entrepreneurship skills and capabilities/qualities and mindset	Demonstrate job-ready skills for careers in hospitals, diagnostic centers, research institutions, and academia. Possess entrepreneurial mindset to establish and manage diagnostic imaging centers and healthcare startups. Understand business models in radiology, including healthcare management, cost-effectiveness, and medical imaging economics.
Credit requirements	First 2 semesters of 2-year PG programme and earns 44 credits, then a Post Graduate Diploma in Radiology Imaging Technology will be awarded.
Entry requirements	3-year Bachelor's Degree in allied health sciences/life sciences

Program Structure

SEMESTER: 1st									
Course Code	**Course Title**	**Type of Courses**	**L**	**T**	**P**	**No. of Credits**	**Int.**	**Ext.**	**Total Marks**
MRI1400	Radiological & Imaging Procedures	Core Course	4	0	0	4	30	70	100
MRI1401	Radiation Safety & Protection	Core Course	4	0	0	4	30	70	100
MRI1402	Newer Imaging Modalities	Core Course	4	0	0	4	30	70	100
MRI1403	Radiological Techniques I	Practicum	0	0	8	4	30	70	100
MRI1404	Indian Cultural Studies	IKS	2	0	0	2	15	35	50
Discipline Elective (Any one of the following)									
MRI1405	Mammography & USG	Disciplinary Elective	4	0	0	4	30	70	100
MRI1406	Pediatric Radiology								
Total			**18**	**0**	**8**	**22**	**165**	**385**	**550**

SEMESTER: 2nd									
Course Code	**Course Title**	**Type of Courses**	**L**	**T**	**P**	**No. of Credits**	**Int.**	**Ext.**	**Total Marks**
MRI2450	Advanced Technique & Instrumentation of MRI	Core Course	4	0	0	4	30	70	100
MRI2451	Management & Planning of Radiology Dept.	Core Course	4	0	0	4	30	70	100
MRI2452	CT and MRI Protocols	Core Course	4	0	0	4	30	70	100
MRI2453	Radiological Techniques II	Practicum	0	0	8	4	30	70	100
MRI2454	Project I	Skill Based	0	0	4	2	15	35	50
Discipline Elective (Any one of the following)									
MRI2455	Care & maintenance of diagnostic equipment/ instruments	Disciplinary Elective	4	0	0	4	30	70	100
MRI2456	General Patient Care in Hospital								
Total			**16**	**0**	**12**	**22**	**165**	**385**	**550**

Programme learning outcomes: A post graduate degree is awarded to students who have demonstrated the achievement of the outcomes located at level 6.5:

Element of the Descriptor	**Programme learning out comes relating to Post graduate degree (2years)**
The Post graduates should be able to demonstrate the acquisition of:	
Knowledge and understanding	Demonstrate in-depth knowledge of radiological imaging techniques, including X-ray, CT, MRI, ultrasound, nuclear medicine, and interventional radiology.
	Explain the fundamentals of radiation physics, imaging protocols, and quality control measures.
	Interpret human anatomy, physiology, and pathology in relation to radiological imaging and diagnostics.
	Apply contrast-enhanced imaging techniques and functional imaging for improved disease detection.
	Stay updated with emerging technologies such as AI-assisted diagnostics, hybrid imaging (PET-CT, PET-MRI), and functional MRI (fMRI).
	Operate and optimize advanced imaging modalities with precision and efficiency.
General, technical and professional skills required to perform and accomplish tasks	Apply image reconstruction, post-processing, and enhancement techniques for improved diagnostic accuracy.
	Demonstrate competency in radiation safety, adhering to ICRP, AERB, NCRP guidelines.
	Assist in image-guided interventional procedures, including angiography, biopsies, and catheter-based interventions.
	Implement evidence-based practices to improve diagnostic accuracy in medical imaging. Integrate clinical, anatomical, and pathological knowledge for precise radiological reporting. Utilize AI-driven tools and machine learning models to enhance medical imaging interpretations. Develop and implement new imaging techniques to optimize patient diagnosis and care
Application of knowledge and skills	Exhibit critical thinking and problem-solving skills in clinical radiology cases. Communicate effectively with radiologists, physicians, and healthcare teams.

	Work collaboratively in multidisciplinary healthcare environments. Adapt to technological advancements in radiology and engage in continuous professional development.
Generic learning outcomes	Uphold ethical principles in radiology practice, including patient confidentiality and informed consent. Adhere to legal and professional regulations governing radiation safety and medical imaging. Promote compassionate patient care, ensuring comfort and safety during imaging procedures.
Constitutional, humanistic, ethical, and moral values	Acquire job-ready skills for roles in hospitals, diagnostic centers, research institutions, and academia. Develop an entrepreneurial mindset for establishing diagnostic imaging centers and healthcare startups. Understand business models and healthcare management in radiology imaging technology.
Employability and job-ready skills, and entrepreneurship skills and capabilities/qualities and mindset	Understanding of market needs, healthcare economics, and business models for imaging centers. Budgeting, equipment procurement, and cost-effective operation of radiology labs. Licensing requirements (AERB, NABH), legal frameworks, and ethical standards. Implementing cloud-based PACS, tele-radiology platforms, and digital health solutions.
Credit requirements	A 1 year / 2 semester Master's programme builds on a bachelor's with Honors/ Honors with research and requires 44 credits for individuals who have complete a Bachelor's degree (Honors/ Honors with research). A 2-year/4-semester Master's Programme builds on a 3-year/6 semester Bachelor's degree and requires a total of 88 credits from the first and second years of the Programme, with 44 credits in the first year and 44 credits in the second year of the Programme at level 6.5 on the NHEQF.
Entry requirements	4-year Bachelor's degree (Honors / honors with research) of Allied health science / Life science

SEMESTER: 3rd									
Course Code	**Course Title**	**Type of Courses**	**L**	**T**	**P**	**No. of Credits**	**Int.**	**Ext.**	**Total Marks**
MRI3500	Recent Advancement in Modern Imaging Technology	Core Course	4	0	0	4	30	70	100
MRI3501	Quality Assurance And Quality Control	Core Course	4	0	0	4	30	70	100
MRI3502	Dissertation I	Compulsory	0	0	0	12	200	100	300
MRI3503	Project II	Skill Based	0	0	4	2	15	35	50
Total			**8**	**0**	**4**	**22**	**275**	**275**	**550**

SEMESTER: 4th									
Course Code	**Course Title**	**Type of Courses**	**L**	**T**	**P**	**No. of Credits**	**Int.**	**Ext.**	**Total Marks**
MRI4550	Research Methodology and Biostatistics	Core Course	4	0	0	4	30	70	100
MRI4551	Dissertation II	Skill Based	0	0	0	12	200	100	300
MRI4552	Employability and Entrepreneurship in Radiology	Skill Based	2	0	0	2	15	35	50
Discipline Elective (Any one of the following)									
MRI4553	Biomedical Instrumentation	Disciplinary Elective	4	0	0	4	30	70	100
MRI4554	Research Publication Ethics and Intellectual Property Right								
Total			**10**	**0**	**0**	**22**	**275**	**275**	**550**
Grand Total			**52**	**0**	**24**	**88**	**880**	**1,320**	**2,200**

1st SEMESTER

Course Title: Radiological & Imaging Procedures	L	T	P	Cr.
Course Code: MRI1400	4	0	0	4

Total Hours 60

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Understand the responsibility of radiographer during radiological procedures.
2. Learn the basic techniques and their correlation with other techniques of the subsequent special procedures.
3. Classify the various types of contrast media used in radiology.
4. Determine appropriate patient interaction and preparation for all Radiographic examinations and procedures maintaining the principle of sterile technique and execute the knowledge of c-arm and manipulation.
5. Understanding the principles, applications, and limitations of X-ray, CT, MRI, ultrasound, PET-CT, fluoroscopy, and interventional radiology.

Course Contents

UNIT-I **14 Hours**

Special Radiographic/Radiological procedures: Selection of Fluoroscopy Equipment, general considerations, responsibility of radiographers. Patient Preparation, Indications Contraindications Technique Post Care and Preparation of Drug Trolley/Tray, Radiation Safety, Contrast Media - Positive and Negative, Ionic & Non – Ionic, Adverse Reactions To Contrast Media and Patient Management, Emergency Drugs in the Radiology Department, Aseptic technique for the following procedures, Gastrointestinal Tract: Barium swallow, pharynx and esophagus. Barium meal and follow through. Hypotonic duodenography. Small bowel enema. Barium Enema routine projections for colon and rectum, colonic activators; double contrast studies; colostomy. Special techniques for specific disease to be examined. Including water soluble contrast media - e.g.gastrographin studies. Including CT, US and MRI Special Imaging Techniques, Salivary glands: Routine technique, procedure - Sialography.

