

# **M.M. (DEEMED TO BE UNIVERSITY), MULLANA – AMBALA**

## **ORDINANCE**

**NAME OF THE COURSE:** B.Sc. Radiography and Imaging Technology

**DURATION OF THE COURSE:**

3 years - followed by one year of compulsory rotatory internship.

**ELIGIBILITY FOR ADMISSION TO THE COURSE:**

1. A Person who shall attain the age of 17 years or more on December 31st of the year of admission.
2. A candidate seeking admission to the B.Sc. Radiography and Imaging Technology should have passed any one of the following:-
  - a) Senior School Certificate Examination (10+2) of a Board of School Education, Haryana or an examination recognized as equivalent there to or Senior Secondary Examination (12<sup>th</sup> ), Pre-Medical or Plus Two or an equivalent examination from any Indian/Foreign Universities/Boards with English, Physics, Chemistry and Biology as optional subjects in the qualifying examination as recognized by MMU, Mullana.

OR

- b) **LATERAL ENTRY**:- Provided that the candidate who has passed 3 year diploma after Matric or two year diploma after 10+2 shall be eligible for admission to the relevant branch of B.Sc. (MLT) in 2<sup>nd</sup> Year through lateral entry. The diploma course should be recognized by MMU.

**METHOD OF ADMISSION:**

- a) Every year in the beginning of the session in July/ August, number of seats for enrolment of B.Sc. RIT will be advertised by MMU, Mullana.
- b) The candidates will be selected on basis of qualifying interview conducted by MMU.
- c) Reservation for NRI/ Foreign candidates as per MMU Guidelines/ Rules/ Regulations.

## TRAINING PERIOD AND TIME DISTRIBUTION:

1. Every Student shall undergo a period of certified study and training extending over 3 years from the date of commencement of course till the date of completion of examination and followed by six months compulsory rotating internship.
2. The period of 3 years will be divided into three phases as follows:-
  - a) Phase I (Ist Year) – consisting of subjects (Human Anatomy, Physiology and Pathology, Radiation Protection, Radiation Physics with additional subjects – Environmental studies, Basics of computer, English, General Physics)
  - b) Phase II (IInd Year ) – consisting of subjects (Clinical Radiography, Xray Film/ Image Processing Techniques, Contrast and special Radiography, with additional subjects- Patient care, Medical Emergencies)
  - c) Phase III (IIIrd Year) - consisting of subjects (Modern imaging equipments like Mammography, USG, Doppler, CT, MRI; Techniques of Modern imaging , Angiography, Nuclear Medicine, Interventional Radiology)

## PHASE DISTRIBUTION AND TIMING OF EXAMINATIONS:

Sr. No.	Examination & Period of Study	Subjects	Annual	Supplementary
Phase I	B.Sc. Ist Year (From date of Admission)	Human Anatomy(Clinical and radiological anatomy), Physiology and pathology, Radiation Protection, Radiation Physics with additional subjects – Environmental studies, Basics of computer, English, General Physics	June – July of next year	September of next year
Phase II	B.Sc. IInd Year (After the end of Ist year of the Admission)	Clinical Radiography, X-ray Film/ Image Processing Techniques. Contrast media and special investigations,	June – July of next year	September of next year

		USG, Doppler and Mammography, with additional subjects - Patient care, Medical Emergencies		
<b>Phase III</b>	B.Sc. IIIrd Year (After the end of IIInd year of the Admission)	CT, MRI; Angiography and Interventional Radiology, Nuclear Medicine.	June – July of next year	September of next year

**Note: - 1. The academic year shall include the time for examinations preparations and Holidays.**

**2. There shall be one main examination in a year and a supplementary to be held not later than 6 months after the publication of its results.**

### **ELIGIBILITY FOR APPEARING IN B.Sc. RIT EXAMINATIONS:-**

#### **1. ATTENDANCE:**

1. Every candidate should have attended at least 80% of the total number of classes conducted in an academic year from the date of commencement of the term to the last working day as notified by university in each of the subjects prescribed for that year separately in theory & Practical.
2. of having obtained at least 35% marks in internal assessment.
3. of having good character.
4. of having enrolled in the college for a period of one year as specified earlier.

### **GENERAL ELIGIBILITY PROVISIONS FOR APPEARING IN ANY EXAMINATIONS:**

#### First year examination:

A candidate who fails in one or more subject(s) in first year shall be permitted to carry over those subjects to second year. However, he/she must pass the 1<sup>st</sup> year examination before appearing in 2<sup>nd</sup> year.

