



BHAIKAKA UNIVERSITY

Curriculum of
M.Sc. - Radiography & Medical Imaging Technology

Bhaikaka University
Curriculum of
M.Sc. - Radiography & Medical Imaging Technology
Examination System and Distribution of Marks: Theory & Practical

Course Code	SUBJECTS	THEORY			Exam Duration
		External	Internal	Total	
M.Sc. Part I (at the end of first Year)					
Main Subjects					
21MRT0101	Radiographic Procedure & Principles	80	20	100	3 Hours
21MRT0102	Instrumentation of Conventional X-Ray & Specialized Radiology Equipments	80	20	100	3 Hours
21MRT0103	Advanced Technique and Instrumentation of Ultrasonography	80	20	100	3 Hours
21MRT0104	Advanced Technique and Instrumentation of Computed Tomography	80	20	100	3 Hours
Subsidiary Subject					
21BSRM0101	Biostatistics and Research Methodology	40	10	50	3 Hours
Theory Total		360	90	450	---
21MRT0105	Practical/Oral -Total (Including Applied Anatomy & Physiology)	360	90	450	1 Day
	TOTAL	720	180	900	--
M.Sc. Part II (at the end of Second Year)					
21MRT0201	Advanced Technique and Instrumentation of MRI	80	20	100	3 Hours
21MRT0202	Interventional Radiology Techniques	80	20	100	3 Hours
21MRT0203	Care of Patients in Diagnostic Radiology	80	20	100	3 Hours
21MRT0204	Radiation Evaluation & Protection in Diagnostic Radiology	80	20	100	3 Hours
21MRT0205	Nuclear Medicine Imaging Techniques	80	20	100	3 Hours
	Theory Total	400	100	500	--
21MRT0207	Practical/Oral	400	100	500	--
21MRT0206	Dissertation Viva	200	--	200	During Practical Examination
	TOTAL	1000	200	1200	---
	Grand Total (M.Sc. I & II)	1720	380	2100	

**Table – I: Distribution of Teaching Hours in
First Year M.Sc. Radiography & Medical Imaging Technology**

S. No.	Main Subjects	Theory No. of hours	Practical No. of hours	Total
1	Radiographic procedure & principles	100	400	500
2	Instrumentation of conventional x-Ray & specialized radiology Equipments	100	300	400
3	Advanced Technique and Instrumentation of Ultrasonography	100	200	300
4	Advanced Technique and Instrumentation of Computed Tomography	150	600	750
5	Biostatistics and Research Methodology	50	--	50
	TOTAL TEACHING HOURS OF FIRST YEAR	500	1500	2000

**Table – II: Distribution of Teaching Hours in
Second Year M.Sc. Radiography & Medical Imaging Technology**

S. No.	Main Subjects	Theory No. of hours	Practical No. of hours	Total
1	Advanced Technique and Instrumentation of MRI	150	600	750
2	Interventional Radiology Techniques	100	160	260
3	Care of Patients in Diagnostic Radiology	50	100	150
4	Radiation Evaluation & Protection in Diagnostic Radiology	100	100	200
5	Nuclear Medicine Imaging Techniques	100	280	380
6	Research Project	---	160	160
7	Elective / Field Training	---	100	100
	TOTAL TEACHING HOURS OF SECOND YEAR	500	1500	2000
	GRAND TOTAL OF TEACHING HOURS OF WHOLE COURSE	1000	3000	4000

BHAIKAKA UNIVERSITY
Degree of
M.Sc. - Radiography & Medical Imaging Technology

INTRODUCTION

Master program in Radiography and Medical Imaging Technology is designed to produce post-graduates of high standards in Advance Radiography and Medical Imaging - including Radiological Technical Research; who are equipped with appropriate skills to meet the challenges of upcoming Advance Radiography, Radiographic Procedures & Medical Imaging Techniques. The curriculum has been designed considering current developments and needs of India and abroad.

Professional Agenda:

- Enhance knowledge from clinical experience about various techniques of radiological modalities, interactions and discussions, as well as technical research to improve the quality of training and education in advances in Radiography and Medical Imaging.
- Explore the subject in depth and develop high degree of expertise to contribute to advancement of knowledge in Radiography and Medical Imaging Technologies.
- Develop teaching and presentation skills necessary to become efficient teachers utilizing state-of-the art facilities and equipment's.
- Build Up leadership qualities in high skilled technical practice, technical education and patient care in radiology and contribute to emerging and vitally important industry through research.