UNIT-II **16 Hours**

Biliary system: Plain film radiography. Intravenous cholangiography. Percutaneous cholangiography, Endoscopic retrograde cholangio-pancreatography (ERCP), Operative cholangiography, Post-Operative cholangiography (T-tube Cholangiography). Including CT, US and MRI23

Special Imaging Techniques, Urinary system: Intravenous urography, retrograde pyelography. Antegrade pyelography. Cystography and micturating cystourethrography, Urethrography (ascending) renal puncture. Including CT, US and MRI23 Special Imaging Techniques, Reproductive system: All the Techniques relating to Male and Female reproductive system including Hysterosalpingography, Breast Imaging: Mammography: Basic views, special views, wire localization. Ductography, Tomosynthesis, ABVS, Various Biopsy Techniques including Prone Table Biopsy, CT, US and MRI23 Special Imaging Techniques

UNIT-III **16 Hours**

Respiratory system: - Bronchography: Including CT, US and MRI23 Special Imaging Techniques, Sinography: Routine technique and procedure, Central Nervous System: Myelography. Cerebral studies. Ventriculography etc including CT, US and MRI23 Special Imaging Techniques, Arthrography: Shoulder, Hip, Knee, Elbow joints etc. including CT, US and MRI23 Special Imaging Techniques, Angiographic Studies: Carotid Angiography (4 Vessel angiography). Thoracic and Arch Aortography, Selective studies: Renal, SMA, Coeliac axis. Vertebral angiography femoral arteriography. Angiocardiography, Peripheral angiography

UNIT-IV **14 Hours**

Venography: Peripheral venography. Cerebral venography. Inferior and superior venocavography. Relevant visceral phlebography, Microbiology: Introduction and morphology - Introduction of microbiology, Classification of microorganisms, size, shape and structure of bacteria. Use of microscope in the study of bacteria. Growth and nutrition -nutrition, culture media, types of medium with example and uses of culture media in diagnostic bacteriology, antimicrobial sensitivity test Sterilization and disinfection - principles and use of equipment's of sterilization namely hot air oven, autoclave and serum inspissator, pasteurization, anti-septic and disinfectants. Introduction to immunology, bacteriology, parasitology, mycology.

Transactional modes: Video based teaching, Collaborative teaching, Case based teaching, Question-Answer

Suggested Readings

- *Berlin, L. (1994). A Guide to Radiological Procedures. Radiology, 191(2), 506- 506.Chapman, S., &Nikielny, R. (1986). A guide to radiological procedures.*
- *Gupta, A. K., Garg, A., & Khandelwal, N. (2017).Diagnostic Radiology:*
- *Gastrointestinal and Hepatobiliary Imaging. JP Medical Ltd.*

Course Title: Radiation Safety & Protection	L	T	P	Cr.
Course Code: MRI1401	4	0	0	4

Total Hours: 60

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Perform the basic construction and handling of safety equipment's against radiation.
2. Acquire the basic knowledge of Radiation Protection, biological effects of radiation.
3. Understand various biological effects of radiation.
4. Explain various dose fractionations.
5. Radiation detection and measurement instruments (Geiger-Müller counter, dosimeters)

Course Contents

UNIT-I **14 Hours**

Radiation safety in diagnostic Radiology Introduction to Radiation Protection-Need for protection, Aim of radiation protection Limits for radiation exposure: Concept of ALARA, maximum permissible dose, exposure in pregnancy, children. Occupational Exposure Limits - Dose limits to public Radiation Protection in: Radiography, Fluoroscopy, Mammography, Mobile Radiography, CT scan, DSA and Interventional Radiology. Radiation measuring instruments: survey meters, area monitor, personnel dosimeters, film badge, thermo luminescent dosimeter, pocket dosimeter. Radiation Quantities and Units: Radiation, Radioactivity, Sources of radiation -natural radioactive sources, cosmic rays, terrestrial radiation, manmade radiation sources. Kerma, Exposure, Absorbed dose, Equivalent Dose, Weighting Factors, Effective Dose

UNIT-II **14 Hours**

Biological Effects of radiation -Direct & Indirect actions of radiation ,concept of detriment, Deterministic & stochastic effect of radiation ,somatic and genetic effects, dose relationship , effects of antenatal exposure Ionization, excitation and free radical formation, hydrolysis of water, action of radiation on cell-Chromosomal aberration and its application for the biological dosimetry- Effects of whole body and acute irradiation, dose fractionation, effects of ionizing radiation on each of major organ system including fetus - Somatic effects and hereditary effects- stochastic and deterministic effects-Acute exposure and chronic exposure-LD50 - factors affecting radio sensitivity. Biological effects of non-ionizing radiation like ultrasound, lasers, IR, UV and magnetic fields.

Newer Radiation safety protocols and recent advances in radiation safety: Role

of Radiographer in Planning & Radiation Protection: Role of technologist in radiology department - Personnel and area monitoring., Setting up of a new X-Ray unit, staff requirement, AERB specifications for site planning and mandatory guidelines –Planning of X-ray/CT rooms, Inspection of X-Ray installations - Registration of X-Ray equipment installation- Certification - Evaluation of workload versus radiation factors –Occupational exposure and protection Tools/devices.

UNIT-III **16 Hours**

Radiation detection and Measurements: Ionization of gases, Fluorescence and Phosphorescence, Effects on photographic emulsion. Ionization Chambers, proportional counters, G.M counters, scintillation detectors, liquid semiconductor detectors, Gamma ray spectrometer. Measuring systems: free air ionization chamber, thimble ion chamber, condenser chamber, Secondary standard dosimeters, film dosimeter, chemical dosimeter thermo-luminescent Dosimeter, Pocket dosimeter, Radiation survey meter- wide range survey meter, zone monitor, contamination monitor -their principle function and uses. Advantages & disadvantages of various detectors & appropriateness of different detectors for different type of radiation measurement

Regulatory Bodies & regulatory Requirements: International Commission on Radiation Protection (ICRP) / National Regularity body (AERB - Atomic Energy Regulatory Board) - Responsibilities, organization, Safety Standard, Codes and Guides, Responsibilities of licenses, registrants & employers and Enforcement of Regulatory requirements. (ICRP, NRPB, NCRP and WHO guidelines for radiation protection, pregnancy and radiation protection).

UNIT-IV **16 Hours**

Dose and Dosimetry - CT Dose Index (CTDI, etc.), Multiple Scan Average Dose (MSAD), Dose Length Product (DLP), Dose Profile, Effective Dose, Phantom Measurement Methods, Dose for Different Application Protocols, Technique Optimization, Dose area product in fluoroscopy and angiography systems, AGD in mammography, Radiation protection, Hazard evaluation and control:Philosophy of Radiation protection Radiation protection of self and patient and General Public, Principles of radiation protection, time - distance and shielding, shielding - calculation and radiation survey, Calculation of Work load, weekly calculated dose to radiation worker & General public Good work practice in Diagnostic Radiology, Planning consideration for radiology, including Use factor, occupancy factors, and different shielding materials Protection for primary radiation, work load, use factor, occupancy factor, protection from scatter radiation and leakage radiation. X-Ray /Fluoroscopy /Mammography/ Intervention /DSA/CT room design, structural shielding, and protective devices.

Transactional modes: Video based teaching, Collaborative teaching, Case based teaching, Question-Answer

Suggested Readings:

- *Sherer, M. A. S., Visconti, P. J., Ritenour, E. R., & Kelli Haynes, M. S. R. S. (2013). Radiation protection in medical radiography. Elsevier Health Sciences*
- *Thayalan, K. (2014). The physics of radiology and imaging. JP Medical Ltd.*
- *Bushberg, J. T., & Boone, J. M. (2011). The essential physics of medical imaging. Lippincott Williams & Wilkins.*

Course Title: Newer Imaging Modalities	L	T	P	Cr
Course Code: BRI1402	4	0	0	4

Total Hours: 60

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Understand the principles and technological advancements in modern imaging modalities such as MRI, CT, and advanced ultrasound techniques.
2. Evaluate the clinical applications and advantages of newer imaging modalities compared to conventional methods.
3. Analyze recent research and emerging trends in imaging, including artificial intelligence integration and quantitative imaging.
4. Discuss safety considerations, radiation dose optimization, and contrast agent innovations in advanced imaging techniques.
5. Apply knowledge of new imaging technologies to clinical decision-making and patient management.

Course Contents

UNIT-I **10 Hours**

CT: Basic Computed Tomography- Basic principles of CT, generations of CT, CT instrumentation, image formation in CT, CT image reconstruction, Hounsfield unit, CT image quality, CT image display, Artifacts

UNIT-II **13 Hours**

MRI:Principle, nuclear magnetism, Quantum mechanical Description, A spinning proton induces nuclear magnetism, Larmer equation, Net magnetization. MR Instrumentation: Types of magnets – RF transmitter – RF receiver – Gradient coils – shim coils – RF shielding – computers. Image formation: 2D Fourier transformation method – K-space representation – 3D Fourier imaging – MIP. Artifacts

UNIT-III **12 Hours**

ULTRASOUND: Ultrasonography and Doppler a. Basic Acoustics, Ultrasound terminologies: acoustic pressure, power, intensity, impedance, speed, frequency, dB notation: relative acoustic pressure and relative acoustic intensity. b. Interaction of US with matter: reflection, transmission, scattering, refraction and absorption, attenuation and attenuation coefficients, US machine controls, US focusing. c. Production of ultrasound: Piezoelectricity, Medical ultrasound transducer: Principle, construction and working, characteristics of US beam. d. Ultrasound display modes: A, B, M e. Real-time ultrasound: Line density and frame rate, Real-time ultrasound

transducers: mechanical and electronic arrays, ultrasound artifacts, ultrasound recording devices, and Distance, area & volume measurements. Artifacts

Unit-IV **15 Hours**

PET MRI AND CT: PET imaging – principles and application, Fusion Imaging including PET-CT, PET- MRI.

Transactional modes: Video based teaching, Collaborative teaching, Case based teaching, Question-Answer.