### Second year examination:

A candidate who fail in one or more subject(s) in 2nd year examination is permitted to carry over same subject(s) to the third year but shall pass this subject before appearing for the third year examination.

### Third year examination :

A candidate who fail in one or more subject, he/she have to pass all subject of third year before joining Internship training.

## **THE DETAILS OF THEORY/PRACTICAL/Radiology POSTING ARE GIVEN AS UNDER:**

### **DISTRIBUTION OF TEACHING HOURS**

#### **First Year**

##### **Main Subjects**

S No	Subject	Theory	Practical	Total
1	Human Anatomy with clinical anatomy	50	140	190
2	Physiology and pathology	80	200	280
3	Radiation Physics	70	160	230
4	Radiation Protection	50	160	210

##### **Additional Subjects**

1	Environmental Studies	80		
2	Basics of Computer	10	10	20
3	English	10	10	20
4	General Physics	10	10	20

#### **Second Year**

##### **Main Subjects**

S L No	Subject	Theory	Practical	Radiology posting	Total
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1	Clinical Radiography	80	80	120	280
2	Xray Film/ Image Processing Techniques	80	50	120	250
3	Contrast and special Radiography	80	60	120	260
4	Ultrasound, Doppler and Mammography	80	60	120	260
	<b>Total</b>	<b>320</b>	<b>250</b>	<b>480</b>	<b>1050</b>

### Third Year

#### Main Subjects

S No	Subject	Theory	Practical	Radiology posting	Total
1	CT	80	80	120	280
2	MRI	80	50	120	250
3	Angiography and Interventional Radiology	80	60	120	260
4	Nuclear Medicine	80	60	120	260
	<b>Total</b>	<b>320</b>	<b>250</b>	<b>480</b>	<b>1050</b>

#### EXAMINATION:

1. A Candidate not passing in Main/Supplementary Examination will attend classes, Seminars, Practicals etc. as decided by the Principal in the subjects in which he/she is to appear at next examination.
2. The Medium of examination will be English.
3. The examination shall be held according to the scheme of examination as in this Ordinance.
4. 20% of the total marks in each subject of every examination separately for theory & Practical should be reserved for internal assessment determined by regular periodical examination and

day to day assessment and certified class work. The marks of internal assessment will be divided equally between theory and practical.

**FEE:**

Admission Fees, Annual Fee, Evaluation Fee, etc. to be paid by the candidates shall be as prescribed by the University from time to time. In case any candidate does not pay his/her dues in time, his/her enrolment shall be cancelled without any further notice.

**PASSING SCORE:**

The Minimum number of marks required to pass in each examination i.e.

First/Second/Third Year shall be 50% Marks in aggregate in each of the subjects separately with a minimum of 50% marks in Theory (including oral examination) and clinical/practical separately inclusive of internal assessment, as the case may be.

1. A candidate who obtains pass marks in one or more subjects need not appear in that/those subjects again in any subsequent examination.
2. As soon as possible, after termination of the examination, the controller of Examinations shall publish the result of the candidates and issue Detailed – Marks – Card/Certificate.
3. Successful candidates who obtain 75% or more marks in any subject shall be declared to have passed with “distinction” in that subject provided he/she passes in all the subjects of the examination at one and the same time and the examination is annual Examination.
4. A successful candidate of the Third year B.Sc. RIT examination shall be granted the degree after he/she has completed the post examination internship training as prescribed.

## DISTRIBUTION OF MARKS AND SCHEME OF EXAMINATION

Each Theory Question Paper will have two Parts:–

**Part – A & Part – B**

**First Year**

Sr. No.	Main Subjects	Written Paper		I.A Theory	Viva - voce	Total	Practical		Total	Grand Total
		Duration	Marks	Marks	Marks	Marks	Univ. Pract	I.A	Marks	Marks
1	Basic Anatomy [Including histology and Clinical Anatomy]	3 hr.	Part A – 30 Part B – 30	20	20	100	80	20	100	200
2	Physiology and Pathology	3 hr.	Part A – 30 Part B – 30	20	20	100	80	20	100	200
3	Radiation Physics	3 hr.	Part A – 30 Part B – 30	20	20	100	80	20	100	200
4	Radiation Protection	3 hr.	Part A – 30 Part B – 30	20	20	100	80	20	100	200
5	Environmental Studies		60	40 (Internal assessment of Theory & Practical)						100