Professional scope:

Radiography and Medical Imaging Technology is a unique professional degree combining various aspects of Radio-Diagnosis and Imaging. Post-Graduates will be able to effectively manage Radio-diagnostic and Imaging service facilities and assist in Radiological investigations and procedures involving Conventional Radiography, Computed Radiography, Digital Radiography, Image Intensifier, Specialized Radiographic Machines (like Mammography & Orthopantomography), Ultrasound Instrumentation & Care, Doppler Instrumentation & Care, Interventional Radiography, Digital Subtraction Angiography (DSA), Multi-Detector Computed Tomography (MDCT) Scan, Magnetic Resonance Imaging (MRI) scan. The post-graduate will be aware of various modern cutting-edge applications of CT scan, MRI scan, DSA etc.

Post-Graduates have great prospects to work in Radio-Diagnosis and Imaging Department or Center in public and private sectors as:

- Senior Technologist handling the high-end sophisticated machines like CT, MRI & DSA.
- Supervisory or management positions in Diagnostic Centers and hospitals.
- In academic Institutes as teaching faculties.
- In industry for Application and Software development for Medical Imaging equipment.
- Military and public health service.
- Medical Imaging Technology is one of the fastest growing professions & it offers tremendous opportunity abroad.

BHAIKAKA UNIVERSITY
Degree of
M.Sc. - Radiography & Medical Imaging Technology
M.Sc. Part - I

PAPER 1: RADIOGRAPHIC PROCEDURE & PRINCIPLES

(Class Room: 100 Hours)

THEORY:

UNIT 1

- ✧ Basic review of all Radiographic Technique

UNIT 2

- ✧ Contrast Media- Application, types, safety aspects, mode & volume of administration, administration techniques

UNIT 3

Digestive System

- ✧ Anatomy and physiology
- ✧ Associated pathology and radiographic appearance
- ✧ Plain radiography
- ✧ Barium swallow
- ✧ Barium meal
- ✧ Barium meal follows through
- ✧ Enteroclysis
- ✧ Barium enema

UNIT 4

Genito-Urinary System

- ✧ Anatomy and physiology
- ✧ Associated pathology and radiographic appearance
- ✧ Plain radiography
- ✧ Intravenous Urogram (IVU)
- ✧ Micturating Cysto-urethrogram (MCU)
- ✧ Ascending Urethrogram (ASU)
- ✧ Hysterosalpingography (HSG)
- ✧ Fallopian Tube Recanalization (FTR)

UNIT 5

Cardio - Respiratory system

- ✧ Anatomy and physiology
- ✧ Associated pathology and radiographic appearance Chest radiography

UNIT 6

Mammography

- ✧ Anatomy and physiology
- ✧ Indications, contraindications and techniques
- ✧ ICRP guidelines, BIRADS

UNIT 7

Skull

- ✧ Related anatomy of facial and cranial bones
- ✧ Associated pathology and radiographic appearance
- ✧ Radiographic projections

UNIT 8

Vertebral Column

- ✧ Related anatomy

- ⤴ Associated pathology and radiographic appearance
- ⤴ Radiographic projections

UNIT 9

Upper limb

- ⤴ Related anatomy
- ⤴ Associated pathology and radiographic appearance
- ⤴ Radiographic projections

UNIT 10

Lower limb

- ⤴ Related anatomy
- ⤴ Associated pathology and radiographic appearance
- ⤴ Radiographic projections

UNIT 11

Pelvis

- ⤴ Related anatomy of pelvic bones and hip joint
- ⤴ Associated pathology and radiographic appearance
- ⤴ Radiographic projections
- ⤴ Pelvimetry

UNIT 12

Hepatobiliary system

- ⤴ Related anatomy
- ⤴ Associated pathology and radiographic appearance
- ⤴ ERCP/ PTBD, T – tube cholangiography

UNIT 13

Dental Radiography

- ⤴ Related anatomy
- ⤴ Associated pathology and radiographic appearance
- ⤴ Intra-oral, Extra-oral and Occlusal views
- ⤴ General precautions
- ⤴ Orthopantomography (OPG)

UNIT 14

Other procedures

- ⤴ Sialography, Dacrocystography, Sinography, Fistulography
- ⤴ Related anatomy
- ⤴ Associated pathology and radiographic appearance
- ⤴ Indications, contraindications and technique

UNIT 15

- ⤴ X-ray production
- ⤴ Interaction of radiation with matter- Compton effect, photoelectric effect, pair-production, coherent scattering.
- ⤴ Useful range
- ⤴ Clinical application

UNIT 16

- ⤴ The Photographic process
- ⤴ Introduction
- ⤴ Basic review of photographic emulsions
- ⤴ Photographic latent image
- ⤴ Film materials
- ⤴ Spectral sensitivity of film material
- ⤴ Speed and contrast of photographic materials
- ⤴ Intensifying screens and cassettes
- ⤴ Film processing