Suggested readings:

- *Beckmann N, Laurent D, Tigani B. Advanced molecular imaging in biomedical research. Future Med Chem. 2022;14(5):349-365.*
- *McCollough CH, Boedeker K, Cody D, et al. Principles and applications of photon-counting CT. Radiology. 2023;306(2):217-232.*
- *Ehman EC, Johnson GB, Villanueva-Meyer JE, et al. PET/MRI: Applications and challenges in oncology. AJR Am J Roentgenol. 2021;216(1):30-45.*
- *Rubin GD, Kanne JP, Harmon SA. AI in radiology: Advances, challenges, and clinical impact. Radiographics. 2024;44(1):12-29.*
- *Gossner J. Spectral CT: Technological advancements and clinical applications. Eur J Radiol. 2023; 161:110607.*

Course Title: Radiological Techniques I	L	T	P	Cr.
Course Code: MRI1403	0	0	8	4

Total Hours 60

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Grasp the responsibility of radiographer during radiological procedures.
2. Understand the basic techniques and their correlation with other techniques of the subsequent special procedures.
3. Classify various types of contrast media used in radiology.
4. Determine appropriate patient interaction and preparation for all Radiographic examinations and procedures maintaining the principle of sterile technique and executing the knowledge of c-arm and manipulation.
5. Describe the basic principles of radiographic imaging, including the nature of X-rays, image formation, and the interaction of radiation with matter.

Course content

List of Practical's / Experiments: 60 Hours

- Barium Swallow & Barium Meal Study – Demonstration of esophageal and upper GI tract imaging.
- Barium Enema Study – Technique and interpretation of large intestine imaging.
- Intravenous Urography (IVU) – Understanding renal imaging using contrast.
- Hysterosalpingography (HSG) – Contrast imaging of the female reproductive system.
- Percutaneous Biopsy & FNAC Procedures – Image-guided biopsy techniques using CT/USG.
- Catheter-based Angiographic Techniques – Demonstration of catheter placement and contrast injection.
- Fluoroscopy-Based Studies – Barium studies, ERCP, DSA (Digital Subtraction Angiography).
- Interventional Radiology (IR) Techniques – Biopsy, catheterization, embolization procedures.
- Hybrid Imaging Techniques – PET-CT, SPECT-CT, PET-MRI applications.
- Computed Tomography (CT) Procedures – Brain, chest, abdomen, angiography, 3D reconstruction.
- Magnetic Resonance Imaging (MRI) Techniques – Brain, spine, musculoskeletal, contrast-enhanced studies.

- Ultrasound (USG) & Doppler Studies – Abdominal, OB-GYN, vascular, elastography techniques.
- Mammography Techniques – Positioning, compression, image interpretation.

Transactional modes: Video based teaching, Collaborative teaching, Case based teaching, Question Answer

Suggested Readings:

- *Berlin, L. (1994). A Guide to Radiological Procedures. Radiology, 191(2), 506-506. – Chapman, S., &Nikielny, R. (1986). A guide to radiological procedures.*
- *Gupta, A. K., Garg, A., & Khandelwal, N. (2017). Diagnostic Radiology: Gastrointestinal and Hepatobiliary Imaging. JP Medical Ltd.*

Course Title: Indian Cultural Studies	L	T	P	Cr.
Course Code: IKS0022	2	0	0	2

Total Hours: 30

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Understanding Modern Indian Thought: Students will gain a theoretical foundation to explore how Indian philosophical and cultural ideas since the early 20th century have shaped individual and collective experiences.
2. Analyzing Cultural Transformations: Learners will investigate the impact of modern Indian thought on personal identity and cultural context, understanding its role in shaping societal values and worldviews.
3. Developing Conceptual Vocabulary: Students will become familiar with key ideas and terminologies introduced in the course, enabling them to critically engage with and interpret modern Indian intellectual traditions.
4. Articulating Personal and Shared Experiences: Learners will cultivate the ability to express their own and others & experiences using the conceptual and philosophical frameworks discussed in the course.
5. Engage respectfully in discussions on caste, gender, tradition, and modernity within Indian cultural contexts.

Course Content

Unit I **7 Hours**

Introduction: (Orientalist, colonial and contemporary representation of India)

Unit II **8 Hours**

Indian difference: (Aurobindo, Ramanujan, Bankimchandra, Malhotra and others), Self and subjectivity: (Gandhi, Upadhyay, M.N. Roy, Ashis Nandy, Dharmapal and others)

Unit III **7 Hours**

Home, Nation and the World: (Nehru, Tagore, Ambedkar, Savarkar, Mazumdar, Malaviya and others)

Unit IV **8 Hours**

Swaraj: (Lajpat Rai, Gandhi, Tilak, Rajaji, Alvares, Balagangadhar and others), Art and aesthetics: (Coomaraswamy, Hiriyana, Radhakrishnan, Aurobindo, Naipaul, Devy and others)

Transactional Mode: Seminars, Group discussion, Team teaching, Focused group discussion, Assignments, Project-based learning, Simulations, reflection and Self-assessment

Suggested Readings:

- *Knut A. Jacobsen. Ed. Modern Indian Culture and Society. Routledge: London, 2009.*
- *Upadhyay, Deendayal. Integral Humanism. 1965. http://www.chitrakoot.org/download/IntegralHumanism.pdf*
- *Savarkar, V.D. The Essentials of Hindutva. http://savarkar.org/en/encyc/2017/5/23/2_12_12_04_essentials_of_hind tva.v001.pdf_1.pdf*
- *Vasudha Dalmia & Rashmi Sadana. Eds. The Cambridge Companion to Modern Indian Culture. Cambridge University Press: Cambridge, 2012.*
- *Alvares, Claude. "A Critique of the Eurocentric Social Science and the Question of Alternatives". Economic and Political Weekly. 46. 22, 2011.*
- *Ambedkar, B.R. Pakistan or the Partition of India. Columbia University: http://www.columbia.edu/itc/mealac/pritchett/00ambedkar/ambedkar_partition*
- *Balagangadhara, S.N. Reconceptualizing India Studies. Oxford University Press: New Delhi, 2012.*
- *Chatterjee, Partha. Nationalist Thought and the Colonial World: A Derivative Discourse. Zed Books: London,1993.*
- *Chattopadhyay, Bankimchandra. "Is Nationalism a Good Thing?" and "Critics of Hinduism". In Awakening Bharat Mata, ed. Swapan Dasgupta. Penguin: New Delhi, 2019.*
- *Coomaraswamy, A.K. "Indian Nationality". Indian Philosophy in English: From Renaissance to Independence. Oxford University Press: New York, 2011.*
- *Gandhi, M.K. Hind Swaraj. Navjeevan Publishing: Ahmedabad, 1938.*
- *Ghosh, Aurobindo. "A Defence of Indian Culture". The Renaissance in India and other Essays on Indian Culture. Sri Aurobindo Ashram: Pondicherry, 2002.*

Course Title: Mammography and USG	L	T	P	Cr.
Course Code: MRI1405	4	0	0	4

Total Hours: 60

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Identify & label the anatomical structures of the breast.
2. Perform mammograms by positioning the patient & equipment according to department protocol or requisition.
3. Recognize clinical breast changes.
4. Assess and quantify pathologies.
5. Physics of mammography and ultrasound (X-ray interactions, acoustic properties.

Course Content

UNIT-I **15 Hours**

Anatomy & Physiology of the Breast

- Normal breast anatomy
- Hormonal influences and changes
- Common breast pathologies

Introduction to Breast Imaging

- Importance of breast cancer screening
- Overview of imaging modalities: Mammography, USG, MRI
- ACR BI-RADS classification

UNIT-II **15 Hours**

Principles of Mammography

- X-ray physics and breast imaging
- Digital vs. Analog Mammography
- Tomosynthesis (3D Mammography)

Mammographic Techniques & Positioning

- Standard views (CC, MLO, Additional views)
- Patient preparation & radiation safety
- Common artifacts & troubleshooting

Interpretation of Mammograms

- Normal vs. abnormal findings
- Microcalcifications, masses, asymmetries
- Screening vs. diagnostic mammography

Interventional Procedures in Mammography

- Stereotactic-guided biopsy
- Needle localization techniques
- Preoperative wire localization

UNIT-III **15 Hours**

Basics of Breast Ultrasound

- Ultrasound physics & instrumentation
- Transducers & scanning techniques
- Doppler applications in breast imaging

Breast USG Interpretation

- Cystic vs. solid lesions
- BI-RADS classification in ultrasound
- Elastography in breast imaging

USG-Guided Interventions

- Fine needle aspiration (FNA)
- Core needle biopsy (CNB)
- Vacuum-assisted biopsy

UNIT-IV **15 Hours**

Comparison of Mammography & USG

- Strengths & limitations of each modality
- Multimodality approach to diagnosis

Breast Cancer Screening Programs

- Guidelines and recommendations (ACR, WHO)
- Risk assessment & genetic counseling

Case-Based Learning & Hands-on Training

- Interactive case discussions
- Hands-on practice on mammography and USG machines

Transactional modes: Video based teaching, Collaborative teaching, Case based teaching, Question Answer

Suggested Readings:

- *Andolina, V., &Lillé, S. (2011). Mammographic imaging: a practical guide. Lippincott Williams & Wilkins.*
- *Hoda, M. N. (2016). INDIA Com-2016.*

Course Title: Pediatric Radiology	L	T	P	Cr.
Course Code: MRI1406	4	0	0	4

Total Hours 60

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Have Knowledge of indications for the Pediatric Imaging examinations
2. Describe the positioning techniques & technical factors leading to optimum chest, abdomen, GI & GU radiographs of the infant.
3. Establish bone age on the basis of radiographic findings.
4. Perform fluoroscopic procedures with the assistance of the radiologist.
5. Explain films with the assistance of the radiologist.