IA = Internal Assessment

### **Theory Examination**

#### **Part – A**

Type of Questions	No. of Questions	Marks	Sub-total
Short Essay (SE)	4 (To attempt 3)	3x5	15
Short Answer (SA)	6 (To Attempt 5)	5x3	15
<b>Total Marks</b>	<b>30</b>		

#### **Part – B**

Type of Questions	No. of Questions	Marks	Sub-total
Short Essay (SE)	4 (To attempt 3)	3x5	15
Short Answer (SA)	6 (To Attempt 5)	5x3	15
<b>Total Marks</b>	<b>30</b>		

**Grand Total - 60**

**Scheme of Examination  
Second Year**

Paper	Subject	Univ. Exam	Theory			Practicals			Grand Total
			Viva Voice	IA	Sub Total	Univ. Practicals	IA	Sub Total	
I	Clinical Radiography	Part A – 30 Part B - 30	20	20	100	160	40	200	300
II	X-ray Film/ Image Processing Techniques	Part A – 30 Part B – 30	20	20	100	160	40	200	300
III	Contrast and special investigations	Part A – 30 Part B - 30	20	20	100	160	40	200	300
IV	Ultrasound, Doppler and Mammography	Part A – 30 Part B - 30	20	20	100	160	40	200	300



## Theory Examination

### Part – A

Type of Questions	No. of Questions	Marks	Sub-total
Short Essay (SE)	4 (To attempt 3)	3x5	15
Short Answer (SA)	6 (To attempt 5)	5x3	15
Total			30

### Part – B

Type of Questions	No. of Questions	Marks	Sub-total
Short Essay (SE)	4 (To attempt 3)	3x5	15
Short Answer (SA)	6 (To attempt 5)	5x3	15
Total			30

**Grand Total - 60**

## Scheme of Examination

### Third Year

Paper	Subject	Theory				Practicals			Grand Total
		Univ. Exam	Viva	IA	Sub Total	Univ. Practical	IA	Sub Total	
I	Modern imaging equipments	Part A – 30 Part B – 30	20	20	100	160	40	200	300
II	Techniques of Modern imaging	Part A – 30 Part B – 30	20	20	100	160	40	200	300
III	Basics of Angiography and Interventional Radiology	Part A – 30 Part B – 30	20	20	100	160	40	200	300
IV	Nuclear Medicine	Part A – 30 Part B – 30	20	20	100	160	40	200	300

## Theory Examination

**Part – A**

Type of Questions	No. of Questions	Marks	Sub-total
Short Essay (SE)	4 (To attempt 3)	3x5	15
Short Answer (SA)	6 (To attempt 5)	5x3	15
Total			30

**Part – B**

Type of Questions	No. of Questions	Marks	Sub-total
Short Essay (SE)	4 (To attempt 3)	3x5	15
Short Answer (SA)	6 (To attempt 5)	5x3	15
Total			30

**Grand Total - 60**

**Grace Marks:**

1. The grace marks as per university regulations.
2. Revaluation, re-totaling etc. as per University regulations.

**INTERNSHIP:**

Every candidate will be required after passing the B.Sc. RIT final year Examination to undergo compulsory rotational internship to the satisfaction of the university.

**APPOINTMENT OF EXTERNAL/INTERNAL EXAMINERS FOR AWARD OF B.SC. RIT COURSE:**

- a) The Examiner shall have atleast **two years** teaching experience in the subject concerned or in allied subjects in a college affiliated to a recognized University and holds the rank of Asstt. Prof. or above.



**2. Locomotion and support:** Cartilage – types with example & histology

Bone – Classification, names of bone cells, parts of long bone, microscopy of compact bone, names of all bones, vertebral column, intervertebral disc, fontanelles of fetal skull

Joints – Classification of joints with examples, synovial joint (in detail for radiology)

Muscular system: Classification of muscular tissue & histology

Names of muscles of the body

**3. Cardiovascular system:** Heart-size, location, chambers, exterior & interior

Blood supply of heart Systemic & pulmonary circulation

Branches of aorta, common carotid artery, subclavian artery, axillary artery, brachial artery, superficial palmar arch, femoral artery, internal iliac artery