UNIT 17

- ⤴ Sensitometry
- ⤴ Photographic density
- ⤴ Opacity
- ⤴ Transmission
- ⤴ Production of Characteristic curve
- ⤴ Features of Characteristic curve
- ⤴ Variation in the characteristic curve with development
- ⤴ Comparison of emulsions by their characteristic curve
- ⤴ Application of Characteristic curve
- ⤴ Information from the Characteristic curve

UNIT 18

- ⤴ Radiographic Image
- ⤴ Radiographic Density
- ⤴ Acceptable range
- ⤴ Factors influence density.
- ⤴ Radiographic Contrast
- ⤴ Components
- ⤴ Factors influence contrast
- ⤴ Management of Radiographic Image quality

UNIT 19

- ⤴ Resolution
- ⤴ Line spread function & Modulation transfer function
- ⤴ Unsharpness in the Radiographic image and various factors contributing towards
- ⤴ Unsharpness
- ⤴ Types of Unsharpness
- ⤴ Radiographic mottle

UNIT 20

- ⤴ Geometry of the radiographic image
- ⤴ Magnification / Distortion -Types and factors
- ⤴ Micro / Macro radiography

UNIT 21

- ⤴ Instrumentation of Processing Equipment
- ⤴ Automatic film processor (AFP)
- ⤴ Maintenance and Quality control tests in AFP
- ⤴ Layout and planning of Darkroom
- ⤴ Viewing accessories: viewing boxes
- ⤴ Magnifiers and viewing conditions

Referral books

1. Radiographic positioning – Clarke's
2. Radiographic positioning – Merriil's
3. Diagnostic Radiography – Glends Bryan
4. Christensen's Physics of Diagnostic radiology
5. Radiographic Imaging – Chesney & Chesney
6. Anatomy & Physiology-Ross and Wilson
7. Normal Radiation Anatomy-Meschan
8. Human anatomy – Chaurasia.
9. Atlas of Human anatomy – Antunez
10. Basic anatomy and Physiology for radiographers – Dean.M.R.E

PAPER 2: INSTRUMENTATION OF CONVENTIONAL X-RAY & SPECIALIZED RADIOLOGY EQUIPMENTS

(Class Room: 100 Hours)

THEORY:

UNIT 1

- ⤴ Generation of electrical energy
- ⤴ AC/DC
- ⤴ Poly-phase supply
- ⤴ Distribution of electrical energy
- ⤴ Use of electrical energy
- ⤴ Current loads & power loss
- ⤴ Uses of electricity in Hospitals
- ⤴ Safety rules for Radiographers

UNIT 2

- ⤴ X ray Circuit components
- ⤴ High tension transformers
- ⤴ Main Voltage Compensation
- ⤴ High tension switches
- ⤴ Stabilizers and UPS

UNIT 3

- ⤴ Fuses
- ⤴ Switches
- ⤴ Earthing
- ⤴ High tension cables construction & design.
- ⤴ Rectification
- ⤴ Types of Rectifiers
- ⤴ X-ray circuits
- ⤴ Filament circuits
- ⤴ High voltage circuits

UNIT 4

- ⤴ Tube rating
- ⤴ Types of Generators
- ⤴ Capacitor discharge generator
- ⤴ Battery Powered generator
- ⤴ Medium frequency & High frequency generator.

UNIT 5

- ⤴ Switches
- ⤴ Circuit breakers
- ⤴ Primary & Secondary switches
- ⤴ Exposure switching and its application.
- ⤴ Interlocking Circuits
- ⤴ Regulating and safety devices
- ⤴ Magnetic relay
- ⤴ Thermal relay switches
- ⤴ Interlock in Tube Circuit and overload interlocks.

UNIT 6

- ⤴ Exposure timers
- ⤴ Timing systems
- ⤴ Electronic timer
- ⤴ Ionization timer

- ⤴ Photo timer
- ⤴ Synchronous timer and impulse timer.

UNIT 7

- ⤴ Devices improving radiographic quality
- ⤴ Cone, Cylinder and Aperture Diaphragm
- ⤴ Collimator
- ⤴ Grid
- ⤴ Filter

UNIT 8

- ⤴ Portable & Mobile Equipments
- ⤴ Mains requirements
- ⤴ Cable connections to wall plugs
- ⤴ Portable X-Ray Equipments
- ⤴ Mobile X-Ray Equipments
- ⤴ Capacitor Discharge Mobile Equipment
- ⤴ Cordless Mobile Equipments
- ⤴ X-Ray Equipments for the Operating Theatre
- ⤴ Mobile Image Intensifier units

UNIT 9

- ⤴ Fluoroscopy Equipments
- ⤴ Construction & Working principles of Image Intensifier
- ⤴ Viewing the Intensified image
- ⤴ Recording the intensified Image
- ⤴ Digital fluoroscopy
- ⤴ Panel type image intensifier

UNIT 10

- ⤴ Fluoroscopic / Radiographic Tables
- ⤴ General features of fluoroscopic / radiographic table
- ⤴ The serial changer
- ⤴ Remote control table
- ⤴ The spot film devices.