Course Contents

UNIT-I **15 Hours**

Fundamentals of Paediatric Radiology

- Introduction to Paediatric Radiology
- Differences between Paediatric and Adult Imaging
- Radiation Protection & ALARA Principles
- Role of Different Imaging Modalities (X-ray, US, CT, MRI, Nuclear Medicine)

Neonatal Imaging

- Imaging of Neonatal Respiratory Disorders (RDS, MAS, TTN, BPD)
- Neonatal Gastrointestinal Disorders (NEC, malrotation, atresias)
- Neonatal Brain Imaging (HIE, IVH, PVL)
- Congenital Anomalies (renal, cardiac, skeletal)

UNIT-II **15 Hours**

Paediatric Chest and Cardiovascular Imaging

- Common Paediatric Lung Diseases (pneumonia, TB, asthma, cystic fibrosis)
- Congenital and Acquired Heart Disease Imaging
- Vascular Anomalies in Children

Paediatric Abdominal and Gastrointestinal Imaging

- Acute Abdominal Emergencies (intussusception, appendicitis, volvulus)
- Chronic Paediatric GI Disorders (IBD, celiac disease)
- Paediatric Hepatobiliary and Pancreatic Disorders

UNIT-III **15 Hours**

Musculoskeletal Imaging in Children

- Developmental Dysplasia of the Hip (DDH)
- Skeletal Dysplasias and Bone Tumors
- Paediatric Trauma Imaging

Paediatric Neuroradiology

- Paediatric Brain Tumors and CNS Infections
- Congenital CNS Malformations
- Pediatric Spine Imaging

UNIT-IV **15 Hours**

Pediatric Oncologic and Emergency Imaging

- Imaging of PediatricTumors (Wilms, Neuroblastoma, Leukemia)
- Child Abuse and Non-Accidental Trauma
- Pediatric Interventional Radiology

Transactional modes: Video based teaching, Collaborative teaching, Case based teaching, Question-Answer

Suggested readings

- *Amis Jr, E. S., Butler, P. F., Applegate, K. E., Birnbaum, S. B., Brateman, L. F., Hevezi, J. M., ... & Zeman, R. K. (2007). American College of Radiology white paper on radiation dose in medicine. Journal of the american college of radiology, 4(5), 272- 284.*
- *Gennadios, A., Weller, C. L., & Gooding, C. H. (1994). Measurement errors in water vapor permeability of highly permeable, hydrophilic edible films. Journal of food engineering, 21(4), 395-409.*

2nd Semester

Course Title: Advanced Technique & Instrumentation of MRI	L	T	P	Cr.
Course Code: MRI2450	4	0	0	4

Total Hours 60

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Understand patient care/safety procedures.
2. Identify normal anatomical structures as seen in MRI.
3. Explain the physical principles of magnetic resonance imaging.
4. Describe and justify the imaging protocols and alternative techniques used in MRI.
5. Critically Evaluate Advanced Imaging Techniques, such as functional MRI (fMRI), diffusion-weighted imaging (DWI), diffusion tensor imaging (DTI), magnetic resonance spectroscopy (MRS), and perfusion imaging.

Course Contents

Unit I **14 Hours**

Basic principles, Spin precession Relaxation time pulse cycle, T1 weighted image T2 weighted image Proton density image, MR instrumentation, Types of magnets, RF transmitter & receiver coils, Gradient coils, shim coils, RF shielding

Unit II **16 Hours**

Pulse sequences-Spin echo pulse sequence – turbo spin echo pulse sequence Gradient echo sequence – Turbo gradient echo pulse sequence, Inversion recovery sequence – STIR sequence, SPIR sequence, FLAIR sequence, Echo planar imaging and fast imaging sequences, Advanced pulse sequences. Image formation, 2D Fourier transformation, K-space representation, 3D fourier imaging, MIP, Functional MRI, Bold Imaging

Unit III **14 Hours**

MR contrast media, MR angiography – TOF & PCA, MR spectroscopy, Protocols in MRI for whole body, MRI artifacts, safety aspects in MRI, Cardiac MRI, Musculoskeletal imaging protocols

Unit IV **16 Hours**

Abdominal imaging protocols, Care, maintenance and tests, General care, Functional tests, Quality assurance program, acceptable limits of variation.

Transactional modes: Video based teaching, Collaborative teaching, Case based teaching, Question-Answer

Suggested Readings

- *Bradley, R., Danielson, L., & Hallahan, D. P. (2002). Identification of learning disabilities: Research to practice. Routledge.*
- *Hassan, H. A. (2020). Study of MRI23 Image Artifacts.*
- *Bushberg, J. T., & Boone, J. M. (2011). The essential physics of medical imaging. Lippincott Williams & Wilkins.*

Course Title: Management & Planning of Radiology Dept.	L	T	P	Cr.
Course Code: MRI2451	4	0	0	4

Total Hours 60

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Have Known the fundamental ideas about circuit analysis, working principles of machines.
2. In addition, the course is expected to develop scientific temperament & analytical skill in students, to enable them logically tackle complex engineering problems in the chosen area of application.
3. Have the basic knowledge of Radiation Protection, Biological effects of radiation, planning of radiation installation-protection, primary & secondary radiation & Personnel monitoring systems.
4. Learn about the regulatory bodies & regulatory requirements.
5. Analyze the rule of technologist in radiology department.

Course Contents

UNIT-I **15 Hours**

Planning consideration for radiology, including Use factor, occupancy factors, and different shielding materials Protection for primary radiation, work load, use factor, occupancy factor, protection from scatter radiation and leakage radiation Ray/Fluoroscopy/Mammography/Intervention/DSA/CT room design, structural shielding, and protective devices. Course Title: Management & Planning of Radiology L T P Cr. Course Code: MRI303 4 0 0 4 Regulatory Bodies & regulatory Requirements: International Commission on Radiation Protection (ICRP) / National Regularity body (AERB - Atomic Energy Regulatory Board) - Responsibilities, organization, Safety Standard, Codes and Guides, Responsibilities of licenses, registrants & employers and Enforcement of Regulatory requirements. (ICRP, NRPB, NCRP and WHO guidelines for radiation protection, pregnancy and radiation protection)

UNIT-II **15 Hours**

Surveys and regulations: Radiation protection survey: Need for survey, Performance standards for beam directing, beam defining and limiting devices in radiation protection equipment survey of the following: Radiographic equipment, Fluoroscopic equipment, CT and special equipment. Controlled and non-controlled areas and acceptable exposure levels, State and local regulations governing radiation protection practice. Personal monitoring and occupational exposures: Personal monitoring for Radiation workers. Monitoring devices, Body badges and ring badges. Thermo-luminescent dosimeters, Pocket ionization chambers, Applications, advantages and limitations of each device, Values for dose equivalent limits for occupational radiation exposures

UNIT-III **15 Hours**

NABH guidelines, AERB guidelines and code, Basic safety standard, PNDT Act and guidelines, Procedural safety Achievable safety through compliance on the regulations in India and recommendations of ICRT, IAEA, Role of Radiographer in Planning & Radiation Protection: Role of technologist in radiology department - Personnel and area monitoring., Setting up of a new X-Ray unit, staff requirement, AERB specifications for site planning and mandatory guidelines –Planning of X-ray/CT rooms, Inspection of XRay installations - Registration of X-Ray equipment installation- Certification -Evaluation of workload versus radiation factors – Occupational exposure and protection

UNIT-IV **15 Hours**

Introduction to Management of a Radiology Department, Strategic Management, Decision Making, conflict and stress management, Managing Change and Innovation, Understanding Groups and Teams, Leadership, Time Management, Cost and efficiency

Transactional modes: Video based teaching, Collaborative teaching, Case based teaching, Question Answer

Suggested Readings

- *Waugh, A., & Grant, A. (2014). Ross & Wilson Anatomy and physiology in health and illness E-book.Elsevier Health Sciences.*
- *Sembulingam, K., &Sembulingam, P. (2012). Essentials of medical physiology. JP Medical Ltd*
- *Chaurasia, B. D. (2004). Human anatomy (p. 53).CBS Publisher.*
- *Marieb, E. N., &Nicpon-Marieb, E. (1992). Human anatomy and physiology Redwood City, CA: Benjamin/Cummings Publishing Company.*
- *Hall, J. E., & Hall, M. E. (2020). Guyton and Hall textbook of medical physiology eBook.Elsevier Health Sciences.*

Course Title: CT and MRI Protocols	L	T	P	Cr.
Course Code: MRI2452	4	0	0	4

Total Hours 60

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Understand the fundamental principles of CT and MRI imaging.
2. Learn detailed protocols for various clinical applications.
3. Gain knowledge of patient preparation, contrast use, and safety measures.
4. Develop skills in optimizing image quality and troubleshooting artifacts.
5. Interpret basic CT and MRI images with a focus on pathology detection.