Peripheral pulse Inferior venacava, portal vein, portosystemic anastomosis

Great saphenous vein Dural venous sinuses

Lymphatic system- cisterna chyli & thoracic duct Histology of lymphatic tissues

Names of regional lymphatics, axillary and inguinal lymph nodes in brief

**4. Gastro-intestinal system:** Parts of GIT, Oral cavity (lip, tongue (with histology), tonsil, dentition, pharynx, salivary glands, Waldeyer's ring)

Oesophagus, stomach, small and large intestine, liver, gall bladder, pancreas

Radiographs of abdomen

**5. Respiratory system:** Parts of RS, nose, nasal cavity, larynx, trachea, lungs, bronchopulmonary segments Histology of trachea, lung and pleura

Names of paranasal air sinuses

**PART – B**

**6. Peritoneum**

Description in brief

**7. Urinary system**

Kidney, ureter, urinary bladder, male and female urethra

Histology of kidney, ureter and urinary bladder

**8. Reproductive system**

Parts of male reproductive system, testis, vas deferens, epididymis, prostate (gross & histology)

Parts of female reproductive system, uterus, fallopian tubes, ovary (gross & histology)

Mammary gland – gross

**9. Endocrine glands**

Names of all endocrine glands in detail on pituitary gland, thyroid gland, parathyroid gland, suprarenal gland – (gross & histology)

**10. Nervous system**

Neuron

Classification of NS: Cerebrum, cerebellum, midbrain, pons, medulla oblongata, spinal cord with spinal nerve (gross & histology)

Meninges, Ventricles & cerebrospinal fluid

Names of basal nuclei

Blood supply of brain

Cranial nerves

Sympathetic trunk & names of parasympathetic ganglia

Skin: Skin-histology

Appendages of skin

Eye: Parts of eye & lacrimal apparatus

Extra-ocular muscles & nerve supply

Ear: parts of ear- external, middle and inner ear and contents

Spermatogenesis & oogenesis

Ovulation, fertilization

Fetal circulation

Placenta

## **PRACTICALS**

Histology of types of epithelium

Histology of serous, mucous & mixed salivary gland

Histology of the 3 types of cartilage

Demo of all bones showing parts, radiographs of normal bones & joints

Histology of compact bone (TS & LS)

Demonstration of all muscles of the body

Histology of skeletal (TS & LS), smooth & cardiac muscle

Demonstration of heart and vessels in the body

Histology of large artery, medium sized artery & vein, large vein

Microscopic appearance of large artery, medium sized artery & vein, large vein, pericardium

Histology of lymph node, spleen, tonsil & thymus

Normal chest radiograph showing heart shadows

Normal angiograms

Demonstration of parts of respiratory system.

Normal radiographs of chest

Histology of lung and trachea

Demonstration of reflections

Demonstration of parts of urinary system

Histology of kidney, ureter, urinary bladder

Radiographs of abdomen-IVP, retrograde cystogram

Demonstration of section of male and female pelvis with organs in situ

Histology of testis, vas deferens, epididymis, prostate, uterus, fallopian tubes, ovary

Radiographs of pelvis – hysterosalpingogram

Demonstration of the glands  
Histology of pituitary, thyroid, parathyroid, suprarenal glands  
Histology of peripheral nerve & optic nerve  
Demonstration of all plexuses and nerves in the body  
Demonstration of all part of brain  
Histology of cerebrum, cerebellum, spinal cord  
Sensory organs:  
Histology of thin and thick skin  
Demonstration and histology of eyeball  
Histology of cornea & retina  
Embryology

## **PAPER II: PHYSIOLOGY & PATHOLOGY**

### **THEORY PAPER**

#### **Part-A**

- ❖ Functions of cell organelles, tissues, organs, coordination amongst various organs as functional systems. Basic physiology of Digestive, Respiratory, Cardiovascular system, Excretory System, Nervous system, Musculoskeletal system, Reproductive system.
- ❖ CVS, humoral & neural regulation of functions. Effect of environment on various functions of body.

#### **Part-B**

**1. Pathology:** Introduction, State of Cell, Inflammation, Metabolism of cell and disorders, Cause of disease, Diseased state, Degeneration.

**2. Immunity and Hypersensitivity:** Immunity: Definition and Classification, Antigen, Antibodies-Immunoglobulin, Antigen and antibody reaction, Structure and function of immune system, Immune response. hypersensitivity.

**3. Principal and Procedure of Serological Tests:** CRP, Brucella, Agglutination, ASO, WIDAL, Cold agglutination, VDRL, TPHA.