UNIT 11

- ⤴ Tomographic Equipment
- ⤴ Principles of tomography
- ⤴ Various types of tomographic movement
- ⤴ Equipment for linear tomography

UNIT 12

- ⤴ Equipment for Cranial and Dental radiography
- ⤴ The skull table
- ⤴ General Dental X-ray equipment
- ⤴ Pan-tomography equipment
- ⤴ Equipment for Cranial & skeletal radiography
- ⤴ Equipment for mammography

UNIT 13

- ⤴ Care, Maintenance and tests
- ⤴ General care
- ⤴ Functional tests
- ⤴ Quality assurance program
- ⤴ Acceptable limits of variation
- ⤴ Corrective action

References

1. X-ray Equipments for Radiographers – Noreen Chesney & Muriel Chesney
2. Christensen's Physics of Diagnostic Radiology
3. Text book of Radiology for Technicians – Bhargava. S. K. & Bharva S.
4. Practical approach to Modern X-ray equipment – Thompson Thomas

PAPER 3: ADVANCED TECHNIQUE AND INSTRUMENTATION OF ULTRASONOGRAPHY

(Class Room: 100 Hours)

THEORY:

UNIT 1

- ⤴ Ultrasound
- ⤴ Properties of ultrasound
- ⤴ Interaction of ultrasound with matter

UNIT 2

- ⤴ Transducers
- ⤴ Types of transducers
- ⤴ Advances in the design of modern ultrasound transducers

UNIT 3

- ⤴ Image display
- ⤴ Display modes
- ⤴ Real time ultrasound
- ⤴ Pulse echo ultrasound instrumentation
- ⤴ Beam former
- ⤴ Pulse transmitter – receiver
- ⤴ Controls
- ⤴ CRT displays – television monitors
- ⤴ Image storage
- ⤴ Scan converter memory
- ⤴ Photographic film
- ⤴ Multi-format camera
- ⤴ Laser imager
- ⤴ Colour & video thermal printers
- ⤴ Computer storage
- ⤴ Pre and post processing techniques

UNIT 4

- ⤴ Doppler Imaging
- ⤴ Doppler principles
- ⤴ Continuous wave Doppler and Pulsed Doppler
- ⤴ Duplex scanning
- ⤴ Doppler spectral analysis & display
- ⤴ Color flow imaging
- ⤴ Power Doppler
- ⤴ Harmonic imaging
- ⤴ Real time compounding
- ⤴ Extended field of view
- ⤴ Doppler Instrumentation

UNIT 5

- ⤴ Ultrasound contrast agents

UNIT 6

- ⤴ Image characteristics and artifacts
- ⤴ Ultrasound tissue characterization and organ dynamics

- ⤴ Vascular, interventional, intra operative and ophthalmic Ultrasonography 3D & 4D ultrasound imaging
- ⤴ Acquisition, visualization and display methods

UNIT 7

- ⤴ Bio-effects and safety considerations in ultrasound US system performance measurements
- ⤴ US equipment quality assurance - Conventional & Doppler system testing & documentation

UNIT 8

Ultrasound Protocols

Referral Books

1. Diagnostic Ultrasound by Carol M. Rumack
2. Color Doppler Ultrasound by Allen Paul
3. Basic physics and technology of medical diagnostic ultrasound – M.Hussey
4. Doppler ultrasound physics instrumentation and clinical applications – D.H.Evans.
5. The essential physics of medical imaging – Bushberg
6. Real time ultrasound manual for Physicians and Technical personnel Bartrum.R.J

PAPER 4: ADVANCED TECHNIQUE AND INSTRUMENTATION OF COMPUTED TOMOGRAPHY

(Class Room: 150 Hours)

THEORY:

UNIT 1

- ⤴ 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

UNIT 2

- ⤴ Isotropic imaging
- ⤴ Image display
- ⤴ Pre and Post Processing techniques
- ⤴ Image quality in single slice and multi slice helical CT scan
- ⤴ Patient radiation dose considerations in Helical CT

UNIT 3

- ⤴ Protocols for adult Whole Body CT
- ⤴ Protocols for pediatric Whole Body CT
- ⤴ Documentation
- ⤴ Common and specific artifacts in Helical CT images