Course Contents

UNIT-I **15 Hours**

CT Basics

- Principles of CT imaging
- X-ray attenuation and Hounsfield Units
- CT scanner generations and technology updates
- Image reconstruction techniques (Filtered Back Projection, Iterative Reconstruction)

MRI Basics

- Principles of MRI
- Pulse sequences (Spin Echo, Gradient Echo, Fast Spin Echo, Inversion Recovery)
- T1, T2, and Proton Density contrast mechanisms
- MRI hardware and coils

Safety Considerations

- Radiation dose in CT and ALARA principle
- MRI safety zones and contraindications
- Gadolinium-based contrast safety

UNIT-II **15 Hours**

Neuroimaging Protocols

- Routine brain CT
- Stroke protocol (Non-contrast, CT Perfusion, CT Angiography)
- Spine CT (trauma, degenerative diseases)

Chest & Cardiovascular CT

- HRCT for interstitial lung disease
- Pulmonary embolism CT angiography
- Coronary CT angiography

Abdominal & Pelvic CT

- CT for liver, pancreas, and kidney pathologies
- CT urography and enterography

Trauma and emergency protocols

- Musculoskeletal CT
- CT for fractures and post-operative assessment
- 3D CT reconstruction techniques

UNIT-III **15 Hours**

Neuro MRI Protocols

- Routine brain MRI sequences
- Stroke MRI (DWI, PWI, MRA)
- Spine MRI (Degenerative, Infectious, Tumor)

Cardiac & Vascular MRI

- Cardiac MRI techniques (Cine, Perfusion, Delayed Enhancement)
- MRA for vascular pathologies

Abdominal & Pelvic MRI

- Liver MRI (Fat suppression, Diffusion, MRCP)
- Prostate MRI (PI-RADS)
- Female pelvis MRI (Fibroids, Endometriosis)

Musculoskeletal MRI

- Sports injury MRI protocols
- Bone marrow and soft tissue tumor MRI

UNIT-IV **15 Hours**

Advanced Techniques

- Dual-Energy CT
- Functional MRI (fMRI)
- Diffusion Tensor Imaging (DTI)
- MR Spectroscopy

Protocol Optimization & Troubleshooting

- Reducing motion and metal artifacts
- Choosing optimal contrast agents
- Improving spatial and temporal resolution

Case-Based Learning & Practical Applications

- Review of real patient cases
- Identifying common errors and pitfalls
- Clinical decision-making using CT/MRI

Transactional modes: Video based teaching, Collaborative teaching, Case based teaching, Question-Answer.

Suggested readings:

- *Haaga JR, Boll DT. Computed Tomography & Magnetic Resonance*

Imaging of the Whole Body. 6th ed. Philadelphia: Elsevier; 2016

- *Bushberg JT, Seibert JA, Leidholdt EM, Boone JM. The Essential Physics of Medical Imaging. 3rd ed. Philadelphia: Lippincott Williams & Wilkins; 2011.*
- *Mannudeep K, Mahesh M. Principles of Radiographic Imaging: An Art and a Science. 5th ed. Clifton Park: Delmar Cengage Learning; 2013.*
- *Pinto A, Reginelli A, Pinto F, et al. "Imaging of Emergency: A Practical Guide to Radiologic Diagnosis." Springer; 2014.*
- *Smith HJ, Adam EJ, Dixon AK. Grainger & Allison's Diagnostic Radiology: A Textbook of Medical Imaging. 5th ed. London: Churchill Livingstone; 2008.*

Course Title: Radiological Technique II	L	T	P	Cr.
Course Code: MRI2453	0	0	8	4

Total Hours 60

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Explain the key principles of healthcare management and their application in radiology departments.
2. Understand the legal, ethical, and regulatory requirements for operating a radiology department.
3. Describe the financial aspects of radiology management, including budgeting, cost control, and revenue generation.
4. Develop a strategic plan for setting up and managing a radiology department.
5. Apply quality control and assurance techniques in radiology imaging and workflow.

List of Practical's / Experiments **30 Hours**

- Advanced Radiographic Positioning
  - Complex Positioning for Trauma Cases (spine, pelvis, skull, extremities).
  - Pediatric Radiographic Positioning Techniques.
  - Special Views and Modified Positions (e.g., Judet views, axial projections).
  - Mobile Radiography Practice (ICU/ER Scenarios).
  - Operating Theater Radiography Techniques (C-Arm Fluoroscopy Use)
- Contrast Studies Practice
  - Preparation and Administration of Contrast Media (oral, intravenous, intrathecal)
  - Simulated Barium Studies (Esophagram, Upper GI, Barium Enema)
  - Urinary Tract Imaging Practice (IVU, MCU)
  - Contrast Study Protocols for Angiographic Simulation
  - Managing Contrast Reactions: Simulation Drills
- CT Lab Practice
  - CT Patient Positioning for Common Protocols (brain, chest, abdomen, spine)
  - Simulating CT Contrast Protocols (preparation, timing, injection techniques)
  - CT Dose Index Monitoring and Reduction Techniques
  - Artifact Identification and Minimization Exercises

  - CT Quality Control Tests and Phantom Imaging
- MRI Lab Practice
  - MRI Safety Screening and Patient Preparation
  - MRI Basic Positioning Techniques (Brain, Spine, MSK)
  - Introduction to MRI Sequences and Protocol Adjustments
  - Simulating Emergency Procedures for MRI (e.g., Quench Drills)

Transactional modes: Video based teaching, Collaborative teaching, Case based teaching, Question Answer

Suggested Readings

- *Rehani MM. Radiation Safety in Medical Imaging and Therapeutic Radiology. 1st ed. Boca Raton: CRC Press; 2021.*
- *Gilmore J. Radiology Business Practice: How to Succeed. 2nd ed. Amsterdam: Elsevier; 2019.*
- *Thrall JH. Principles and Practice of Radiology Administration, Leadership, and Career Development. 1st ed. Philadelphia: Elsevier; 2023.*
- *Hendee WR, Ritenour ER. Medical Imaging Physics. 4th ed. New York: Wiley-Liss; 2002.*
- *Carter BR, Veale B. Digital Radiography and PACS. 3rd ed. St. Louis: Elsevier; 2022.*

Course Title: Project I	L	T	P	Cr.
Course Code: MRI2454	0	0	4	2

Total Hours 30

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Students will be able to independently research a specific topic related to the field of study, identify key questions or problems, and gather relevant information from reliable sources.
2. Students will be able to design a clear and feasible project plan, including objectives, methodology, timeline, and resource management.
3. Students will demonstrate the ability to collaborate effectively within a team, contributing to group discussions, decision-making, and the completion of the project.
4. Students will reflect on their learning experiences throughout the project, evaluating their strengths and areas for improvement, and setting goals for future projects.
5. Use foundational concepts and techniques relevant to the discipline to inform project planning and execution.

List of Project I **30 Hours**

- Diagnostic Radiology
  - AI in Radiology: Role of artificial intelligence in detecting lung nodules in chest X-rays.
  - MRI vs CT: Comparative study of MRI and CT in diagnosing brain tumors.
  - Ultrasound in Emergency Medicine: Evaluating the effectiveness of FAST (Focused Assessment with Sonography for Trauma) in trauma patients.
  - Pediatric Radiology: Radiation dose optimization in pediatric CT scans
  - Portable X-Ray Systems: Comparative analysis of image quality in portable vs. stationary X-ray machines.
- Interventional Radiology
  - DVT and Doppler: Role of Doppler ultrasound in diagnosing deep vein thrombosis.
  - Transarterial Chemoembolization (TACE): Outcomes of TACE in hepatocellular carcinoma.
  - CT-Guided Biopsy: Efficacy of CT-guided lung biopsies in diagnosing malignancies.
  - MRI-Guided Interventions: Advances and future trends in MRI-guided procedures.
  - Endovascular Therapy: Role of endovascular coiling in treating intracranial aneurysms.

- Radiation Safety & Physics
  - Radiation Dose Reduction: Strategies for reducing radiation exposure in fluoroscopic procedures.
  - Lead Apron Effectiveness: Evaluation of different types of radiation protection aprons.
  - ALARA Principle: Compliance of radiology departments with ALARA (As Low As Reasonably Achievable) guidelines.
  - Radiology Reporting Errors: Analyzing factors contributing to diagnostic errors in radiology reports.
  - Quality Control in Imaging: Assessment of quality control measures in digital radiography systems.

Course Title: Care & maintenance of diagnostic equipment/ Instruments	L	T	P	Cr.
Course Code: MRI2455	4	0	0	4

Total Hours 60

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Have knowledge about Appropriate label, file and store film.
2. Demonstrate proper maintenance of radiographic equipment, including recognition of faulty equipment operation.
3. Implement radiographic quality control measures.
4. Develop an understanding of proper processing and handling methods for radiographic film
5. Describe the function and working principles of common diagnostic equipment (e.g., X-ray, ultrasound, ECG, CT, MRI).

Course Contents

UNIT-I **15 Hours**

Methods used for the development of a radiographic technique chart Importance of screen and film preparation in the production of diagnostic quality radiographs

UNIT-II **15 Hours**

Explain different electrical & physical properties of a X ray machine affect the X ray beam before it enters the subject. Proper handling of x ray machine and its component parts

UNIT-III **15 Hours**

Maintenance & care of all X Ray equipment's & accessories, Effect of KV and mAs. Radiation protection devices, X Ray tubes and accessories. Portable X Ray equipment

UNIT-IV **15 Hours**

Care of X ray cassettes, Intensifying screen, Image processing equipment's with demonstration. Handling of processing chemicals Safe light test

Transactional modes: Video based teaching, Collaborative teaching, Case based teaching, Question-Answer

Suggested Readings:

- *Curry, T. S., Dowdey, J. E., & Murry, R. C. (1990). Christensen's physics of diagnostic radiology. Lippincott Williams & Wilkins.*
- *CAS, M., & ICSSR, A. (1997). Evaluative Report of the Department.*

Science, 1, 1.