**4. Human Blood Group Antigens and Antibodies**

**5. ABO Blood Group Systems:** Subgroups, Source of antigens and types of antibodies

**6. Rh Blood Group System**

**7. Growth disorders and Neoplasia:** Neoplasia, Tumors, Histopathology of diseases.

## **PRACTICALS**

1. Instrumentation used in Physiology
2. Various techniques used in Physiology
3. Instrumentation and Basic Techniques in Pathology

## **PAPER III : RADIATION PHYSICS**

**1. Basic concepts:** Basic Units, Heat, Acoustics etc. Basic concepts of power, work, force, energy - Einstein's formula - Electronics, Electricity & Magnetism, -electromagnetic waves - Units and measurements - temperature and heat-SI units of above parameters-Atomic structure- Nucleus - Atomic Number, Mass Number electron orbit and energy levels-Periodic table -Isotopes-Isobars-Ionization and excitation.

**2. Electromagnetic induction:** Electric charges-electric induction - electric potential-capacitance and capacitors. Electrical energy and power - unit of current-resistance and Ohm's law - circuit laws -

heating effect of current - sources of electrical energy - e.m.f. Magnetism-Magnetic effect of an electric current - applications of magnetic field. Electro-magnetic induction, laws of mutual induction and self induction. Alternating current-transformers theory and losses - practical aspects-reactance –resonance - impedance and power factors.

**3. X-Rays:** Electromagnetic waves - quantum theory of radiation - visible light - fluorescence. X-Rays – properties and production of x-rays -- interaction of electrons with target-spectra of x-rays – the quality and intensity of x-rays – the factors such as Filters, applied voltage affecting quality and intensity-Characteristics X-Rays - factors affecting X-Ray-emission spectra - X-ray Quantity and quality – measurements -heel effect - soft and hard X-Rays - added and inherent filtration - reflection and transmission.

**4. X-Ray Circuits:** Thermionic diode - X-ray valves and tubes -principle and practical aspects - Semiconductors and semiconductor devices-Introduction, energy bands in solids, the semiconductor types, charge carriers and conductivity, p-n junction diode as rectifier, junction transistor -logic gates. – triode valves – cathode ray oscilloscopes. Self rectifying circuits – Half wave pulsating voltage circuits – full wave pulsating voltage circuits – constant potential circuits – measurement of high voltage – control of KV circuit – MA circuit.-KvP-mA-mAS-HU.

**5. Radioactivity:** Natural and artificial radioactivity-alpha decay-beta decay and spectra – gamma emission-positron decay electron capture and internal conversion-Exponential decay-Half life-Unit of activity-specific activity. Nuclear Fission-Nuclear reactor. Radiation sources-Natural and artificial-production of radio isotopes-reactor produced isotopes-Fission products-Gamma ray source for Medical uses.

**6. Interaction of X-and Gamma rays:** Attenuation of X-ray or Gamma rays-absorption and scattering-half value layer-coherent scattering-Photo electric absorption-compton scattering-pair production and photoelectric disintegration. X-Ray transmission through medium-linear and mass attenuation coefficients. HVT - TVT and interaction of charged particle and neutrons with matter. Interaction of X-and Gamma rays in body-fat-soft-tissue-bone-contrast medium-Total attenuation coefficient. Relative important of different types of interactions.

**7. Physics of Diagnostic Radiology : X-ray Tube:** Anode & Cathode - Thermionic diode – X-ray valves and tubes –principle and practical aspects – semiconductors – triode valves – cathode ray oscilloscopes – X-ray circuits – self rectifying circuits – half wave pulsating voltage circuits – full



valve pulsating voltage circuits - measurement of high voltage – control of KV circuit – mA circuit.  
X-ray beam quality.

**8. X-Ray generators and circuits**-Filament current and voltage, X-Ray circuits -primary circuit- auto transformer-switch and timers- principle of automatic exposure control and practical operation - filament circuit -high voltage circuits - half wave & full wave rectification -three phase circuits. Types of generators, 3 phase, 6 and 12 pulse circuits- falling load generators-capacitors discharge and grid control systems.