UNIT 4

- ⤴ HRCT of Lungs
- ⤴ Technical aspects
- ⤴ Volumetric HRCT
- ⤴ Expiratory HRCT
- ⤴ HRCT protocols
- ⤴ Artifacts

UNIT 5

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

UNIT 6

- ⤴ CT Perfusion scanning
- ⤴ CT colonoscopy
- ⤴ CT bronchoscopy

UNIT 7

- ⤴ CT coronary angiography
- ⤴ CT calcium scoring
- ⤴ Myocardial Imaging

UNIT 8

- ⤴ Care, Maintenance and tests
- ⤴ General care
- ⤴ Functional tests
- ⤴ Quality assurance program
- ⤴ Acceptable limits of variation
- ⤴ Corrective action

Referral books

1. Computed Tomography – Physical Principles, Clinical Applications & Quality Control by Euclid Seeram
2. Computed Tomography by Stewart C. Bushong
3. The essential physics of medical imaging – Bushberg
4. Clinical Computed Tomography for the Technologist – Chiu.L.C

PAPER 5: BIOSTATISTICS & RESEARCH METHODOLOGY

(Class room: 50 hours)

THEORY:

UNIT 1

Introduction

- ✧ Introduction to Biostatistics & research methodology, types of variables & scales of measurements, measures of central tendency and dispersion, rate, rate, ratio, proportion, incidence & prevalence

UNIT 2

Sampling

- ✧ Random & non-random sampling, various methods of sampling-simple random, stratified, systematic, cluster and multistage. Sampling and non-sampling errors & methods of minimizing these errors.

UNIT 3

Basic probability distributions and sampling distributions

- ✧ Concept of probability distribution. Normal, Poisson and Binomial distributions, parameters and applications. Concept of sampling distributions. Standard error and confidence intervals. Skewness and Kurtosis

UNIT 4

Tests of significance

- ✧ Basics of testing of Hypothesis-Null and alternate hypothesis, type I and type II errors, level of significance (parametric) and power of the test, p value. Tests of significance –t-test (paired & unpaired), Chi square test and test of proportion, one-way analysis of variance. Repeated measures analysis of variance. Repeated measures analysis of variance.
- ✧ Tests of significance (nonparametric) – Mann-Whitney u test, Wilcoxon test, Kruskal-Wallis analysis of variance. Friedmann's analysis of variance.

UNIT 5

Correlation and Regression

- ✧ Simple Correlation-Pearson's and Spearman's; testing the significance of correlation coefficient linear and multiple regression.

UNIT 6

Sample size determination

- ✧ General concept. Sample size for estimating means and proportion, testing of difference in means and proportions of two groups.

UNIT 7

Study designs

- ✧ Descriptive epidemiological methods- case series analysis and prevalence studies. Analytical epidemiological methods- case control and cohort studies. Clinical trials/intervention studies, odds ratio and relative risk, stratified analysis.

UNIT 8

Multivariate analysis

- ✧ Concept of multivariate analysis, introduction to logistic regression and survival analysis

UNIT 9

- ✧ Reliability and validity evaluation of diagnostic tests.

UNIT 10

Format of scientific documents

- ✧ Structure of research protocol, structure of thesis/ research report, formats of reporting in scientific journals. Systematic review and meta-analysis

Referral Books:

1. Mathematical Physics -THE BASICS - S.D. Joglekar
2. A text book of Mathematical Physics - S. Chandra
3. Statistical Methods – An introductory text - J. Medhi
4. A text book of Engineering Mathematics - N.P. Bali & Dr. N.Ch. Srimannarayana Iyengar

BHAIKAKA UNIVERSITY
Degree of
M.Sc. - Radiography & Medical Imaging Technology
M.Sc. Part - II

PAPER 1: ADVANCED TECHNIQUE AND INSTRUMENTATION OF MRI

(Class Room: 150 Hours)

UNIT 1

- ⤴ Basic Principles
- ⤴ Spin
- ⤴ Precession
- ⤴ Relaxation time
- ⤴ Pulse cycle
- ⤴ T1 weighted image
- ⤴ T2 weighted image
- ⤴ Proton density image

UNIT 2

- ⤴ MR Instrumentation
- ⤴ Types of magnets
- ⤴ RF transmitter & receiver coils
- ⤴ Gradient coils
- ⤴ Shim coils
- ⤴ RF shielding
- ⤴ Computers

UNIT 3

- ⤴ 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.