Course Title: General Patient Care in Hospital	L	T	P	Cr.
Course Code: MRI2456	4	0	0	4

Total Hours 60

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Gain knowledge regarding maintenance of medical record and documents in radiology department
2. Understand about transferring the patients without causing any hurdle and can restrain the un co-operative patients throughout radiological examinations.
3. Categorize the moral, clinical and ethical liability of radiographer.
4. Analyze sterilized techniques to reduce the chance of infection in work practices.
5. Demonstrate respectful, empathetic, and culturally sensitive communication with patients, families, and healthcare teams.

Course Contents

Unit-I **15 Hours**

Hospital Staffing and Administration, records, professional, ethics, cooperation with other staff and departments, Departmental organizations. Handling of the patients, seriously ill and traumatized patients, visually impaired, speech and hearing impaired, mentally impaired, drug addicts and non-English speaking patients. Understanding patient needs - patient dignity of inpatient and out patients. Interaction with the patient's relatives and visitors

Unit-II **15 Hours**

Methods of Effective Communication - Verbal skills, body language, professional appearance, visual contact etc., Elementary personal and departmental hygiene, dealing with receptacles, bedpans and urinals etc., General preliminaries to the exam

Unit-III **15 Hours**

Moving Chair and Stretcher Patient, Unconscious patient, general comfort and reassurance for the patient Vital signs and oxygen - patient's Homeostasis status, Body temp, respiratory rate, pulse, blood pressure, oxygen therapy, oxygen devices, Chest tubes and lines

Unit-IV **15 Hours**

First aid - Shock, electrical shock, hemorrhage, burns, Asphyxia, fractures, loss of consciousness, Emergency treatment to the collapsed patient, Artificial

respiration and resuscitation, Preparation of patients for general and special radiological examinations, Supervision of patients undergoing special examination, Administration of drugs and contrast media. Aseptic and Sterile procedures, handling of infections patients in the department or in the ward, Regulation of dangerous drugs, Trolley set up for special xray examinations, Radiation hazardous and protective measures.

Transactional modes: Video based teaching, Collaborative teaching, Case based teaching, Question-Answer

Suggested Readings

- *Ashalatha, P. R., &Deepa, G. (2012).Textbook of Anatomy & Physiology for Nurses. JP Medical Ltd.*
- *Pal, G. K. (2006).Textbook Of Practical Physiology-2Nd Edn. Orient Blackswan.*
- *Ehrlich, R. A., &Coakes, D. M. (2016).Patient care in radiography-ebook: with an introduction to medical imaging. Elsevier Health Sciences.*
- *Adler, A. M., & Carlton, R. R. (2015).Introduction to Radiologic and Imaging Sciences and Patient Care-EBook.Elsevier Health Sciences.*

3rd Semester

Course Title:Recent Advancement in Modern Imaging Technology	L	T	P	Cr.
Course Code: MRI3500	4	0	0	4

Total Hours 60

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Have the basic knowledge of systematic investigations using contrast media and image intensifier.
2. Know about Radiography in various positions for all the special Radiological procedures, using contrast media.
3. Identify various films for all the special radiological procedures, using contrast media and related pathologies.
4. Analyze various pathologies.
5. Identify and describe recent advancements in medical imaging technologies, including but not limited to AI-enhanced imaging, spectral CT, photon-counting CT, advanced MRI techniques (e.g., diffusion tensor imaging, functional MRI), and hybrid modalities (e.g., PET/MRI).

Course Contents

Unit-I **16 Hours**

High Frequency X-Ray Generators and their types and applications, Modern x-ray tubestheir types and advancements, Special radiological equipment: Computed radiography: its Course Name: Recent Advancement in Modern Imaging Technology L T P Cr. Course Code: MRI202 4 0 0 4 principle, physics & equipment. Digital Radiography, Direct and indirect digital radiography Digital Fluoroscopy , Digital Mammography; including cones compression devices Stereotactic Biopsy system including Prone Table Biopsy system, Image Receptors: Flat Panel Detectors, Image Processing Workstation and Imaging Cameras.

Unit-II **14 Hours**

Tomography: Body section radiography, basic principle and equipment, multi section tomography, various types of topographic movements, Tomosynthesis, Stitch radiography, Dual energy x-ray absorptiometry (DEXA) scan, Vascular Imaging Equipment: Introduction, historical developments DSA Equipment- Principle, applications and definition of terms, Single Plane, Biplane, Hybrid DSA Lab- digital subtraction techniques.

Unit-III **16 Hours**

Scatter radiation its formation and control: beam centering devices, collimators, cone diaphragms and grids, Fluoroscopy and IITV systems including cine radiography with various recording devices, Computed Tomography -Principle, data acquisition concepts, image reconstruction, instrumentations, image manipulation Historical developments - Various generations, spiral/helical, single slice/multislice CT, Electron beam CT, mobile CT, Advances in volume scanning, continuous, sub-second scanning Real time CT fluoroscopy, interventional guidance tool, 3D CT, CT angiography. Virtual reality imaging, including image quality and quality control in CT Scanners.

Unit-IV **14 Hours**

Ultrasonography: Basic principle of U.S., various types of transducers, mechanism of image formation, various advancements including Doppler, Elastography, HIFU, ABVS and image artifacts. MRI: Basic principle of MRI, complete imaging equipment and various requirements, T1 and T2 Relaxation behaviors of tissues, T1, T2 and proton density images, spatial localization of images. Types of imaging sequences (spin echo, fast spin echo, flash, inversion recovery, gradient echo etc. MR spectroscopy, principle and techniques, Contrast Agents in MRI, Image quality, Image artifacts and its compensators, NMR hazard and safety. Advances in MRI, Radionuclide scanning including rectilinear scanner, gamma camera, PET, SPECT, their principles, working, applications and advancements, Care and maintenance of radiological equipment's

Transaction Modes: Video based teaching, Collaborative teaching, Case based teaching, Question-Answer

Suggested Readings

- *Stanton, L. (1969). Basic Medical Radiation Physics.*
- *Seeram, E. (2019). "Digital Radiography: Physical Principles and Quality Control". Springer.*
- *Debnath, J. (2016). Textbook of radiology for residents and technicians. Astrocyte, 2(4), 221-221.*
- *Curry, T. S., Dowdey, J. E., & Murry, R. C. (1990). Christensen's physics of diagnostic radiology. Lippincott Williams & Wilkins*
- *Allisy-Roberts, P. J., & Williams, J. (2007). Farr's physics for medical imaging. Elsevier Health Sciences.*

Course Title: Quality Assurance And Quality Control	L	T	P	Cr.
Course Code: MRI3501	4	0	0	4

Total Hours 60

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Understand the Concepts of QA and QC **–** Differentiate between quality assurance and quality control in medical imaging and radiation therapy.
2. Explain QA/QC Procedures in Radiology – Identify key QC tests for X-ray, CT, MRI, ultrasound, and nuclear medicine systems.
3. Understand Image Quality Parameters – Assess factors such as contrast, resolution, noise, and artifacts in diagnostic imaging.
4. Perform Routine Quality Control Tests – Conduct performance evaluations of imaging equipment, including calibration and safety checks.
5. Evaluate Radiation Dose Optimization Techniques – Apply ALARA principles to minimize radiation exposure while maintaining diagnostic image quality.

Course Contents

UNIT-I **15 Hours**

Objectives of quality Control: Improve the quality of imaging thereby increasing the diagnostic value; to reduce the radiation exposure; Reduction of film wastage and repeat examination; to maintain the various diagnostic and imaging units at their optimal performance. Quality assurance activities: Equipment selection phase; Equipment installation and acceptance phase; Operational phase; Preventive maintenance.

UNIT-II **15 Hours**

Quality assurance programme at the radiological facility: Responsibility; Purchase; Specifications; Acceptance; Routine testing; Evaluation of results of routine testing; Quality assurance practical exercise in the X ray generator and tube; Image receptors from processing; Radiographic equipment; Fluoroscopic equipment; Mammographic equipment; Conventional tomography; Computed tomography; Film processing,manual and automatic; Consideration for storage of film and chemicals; Faults tracing; Accuracy of imaging-image distortion for digital imaging devices. LASER printer calibration, View box maintenance.

Quality assurance programme tests: General principles and preventive maintenance for routine, daily, weekly, monthly, quarterly, annually – machine calibration. Basic concepts of quality assurance – LASER printer -

Light beam alignment; X-ray out-put and beam quality check; KVp check; Focal spot size and angle measurement; Timer check; mAs test; Grid alignment test; High and low contrast resolutions; Mechanical and electrical checks; Cassette leak check; Proper screen-film contact test; Safe light test; Radiation proof test; Field alignment test for fluoroscopic device; Resolution test; Phantom measurements - CT, US and MRI.

UNIT-III **15 Hours**

Quality assurance of film and image recording devices: Sensitometry; Characteristic curve; Film latitude; Film contrast; Film speed Resolution; Distortion; Artifacts of films and image recording. Monitor calibration. SMPTE pattern.

Maintenance and care of equipment: Safe operation of equipment; Routine cleaning of equipment and instruments; Cassette, screen maintenance; Maintenance of automatic processor and manual processing units; Routine maintenance of equipment's; Record keeping and log book maintenance; Reject analysis and objectives of reject analysis programme.