**9. X-ray tables:** floating top table & variable height table.

**10. X-Ray Grids /Bucky:** Scattered Radiation -Significance of scatter – Beam limiting devices.-Grid principle and structure – Types of Grids - vertical bucky- versatile bucky -Stationary grid, parallel grid, focused grid – crossed grid, moving grid – Potter Bucky Diaphragm- Control of scattered radiation and grids/Bucky - Methods of minimizing formation of scatter radiation, types of grids and grid ratio- use of cones – diaphragm/ light beam devices - effectiveness of collimation - limitations of the primary beam/the light beam diaphragm -Effects of scatter radiation on radiograph image quality, patient dose and occupational exposure.

**11. X-Ray Cassettes & Intensifying screens:** Fluorescence – constituents of intensifying screens – types of screens-intensification factors-speed of screen-screen unsharpness. Cassette-construction- types of cassettes- use of fluorescent screen in radiology, effect of screen in reduction of patient dose.

## **Practical**

Topics:-

1. Congruence of Radiation and Optical field and beam.
2. Determination of focal spot size of diagnostic X-ray tube.
3. K.V. and Exposure time testing.
4. Linearity testing of the Timer.
5. Consistency of M.A. loading.
6. Consistency of Radiation Output.
7. Evaluation of Total filtration of the tube.
8. Film screen contact testing.
9. Table top Exposure rate measurement in fluoroscopy.
10. Radiation protection survey, in and around of diagnostic installations.

## PAPER IV : RADIATION PROTECTION

### 1. Radiation Quantities and Units

Radiation- Radioactivity- Sources of radiation - natural radioactive sources -cosmic rays-terrestrial radiation - - man made radiation sources. Units of radiation - Quality factor - Flux-Fluence-Kerma- Exposure- Absorbed dose- Equivalent Dose- Weighting Factors-Effective Dose - Occupational Exposure Limits - Dose limits to public.

### 2. Biological Effects of radiation

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.

**3. 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 – Victorian electrometer – secondary standard dosimeters – film dosimeter – chemical dosimeter- thermoluminescent Dosimeter. - Pocket dosimeter-Radiation survey meter- wide range survey meter -zone monitor-contamination monitor -their principle-function and uses. Advantages & disadvantages of various detectors & its appropriateness of different detectors for different type of radiation measurement.

**4. Radiation protection:** Radiation protection of self and patient- Principles of radiation protection, time - distance and shielding, shielding - calculation and radiation survey –ALARA- personnel dosimeters (TLD and film batches)- occupational exposure.

### 5. Q.A in Diagnostic Radiology

Quality assurance (Q.A), acceptance testing and quality control tests in Radiology-

Meaning of the terms used and aspects of a QA programme, equipment and staff requirements, benefits of QA procedures in an imaging department –NABH guidelines. Verification of Optical & Radiation field congruence, Beam alignment, Focal spot size, Linearity of tube current mA and Timer, applied

potential, HVT and total tube filter, Contact between film and intensifying screen, contrast resolution, Grid alignment, Special techniques like mammography, CT - CT Dose Modulation-Patient dose management.

## **6. Radiation Hazard evaluation and control**

Philosophy of Radiation protection, effects of time, Distance & Shielding. 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 material.

## **7. 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.

## **8. Role of Radiographer in Planning, QA & 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 rooms, dark 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.

ICRP, NRPB, NCRP and WHO guidelines for radiation protection, pregnancy and radiation protection.

## **Practical**

1. Time, Dose, Shielding, Measurement of HVT & TVT
2. Familiarization of Radiation Survey meters and their functional performance checks
3. Radiological Protection Survey of Diagnostic X-Ray installation
4. Diagnostic Imaging: Quality Assurance
5. AERB safety requirements- Atomic Energy Act, Radiation protection rules.

## **SECOND YEAR**

### **PAPER I : CLINICAL RADIOGRAPHY**

#### **Conventional Non contrast radiography-**

**Extremities Radiography** – Hand- Finger –MCP- Wrist joint- Forearm -Elbow joint – humerus - shoulder joint. Foot – Toes- Tarsal bones -Ankle joint - Knee joint – patella – tibia- femur – Hip joint – pelvis -sacroiliac joint.

**Spine Radiography** -Vertebral column – Atlanta occipital articulation- cervical spine- dorsal spine - lumbar spine – sacrum -vertebral canal- vertebral foramen.

**Skull Radiography** – general, sella – temporal bone – mastoid – optic foramen – Internal auditory canal – Superior and inferior orbital fissure – base of skull – facial bones – petrous apex – Zygomatic

bone, nasal bone, sinuses of skull – mandible – Temporo-Mandibular joint – Paranasal sinuses  
Radiography.