UNIT 4

- ⤴ Image formation
- ⤴ 2D Fourier transformation method
- ⤴ K-space representation
- ⤴ 3D Fourier imaging
- ⤴ MIP

UNIT 5

- ⤴ MR contrast media
- ⤴ MR angiography – TOF & PCA
- ⤴ MR Spectroscopy

UNIT 6

- ⤴ Protocols in MRI for whole body
- ⤴ MRI artifacts
- ⤴ Safety aspects in MRI

UNIT 7

- ⤴ Cardiac MRI

UNIT 8

- ⤴ Musculoskeletal imaging protocols
- ⤴ Abdominal imaging protocols

UNIT 9

- ⤴ Functional MRI
- ⤴ BOLD Imaging

UNIT 10

- ⤴ Care, Maintenance and tests
- ⤴ General care
- ⤴ Functional tests
- ⤴ Quality assurance program
- ⤴ Acceptable limits of variation
- ⤴ Corrective action

References

1. MRI physics for Radiologist - Alfred Horowitz
2. Fundamentals of MRI – Stark & Bradley
3. MRI in Practice – Catherine brook
4. The essential physics of medical imaging – Bushberg

PAPER 2: INTERVENTIONAL RADIOLOGY TECHNIQUES

(Class Room: 100 Hours)

THEORY:

UNIT 1

- ✧ Introduction
- ✧ Need for interventional procedures
- ✧ Informed consent
- ✧ DSA
- ✧ Basic Principle
- ✧ Types
- ✧ Equipments
- ✧ Basics of Angiographic Equipments
- ✧ Single and biplane angiographic equipment
- ✧ Angiographic Table
- ✧ Image intensifier
- ✧ Flat panel detector
- ✧ Recording systems
- ✧ Pulse-oximetry
- ✧ Cardiac resuscitation measures - ECG
- ✧ Pressure injector
- ✧ Catheters, needles and other tools
- ✧ 3-D rotational angiography
- ✧ Image processing
- ✧ Patient monitor
- ✧ ACT equipment
- ✧ CO₂ angiography

UNIT 2

- ✧ Patient care
- ✧ Preparation for procedure
- ✧ Post procedure care
- ✧ Role of radiographer in interventional procedure
- ✧ Crash trolley- Emergency drugs

UNIT 3

- ✧ Procedures
- ✧ Diagnostic & Therapeutic interventional procedures
- ✧ PTC, PTBD, Stenting
- ✧ Nephrostomy, ureteric stenting
- ✧ Guided biopsies of different organs
- ✧ Drainage of collections/abscesses
- ✧ Angiograms, angioplasty, embolization
- ✧ Venus's access
- ✧ Radiofrequency ablation
- ✧ Image guided nerve blocks

UNIT 4

- ✧ Neuro interventional procedures
- ✧ Embolization of extra or intracranial tumors, vascular malformations
- ✧ Vertebroplasty – direct puncture
- ✧ Laser guided procedure

UNIT 5

- ✧ Basics of cardiac catheterization

UNIT 6

- ✧ Safety considerations in angiography room
- ✧ Room design
- ✧ Protective devices
- ✧ Radiation monitoring

UNIT 7

- ✧ Care, Maintenance and tests
- ✧ General care
- ✧ Functional tests
- ✧ Quality assurance program
- ✧ Acceptable limits of variation
- ✧ Corrective action

References

1. Current Techniques in Interventional Radiology – Cope, Constantin
2. Interventional Radiology - A Practical Guide by Anthony Watkinson and Andreas Adam

PAPER 3: CARE OF PATIENTS IN DIAGNOSTIC RADIOLOGY

(Class Room: 50 Hours)

THEORY:

UNIT 1

- ⤴ Introduction to Patient Care Responsibilities of the Healthcare Facility Responsibilities of the Imaging Technologist

UNIT 2

- ⤴ General Patient Care
- ⤴ Patient transfer technique
- ⤴ Restraint techniques
- ⤴ Aspects of patient comfort
- ⤴ Specific patient conditions
- ⤴ Security of patient property
- ⤴ Obtaining vital signs
- ⤴ Laying up a sterile trolley
- ⤴ IV injection administration

UNIT 3

- ⤴ Nursing procedure in Radiology
- ⤴ General abdominal preparation
- ⤴ Clothing of the patient
- ⤴ Giving an enema
- ⤴ Handling the emergencies in Radiology
- ⤴ First aid in the X-Ray department

UNIT 4

- ⤴ Patient care during Investigation G.I. Tract, Biliary tract, Respiratory tract, Gynecology, Cardiovascular, Lymphatic system, C.N.S. etc.

UNIT 5

- ⤴ Infection Control
- ⤴ Isolation technique
- ⤴ Infection sources
- ⤴ Transmission modes
- ⤴ Procedures
- ⤴ Psychological considerations
- ⤴ Sterilization & sterile techniques.