UNIT-IV **15 Hours**

Care and maintenance of diagnostic equipment: General principles and preventive maintenance for routine -daily, Weekly, monthly, quarterly, annually: care in use, special care of mobile equipment.

Quality Assurance and quality control of Modern Radiological and Imaging Equipment which includes Digital Radiography, Computed Radiography, CT scan, MRI Scan, Ultrasonography and PACS related. Image artifacts their different types, causes and remedies, Newer Radiation safety protocols and recent advances in radiation safety including AERB guidelines.

Transactional modes: Video based teaching, Collaborative teaching, Case based teaching, Question-Answer.

Suggested readings:

- *Bushong SC. Radiologic Science for Technologists: Physics, Biology, and Protection. 11th ed. St. Louis, MO: Mosby; 2020.*
- *Bushberg JT, Seibert JA, Leidholdt EM, Boone JM. The Essential Physics of Medical Imaging. 3rd ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2011.*
- *Martin JE. Physics for Radiation Protection: A Handbook. 3rd ed. Weinheim: Wiley-VCH; 2013.*
- *Knoll GF. Radiation Detection and Measurement. 4th ed. Hoboken, NJ: John Wiley & Sons; 2010.*
- *Cember H, Johnson TE. Introduction to Health Physics. 5th ed. New York,*

NY: McGraw-Hill; 2009.

Course Title: Dissertation I	L	T	P	Cr.
Course Code: MRI3502	0	0	24	12

Total Hours 180

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Demonstrate an understanding of research methodologies used in radiology and imaging technology, including qualitative and quantitative research methods, study designs, and data collection techniques.
2. Conduct a comprehensive literature review on a relevant research topic in radiology and imaging technology, synthesizing current knowledge and identifying gaps or areas requiring further research.
3. Develop a well-structured research proposal, including a clear statement of the research problem, objectives, hypotheses, and methodologies.
4. Understand and apply ethical principles in research, including obtaining informed consent, ensuring patient confidentiality, and following ethical guidelines for research involving human subjects or animal models.
5. Apply principles of research ethics by obtaining necessary approvals and understanding confidentiality, informed consent, and data protection.

Course Content

Dissertation (Phase) I will include Synopsis approval from Doctoral Advisory Committee (DAC) will be taken by the student and after that it will send to Institutional Research Committee (IRC), followed by Institutional Ethical Committee (IEC) for final approval.

Course Title: Project II	L	T	P	Cr.
Course Code: MRI3503	0	0	4	2

Total Hours 30

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Analyze complex research data using appropriate statistical tools and techniques, ensuring accurate interpretation of the findings.
2. Demonstrate advanced skills in conducting research within radiology and imaging technology, including refining research methods and overcoming challenges that arose during Project I.
3. Demonstrate proficiency in scientific writing, ensuring clarity, conciseness, and logical flow of ideas, with proper referencing and adherence to ethical writing standards.
4. Ensure that the research adheres to ethical standards, including respect for participant confidentiality, informed consent, and compliance with regulations governing human subjects or animal research.
5. Demonstrate in-depth understanding of the selected radiological topic, including relevant anatomy, pathology, and imaging principles.

List of Project I **30 Hours**

- Neuroimaging
  - Functional MRI (fMRI) in Stroke: Role of fMRI in predicting stroke recovery.
  - Diffusion-Weighted Imaging (DWI): Applications of DWI in early ischemic stroke detection.
  - MR Spectroscopy in Brain Tumors: Differentiating between benign and malignant brain tumors using MRS.
  - CT Perfusion in Neuroimaging: Assessment of cerebral blood flow in stroke patients.
  - Parkinson's Disease Imaging: Use of DaTSCAN in diagnosing Parkinsonian syndromes.
- Musculoskeletal Radiology
  - MRI in Sports Injuries: Accuracy of MRI in diagnosing anterior cruciate ligament (ACL) injuries.
  - Osteoporosis Screening: Role of dual-energy X-ray absorptiometry (DEXA) in osteoporosis risk assessment.
  - CT vs MRI in Bone Tumors: A comparative study of imaging modalities in musculoskeletal oncology.
  - Radiological Evaluation of Rheumatoid Arthritis: Role of ultrasound vs MRI in early detection.
  - Spinal Imaging: Role of CT myelography vs MRI in diagnosing

spinal cord compression.

- Chest & Cardiovascular Imaging
  - Lung Nodule Detection: AI-based algorithms in detecting lung nodules on chest X-rays.
  - Cardiac MRI in Myocarditis: Role of cardiac MRI in differentiating ischemic and non-ischemic myocarditis.
  - Pulmonary Embolism Imaging: Sensitivity and specificity of CT pulmonary angiography.
  - Coronary CT Angiography: Comparison of CCTA and invasive coronary angiography in detecting coronary artery disease.
  - PET-CT in Lung Cancer Staging: Accuracy of PET-CT in detecting mediastinal lymph node metastases.

4th Semester

Course Title: Research Methodology and Biostatistics	L	T	P	Cr.
Course Code: MRI4550	4	0	0	4

Total Hours 60

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Demonstrate a comprehensive understanding of the principles of research methodology, including different types of research designs (e.g., experimental, observational, descriptive, analytical) and their appropriate applications in the field of hematology and blood banking.
2. Understand the importance of sample size, sampling methods (e.g., random, stratified, convenience), and study population in ensuring the validity and reliability of the research outcomes.
3. Identify and address ethical issues that may arise in biomedical research, particularly in the context of human blood samples, clinical studies, and patient consent.
4. Apply appropriate statistical methods to analyze research data, including t-tests, chi-square tests, ANOVA, correlation, regression analysis, and survival analysis.
5. Understand fundamental research concepts including types of research (qualitative, quantitative, mixed-methods), study design, and levels of evidence.

Course Contents

Unit-I **15 Hours**

Introduction to Research: Definition of Research, Types & Methods of research Applied versus Fundamental research, exploratory research, Observational research, Inductive and Deductive approaches; Designing Research protocol: Research Protocol Development, Literature search, Identification of Research problem, Research gap, Research question, Research Hypothesis, Null and Alternative Hypothesis, Study Objectives; Data and types: Types of Data, Primary and Secondary data, Scales of measurement of data- Nominal data, Ordinal, Interval and Ratio scale, Variables and Confounders, Dependent and Independent Variables, Extraneous variable, Control variable.

Unit-II **15 Hours**

Literature Review: Importance of literature review, Sources of literature: Journals, books, and online databases, Organizing and synthesizing research findings; Research Design: Meaning of Research Design, Need for Research Design, Features of a Good Design, Different Research Designs, Basic Principles of Experimental Designs; Study population: Selecting Cases and

Control, Comparison Group, Target population, Matching, Case Definition, Inclusion and Exclusion Criteria; Qualitative vs. Quantitative research methods; Data Collection and analysis : Types and sources of data – Primary and secondary, Methods of collecting data, Concept of sampling and sampling methods – sampling frame, sample, characteristics of good sample, simple random sampling, purposive sampling, convenience sampling, snowball sampling.

Unit-III **15 Hours**

Statistics: Measures of central tendency: Mean, median, and mode, Measures of dispersion: Range, variance, and standard deviation, Frequency distributions and histograms, Data visualization: Bar charts, pie charts, and box plots; Probability and Probability Distributions: Basic probability concepts, Probability distributions: Normal distribution, binomial distribution, and Poisson distribution, Law of large numbers and central limit theorem.

Unit-IV **15 Hours**

Chi-square test for independence and goodness of fit, One-way and two-way analysis of variance (ANOVA), Post-hoc tests following ANOVA; Regression Analysis: Simple linear regression, Multiple linear regression, Model assumptions and diagnostics, Logistic regression (binary outcomes), Poisson regression (count data); Biostatistics for Clinical Trials: Design and analysis of clinical trials, Randomization techniques, Statistical monitoring of trials, Regulatory considerations (e.g., FDA guidelines.

Transaction Modes: Video based teaching, Collaborative teaching, Case based teaching, Question-Answer

Suggested Readings

- *"The Craft of Research" by Wayne C. Booth, Gregory G. Colomb, and Joseph M. Williams*
- *"Research Methods in Education" by Louis Cohen, Lawrence Manion, and Keith Morrison*
- *"Research Methods in Hematology" by B.L. Pati and D.P. Mahapatra*
- *"Medical Research: A Guide for the Student and Researcher" by Ian D. Young*

Course Title: Dissertation II	L	T	P	Cr.
Course Code: MHB4551	0	0	24	12

Total Hours 180

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Utilize advanced research methods and tools to analyze and interpret complex data, showing an understanding of the latest developments and trends in the field.
2. Synthesize and integrate findings from primary research with existing literature to provide a coherent discussion on the topic.
3. Structure the dissertation in a logical manner, including introduction, literature review, research methodology, results, discussion, conclusion, and recommendations.
4. Adhere to ethical guidelines in the execution and reporting of research, ensuring that research involving human subjects or clinical data complies with ethical standards (e.g., informed consent, confidentiality, data protection).
5. Demonstrate academic writing skills appropriate for scholarly work, including correct referencing and adherence to academic integrity standards.

Course Content

Dissertation (Phase) II - Dissertation will be evaluated for **300 marks** on the parameter laid down in the proforma for the evaluation in which the students will give a presentation on the dissertation and an open viva-exam examination will be conducted by the external examiner. Student will submit three hard copies of her/his dissertation along with soft copy as PDF file to the Department and 1 Review & Research paper based on his/her research work.