**Chest Radiography** –Basic views (PA & AP) - inspiratory & expiratory films- special chest views & their significance – larynx- trachea- thoracic inlet -Sternum - Ribs – Heart and great vessels – mediastinum -Diaphragm – double exposure technique.

**Abdomen & Pelvic Radiography** – all projection – the acute abdomen investigation.

*Soft tissue radiography:* Preparations, Instructions, Various techniques, positioning digital mammography, High and low KV Technique – radiography – technique for steep range radiography – intensifying screen.

*Stereo Radiography:* Principle – tube shifting relation of patient – correct making and viewing of stereo radiographs.  
– applications.

*Macro radiography:* Principle sizes of focal spot its limitation in its application.

**High kV technique:** technique & usefulness.

**Dental radiography**-types of equipments –techniques- indications-films-dental radiography in trauma patient

## **Practicals**

Positioning and clinical radiography

## PAPER II : X-RAY FILM / IMAGE PROCESSING TECHNIQUES

- 1. X-Ray film-** X-ray film construction and film characteristics – Composition of single and double coated radiographic films -structure of emulsion- film characteristics; speed, base fog, gamma, latitude -effect of grain size on film response to exposure, interpretation of characteristics curve- exposure to x-rays.
- 2. Types of Radiographic Films-** Applications -advantages/limitations of different types Structure, properties of different parts-Film storage - handling -film wrappings- handling of exposed and unexposed films -safe light requirements.
- 3. Cassettes:** Loading and unloading of cassettes and their care/maintenance - effects of kV and mA on variation of emitted radiation intensity- Intensifying screens-determination of relative speeds - film contrast -film screen contact.
- 4. Radiographic Image:** Meaning of radiographic image contrast, density, resolution, sharpness, magnification and distortion of image, noise and blur. Primary radiological image formation- Image quality – unsharpness- resolution – fog and noise - use of contrast media-density- contrast – brightness- optical density measurements- Image recording devices.
- 5. Image processing**– Film developing principles- acidity, alkalinity, pH, the processing cycle-process of film developing - development -developer solution- constituents of developer. Fixing- fixer solution- composition of fixer –washing – drying replenishment -checking and adjusting replenishment rates - other processing solution – effect of temperature and development time - film processing methods - common errors and faults while processing manual and automatic processing- latent image formation– silver recovery and economics.
- 6. Film archiving systems-** Image recording devices-Laser imager/camera functioning.  
Multiformatter-  
Optical Disc. System  
Film archieving systems - MOD/disc/PACS etc.
- 7. Automatic processing** - Automatic film handling systems -Automated Processors - equipment for Film Processing-functions of various components- film roller transport - transport time -film feed system-Importance and relation to temp, fixed and variable time cycles-Care and maintenance - cleaning routine and methods of cleaning.
- 8. Radiographic illuminators:** and viewing conditions, visual acuity and resolution.
- 9. Dark Room-** Site – layout - dark room design- construction- processing area– illumination-safe light compatibility - entrance safe lighting – types- storage- shelving of films-cleaning and maintenance.

**10. Computed and Digital Radiography and PACS:** Image acquisition, photostimulable phosphors, digital chest radiography and future developments, Picture characteristics, archiving possibilities; transfer system and designs, Image recording devices, laser imager and multiformatter

#### **4. Recent Advances in Imaging Systems**

Mobile units of Computer Radiography & Digital Radiography system.

Image processing & Display systems-Recent advances, concepts and applications in processing of images in digital form using computer based systems.

### **Practicals**

Darkroom procedures and processing

## **PAPER III: CONTRAST & SPECIAL RADIOGRAPHY PROCEDURES**

### **Non-contrast Special radiography-**

#### **1. Paediatric Imaging:**

special needs of patient and radiographer- use of dedicated equipment and accessories-modified technical considerations - selection of exposure factors-image quality considerations

– radiation protection of the patient - special techniques in children for contrast studies.

#### **2. Geriatric radiography**

Equipment and accessories – exposure factor considerations in special care. Elderly patients profile - difficulties during radiography – technical considerations-projections with unconventional special positioning.

#### **3. Trauma/Emergency Radiography**

Selection of suitable X-Ray equipment – patient position -radiographic projections and sequence for each patient – modification of routine positioning– radiation protection – patient care.