UNIT 6

- ⤴ Patient Education
- ⤴ Communication
- ⤴ Patient communication problems
- ⤴ Explanation of examinations
- ⤴ Radiation Safety / Protection
- ⤴ Interacting with terminally ill patient
- ⤴ Informed Consent

References

1. Care of Patients in Diagnostic Radiology – Chesney & Chesney
2. Care of Patients in Diagnostic Radiology – Gunn
3. Basic Medical Techniques and patient care for Radiologic Technologist – Torres.

PAPER 4: RADIATION EVALUATION AND PROTECTION IN DIAGNOSTIC RADIOLOGY

(Class Room: 100 Hours)

THEORY:

UNIT 1

- ✧ 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.

UNIT 2

- ✧ Limits for Radiation exposure
- ✧ Concept of ALARA (or ALARP)
- ✧ ICRP regulation
- ✧ Maximum permissible dose
- ✧ Exposure in pregnancy, children

UNIT 3

- ✧ 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

UNIT 4

- ✧ Technical protective consideration during Radiography
- ✧ Evaluation of hazards
- ✧ Effective communication
- ✧ Immobilization
- ✧ Beam limiting devices
- ✧ Filtration
- ✧ Exposure factors

UNIT 5

Protection in:

- Fluoroscopy
- Mammography,
- Mobile radiography
- CT Scan

- Angiography room

- ⤴ Radiation measuring instruments
- ⤴ Area monitoring
- ⤴ Personnel dosimeter
- ⤴ Film badge
- ⤴ Thermoluminescent dosimeter
- ⤴ Pocket dosimeter.

UNIT 6

- ⤴ Biological aspects of Radiological Protection 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

References

1. Physics of Diagnostic radiology – Christensen
2. ICRP manual
3. Radiation protection measurement – Glenn F.Knoll
4. Radiation protection in hospitals – R.F.Mold
5. Advanced medical radiation dosimetry – Govinda Rajan
6. Radiation protection – Medical Radiography – Sherer
7. Radiation protection for radiologic technologist – Frankerl Robert

PAPER 5: NUCLEAR MEDICINE IMAGING TECHNIQUES

(Class Room: 100 Hours)

THEORY:

UNIT 1

- ⤴ Basic atomic & nuclear physics
- ⤴ Quantities and Units
- ⤴ Atom composition and structure
- ⤴ Nucleus composition
- ⤴ Radioactivity
- ⤴ Exponential decay
- ⤴ Specific activity
- ⤴ Parent / Daughter decay
- ⤴ Modes of Radioactive decay.

UNIT 2

- ⤴ Radiation detectors
- ⤴ Gas filled detectors - Basic principles
- ⤴ Ionization chambers
- ⤴ Proportional counters
- ⤴ Geiger Muller counters
- ⤴ Semiconductor detectors
- ⤴ Scintillation detectors – basic principles

UNIT 3

- ⤴ Production of Radio nuclides
- ⤴ Reactor produced radionuclide
- ⤴ Reactor principles
- ⤴ Accelerator produced radionuclide
- ⤴ Radionuclide generators

UNIT 4

- ⤴ Instrumentation
- ⤴ The Anger Camera
- ⤴ Basic principle
- ⤴ System components
- ⤴ Detector system and electronics
- ⤴ Collimators
- ⤴ Image display and recording systems
- ⤴ Scanning camera

UNIT 5

- ⤴ Radio pharmacy
- ⤴ Radiopharmaceuticals
- ⤴ General principle of tracer technique
- ⤴ Preparation of different labeled compounds with technetium-99m isotope Cold kit
- ⤴

UNIT 6

- ⤴ In vivo technique
- ⤴ Static and dynamic studies
- ⤴ Thyroid imaging
- ⤴ Imaging of bone
- ⤴ Respiratory system

- ⤴ Urinary system
- ⤴ G.I. system
- ⤴ Cardiovascular system
- ⤴ Iodine131 uptake studies
- ⤴ Iodine 131 therapy for thyrotoxicosis and thyroid ablation

UNIT 7

- ⤴ Image quality in Nuclear medicine
- ⤴ Spatial resolution
- ⤴ Contrast
- ⤴ Noise
- ⤴ Types of noise
- ⤴ Quality assurance of imaging equipments
- ⤴ Variation in Image perception – with physician, within technologist & technical parameter

UNIT 8

SPECT imaging

UNIT 9

PET imaging

UNIT 10

Fusion Imaging

- SPECT –CT
- SPECT-MR
- PET-CT
- PET-MR

UNIT 11

- ⤴ Radiation safety in Nuclear medicine
- ⤴ Radiation units and quantities
- ⤴ MPD
- ⤴ Safe handling of Radioactive materials
- ⤴ Storage of radioactive materials
- ⤴ Procedures for handling spills
- ⤴ Disposal of Radioactive waste
- ⤴ Radiation monitoring
- ⤴ Survey meters
- ⤴ Personnel dosimeters
- ⤴ Wipe testing
- ⤴ Contamination monitor
- ⤴ Isotope calibrator
- ⤴ Area monitor
- ⤴ Inventory of isotopes