Course Title: Employability and Entrepreneurship in Radiology	L	T	P	Cr.
Course Code: MRI4552	2	0	0	2

Total Hours 30

Learning Outcomes: On completion of this course, the successful students will be able to:

1. To develop employability skills required for a successful career in hematology and blood banking.
2. To equip students with entrepreneurship skills for setting up and managing blood banks, diagnostic labs, and biotech startups.
3. To enhance communication, leadership, and problem-solving skills relevant to the healthcare industry.
4. To provide an understanding of financial management, regulatory policies, and business strategies for healthcare ventures.
5. Identify and evaluate career pathways within clinical radiology, academic radiology, medical imaging technology, and industry roles.

Course Contents

Unit-I **10 Hours**

Career opportunities in hematology and blood banking, Essential soft skills: Communication, teamwork, adaptability, and leadership, Resume writing, job applications, and interview techniques, Professional ethics and work culture in healthcare and diagnostics and Digital skills: Use of technology in healthcare, data management, and reporting.

Unit-II **5 Hours**

Laboratory quality assurance and accreditation (NABL, CAP, AABB standards), Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP),Automation and AI in hematology and transfusion medicine, Role of biomedical research and innovation in career advancement and continuing medical education (CME) and professional certifications.

Unit-III **10 Hours**

Fundamentals of Entrepreneurship in Healthcare:Basics of entrepreneurship and business models in healthcare, Starting a blood bank, diagnostic laboratory, or biotech startup, Identifying business opportunities and market analysis in blood banking, Writing a business plan: Key components and strategic planning and Risk assessment and management in healthcare entrepreneurship.

Unit-IV **5 Hours**

Basics of financial management for healthcare businesses, Funding

opportunities: Government grants, venture capital, and crowdfunding, Health economics and pricing strategies for diagnostic services, Regulatory frameworks for blood banking and diagnostic startups (FDA, WHO, ICMR guidelines) and Ethical considerations and legal aspects in healthcare entrepreneurship.

Transaction Modes: Video based teaching, Collaborative teaching, Case based teaching, Question-Answer

Suggested Readings

- *"The 7 Habits of Highly Effective People" by Stephen R. Covey*
- *"Crucial Conversations: Tools for Talking When Stakes Are High" by Kerry Patterson, Joseph Grenny, Ron McMillan, Al Switzler*
- *"The Power of Habit: Why We Do What We Do in Life and Business" by Charles Duhigg*
- *"The Hard Thing About Hard Things: Building a Business When There Are No Easy Answers" by Ben Horowitz*
- *"Good to Great: Why Some Companies Make the Leap... and Others Don't" by Jim Collins*
- *"Grit: The Power of Passion and Perseverance" by Angela Duckworth*

Course Title: Biomedical Instrumentation	L	T	P	Cr.
Course Code: MRI4553	4	0	0	4

Total Hours 60

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Demonstrate a deep understanding of the fundamental principles and working mechanisms of various biomedical instruments, including sensors, transducers, and analyzers.
2. Identify various types of biomedical instruments used in hematology (e.g., automated hematology analyzers, centrifuges, electrophoresis machines) and blood banking (e.g., blood typing machines, blood storage refrigerators, and platelet agitators).
3. Understand and implement appropriate calibration and maintenance procedures to ensure accurate and reliable performance of biomedical instruments.
4. Analyze how various biomedical instruments influence blood banking practices such as blood typing, crossmatching, donor screening, and blood product processing.
5. Understand the fundamentals of biomedical instrumentation and the physiological systems they are designed to measure or monitor.

Course Contents

Unit-I **15 Hours**

Introduction to Biomedical Instrumentation,Basics of biomedical instrumentation in haematology and blood banking, Classification of instruments: Analytical, Diagnostic, and Monitoring Equipment, Bioelectric signals and their measurements, Safety protocols and regulatory guidelines in biomedical instrumentation.

Unit-II **15 Hours**

Optical and Spectrophotometric Techniques: Principles of spectrophotometry, Use of UV-Vis spectrophotometers in haemoglobin estimation, Nephelometry and Turbidimetry for protein and antigen detection, Fluorescence and chemiluminescence in blood component analysis.

Unit-III **15 Hours**

Hematology Analyzers and Automation:Introduction to automated hematologyanalyzers,Coulter Principle and Electrical Impedance in cell counting,Laser-based Flow Cytometry: Working principle and applications,Hematocrit measurement techniques,Reticulocyte counting and automated differential leukocyte counting.

Unit-IV **15 Hours**

Coagulation and Blood Banking Instruments:Coagulation analyzers: Prothrombin Time (PT), Activated Partial Thromboplastin Time (aPTT), Thromboelastography (TEG) and Rotational Thromboelastometry (ROTEM), Blood bank refrigerators and plasma freezers, Cryopreservation of blood components and stem cells, Blood bag separator and apheresis technology.

Transaction Modes: Video based teaching, Collaborative teaching, Case based teaching, Question-Answer

Suggested Readings

- *"Biomedical Instrumentation: Technology and Applications" by Omer A. Faruk and Shashank A. Joshi*
- *"Introduction to Biomedical Equipment Technology" by Joseph J. Carr and John M. Brown*
- *"Biomedical Instrumentation and Measurements" by Leslie Cromwell, Fred J. Weibell, and Erich A. Pfeiffer*
- *"Fundamentals of Biomedical Instrumentation" by David Prutchi and Michael Norris*
- *"Principles of Biomedical Instrumentation and Measurement" by Richard Aston*

Course Title: Research Publication Ethics and Intellectual Property Right	L	T	P	Cr.
Course Code: MHB4554	4	0	0	4

Total Hours 60

Learning Outcomes: On completion of this course, the successful students will be able to:

1. Demonstrate a clear understanding of fundamental ethical principles in research, including honesty, integrity, transparency, and respect for intellectual property.
2. Recognize the role of academic journals in publishing high-quality, ethical research findings and their significance in advancing knowledge in blood-related diseases, transfusion medicine, and hematological diagnostics.
3. Understand the importance of maintaining research integrity in all aspects of research, from data collection and analysis to reporting findings.
4. Learn how to protect research findings, inventions, and discoveries through appropriate intellectual property protection mechanisms (e.g., filing patents, copyright registration) and how to respect the intellectual property of others.
5. Understand ethical principles governing research and scholarly publications, including issues of plagiarism, authorship, and data integrity.

Course Contents

Unit-I **15 Hours**

Scientific Writing: Structure of a scientific paper (Title, abstract, introduction, methodology, results, discussion, conclusion); Writing a research proposal: Objectives, methodology, expected outcomes, Academic writing style and language (Clarity, conciseness, and logical flow), Citation and referencing: Understanding various citation styles (APA, MLA, Chicago, etc.), Reference management tools.

Unit-II **15 Hours**

Plagiarism: Types, plagiarism detection software, Publication misconduct and Publication Ethics, Plagiarism avoiding techniques, regulation of plagiarism in India; Publication Ethics: Integrity and Ethics, Best Practices, Intellectual Honesty & Research Integrity: Scientific Misconducts & Redundant Publications, Conflict of Interest, Publication Misconduct, Violation of Publication Ethics, Authorship and Contributorship; Identification of Publication Misconduct: Fabrication, Falsification and Plagiarism (FFP), Predatory Publishers & Journals.

Unit-III **15 Hours**

Open Access Publishing: Concept of OER, Concept of open license, Open access publishing, Open access content management; Database and Research Metrics: Indexing Databases, Citation Databases: Web of Science, Scopus, Google Scholar, Metrics: h-index, g-ind, i10 index, Understanding Citation Metrics for Quality Research: Impact & Visualization Analysis; Peer Review and Journal Selection: Understanding the peer-review process, Types of journals: Open access vs. subscription-based journals, How to select a journal for publication, Writing a cover letter and responding to reviewer comments.

Unit-IV **15 Hours**

Intellectual Property Rights (IPR): Definition and types of intellectual property (IP): Copyright, patents, trademarks, and trade secrets; The importance of IP in research and innovation, Historical development and international IP laws (e.g., the role of WIPO, TRIPS Agreement); Key IP terms: Patentable inventions, originality, novelty, and industrial applicability; Patents: Overview of the patent system: Types of patents, Steps involved in obtaining a patent: Application, examination, and grant, Patentability requirements: Novelty, non-obviousness, and usefulness, Patent infringement and enforcement; Licensing and Commercialization of IP: Types of IP licenses: Exclusive vs. non-exclusive licenses, Licensing agreements and revenue sharing, Commercialization of research findings: Startups, spin-offs, and patent exploitation, Technology transfer offices: Role in university-based IP commercialization; Patent issues in academic research: Balancing public knowledge with commercial interests, Ethical concerns in patenting research outcomes, Impact of IP laws on collaborative research, IP in publicly funded research.

Transaction Modes: Video based teaching, Collaborative teaching, Case based teaching, Question-Answer

Suggested Readings

- *"Intellectual Property and Health Technologies: Balancing Innovation and the Public Interest" by Peter Drahos and John Braithwaite*
- *"The Ethics of Scientific Research: A Guidebook for Course Development" by B. H. Dubois*
- *"Research Ethics: A Handbook of Principles, Guidelines, and Procedures" by Barbara S. Smith*
- *"The Craft of Research" by Wayne C. Booth, Gregory G. Colomb, and Joseph M. Williams*