References

1. Nuclear Medicine basics – Chandra.R
2. Principles & practice of Nuclear medicine – Early.P.J
3. Physics and Radiobiology of Nuclear Medicine – Gopal.
4. Essentials of Nuclear Medicine Imaging – Mettler
5. Radionuclide Imaging artifacts – Wells & Bernier

ALLIED BRANCH FACILITY [DESIRABLE]:

- I. Radiotherapy Department (Desirable allied branch) with following facilities.
- Teletherapy machine (at least one unit of the below mentioned)
Essential: Linear Accelerator with Multi Leaf Collimator (MLC)
IMRT capabilities, Desirable: Linac with IGRT capabilities, Tele cobalt machine
 - Brachytherapy machine (at-least one unit of the below mentioned) Essential: High Dose Rate Machine
Desirable: Manual after loader
 - Treatment Planning system for radiotherapy (at least one facility of the below mentioned):
Essential: CT scan-based treatment planning
Associated contouring workspace
Teletherapy plans including 3D-CRT and IMRT
Brachytherapy planning (HDR)
Desirable: IGRT planning; Virtual simulation
 - Beam verification devices and other devices (at least any one of the below)
 - Electronic Portal Imaging Device
 - Film dosimetry with appropriate phantom
 - 2D array
 - Immobilization devices
 - Moulding facility and Mould Room

LISTS OF TEXTBOOKS AND REFERENCE BOOKS

Anatomy		
1	Manipal Manual Of Anatomy	Dr. Sampath Madhyastha
2	Human Anatomy	B. D. Chaurasia
Physiology		
1	Manipal Manual of Physiology	C.N.Chandrasheka
2	Text Book of Physiology	Prof. A. K. JAIN
Radiographic Procedures		
1.	Merrill's Atlas of Radiographic Positioning & Radiological Procedure	Philip W Ballinger & Eugene D Frank
2.	Clarks Positioning In Radiography	R. A. Swallow, E Naylor
3.	Concise Radiology for Undergraduates	Bhushan N. Lakhkar Chandrakant M. Shetty
4.	Diagnostic Radiography	Glenda Bryan
5.	Radiographic Anatomy	Frank Slaby, Eugene R J
Instrumentation Of Conventional & Specialized Radiology Equipment's		
1.	X-ray Equipments for Radiographers	Noreen Chesney & Muriel Chesney
2.	Christensen's Physics of diagnostic radiology	Thomas Curry, James E Dowdey, Robert C Murry
3.	First year Physics for Radiographers	George Hay
4.	Equipments in Diagnostic Radiology –	E. Forster
5.	PACS Basic Principles & Applications	H. K. Huang
6.	Diagnostic U.S Principles And Instruments	Frederick W Kremkau
Principles of Radiographic Exposure		
1.	Chesney's Radiographic Imaging	John Ball & Tony Price
2.	Fundamental of X- Ray and Radiation Physics	Joseph Selmen
3.	Radiologic Science for Technologists	Stewart C. Bhushong
Advanced tech. & Instrumentation of Ultrasound		
1.	Diagnostic Ultrasound	Carol M. Rumack
2.	Color Doppler Ultrasound	Allen Paul

Advanced tech. & Instrumentation of Computed Tomography		
1.	Computed Tomography : Physical Principle, Clinical Applications, and Quality Control	Dr Seeram Eudid
Care of patients in Diagnostic Radiology		
1.	Patient Care in Radiography	Ruth Ann Ehrlich Ellen Double, McCloskey Joan A. Daly
Radiation Evaluation and Protection In Diagnostic Radiology		
1	Radiation Protection in Medical Radiography	E. Russel Ritenour
	International Committee on Radiation Protection (ICRP) Manual	Committee Members
Nuclear Medicine Imaging		
1.	Physics in Nuclear medicine	Soroenson
2.	Physics of Nuclear medicine	Powsner
Advanced tech. & Instrumentation of MRI		
1.	MRI In Practice	Catherine Wesstbrook & Caralyn Kaut
2	Hand Book of MRI Techniques	Catherine Westbrook
3	MRI Basic principles and Applications	Mark A Brown & Richard C Semelka
Interventional Radiology Techniques		
1.	Current Techniques in Interventional Radiology	Cope , Constantin
2.	Interventional Radiology - A Practical Guide	Anthony Watkinson and Andreas Adam