#### **4. Operation theatre radiography**

O.T procedures-Operative cholangiography – orthopaedic procedures –maintenance of asepsis – preparation of radiographer and equipment/accessories – careful safe use of mobile and fluoroscopic equipment – radiation protection – patient care – rapid availability of radiographic image-cooperation with OT staff-type of studies done -clinical applications - clinical applications- per operative radiographs- peroperative fluoroscopy studies -patient care-radiation protection of all staff.

## **Contrast radiography**

*Radiological contrast media* – classification -need for radiological contrast media - methods of administration-dosage-reactions to contrast media- role of radiographer in management of patient with contrast reaction.

*For all contrast investigations*-patient preparation, positioning, patient care during the study-post procedural patient care-types of contrast media used and dosage-alternative contrast used-side effects and its identification-treatment of complication during the procedure - pathological conditions- indications and contraindications- injection procedure –techniques for radiographic projections - radiographic appearances– radiation protection.

**5. Sialogram-** indications and contraindications, patient preparation, positioning, patient care during the study-post procedural patient care-types of contrast media used, techniques for radiographic projections - radiographic appearances– radiation protection.

**6. Barium studies-** different types – Barium swallow Barium meal study of upper GIT, Barium meal follow through, Barium enema, small bowel enema, distal colography, defaecography.

**7. Percutaneous Transhepatic Cholangiogram, ERCP, T-Tube cholangiography, per-operative cholangiography--** indications and contraindications, patient preparation, positioning, patient care during the study-post procedural patient care-types of contrast media used, techniques for radiographic projections - radiographic appearances– radiation protection.

**8. IVP-rapid sequence-infusion pyelography-high dose urography, Cystogram, Anterior Urethrogram RGU, MCU, RCP--** indications and contraindications, patient preparation, positioning, patient care during the study-post procedural patient care-types of contrast media used, techniques for radiographic projections - radiographic appearances– radiation protection.

**9. Angiography, Diagnostic & therapeutic, venography, Lymphangiogram-** indications and contraindications, patient preparation, positioning, patient care during the study-post procedural patient care-types of contrast media used, techniques for radiographic projections - radiographic appearances– radiation protection.

**10. Orthography, Discography-** indications and contraindications, patient preparation, positioning, patient care during the study-post procedural patient care-types of contrast media used, techniques for radiographic projections - radiographic appearances– radiation protection.

**11. Myelogram-** indications and contraindications, patient preparation, positioning, patient care during the study-post procedural patient care-types of contrast media used, techniques for radiographic projections - radiographic appearances– radiation protection.

**12. Hysterosalphingography-** indications and contraindications, patient preparation, positioning, patient care during the study-post procedural patient care-types of contrast media used, techniques for radiographic projections - radiographic appearances– radiation protection.



13. **Sinography-** indications and contraindications, patient preparation, positioning, patient care during the study-post procedural patient care-types of contrast media used, techniques for radiographic projections - radiographic appearances– radiation protection.
14. **Fistulogram--** indications and contraindications, patient preparation, positioning, patient care during the study-post procedural patient care-types of contrast media used, techniques for radiographic projections - radiographic appearances– radiation protection.
15. **Ductogram-** indications and contraindications, patient preparation, positioning, patient care during the study-post procedural patient care-types of contrast media used, techniques for radiographic projections - radiographic appearances– radiation protection.

### Practicals

Special and Contrast Radiographic procedures.

#### PAPER IV : ULTRASOUND, DOPPLER AND MAMMOGRAPHY

**1. Ultrasonography and Doppler systems:** Basic acoustics principle- Basic physics of sound propagation in different media, production of Ultrasound (piezoelectric effect), ultrasound terminologies – interaction of ultrasound with matter – ultrasound properties propagation in tissue, absorption, scattering, reflection and refraction- acoustic impedance – piezo electric effect – transducer – Pulsar – receiver – beam/sensitivity and gain - generators- A, B and M scanning & echo modes- transducers-techniques of sonography-equipment selection- display methods – ultrasound image formation - data storage and display – image and artifacts – doppler instrumentation – doppler equation – transducer – quality assurance and performance tests – bio effects and safety considerations. Types of machines – portable systems- acoustic coupling agents-ingredients/preparation.

**2. Ultrasonography and Doppler studies:** Techniques of sonography-selection- Preparations - instructions and positioning of patient for TAS, TVS, TRUS, neck USG and extremities- patient care and maintenance protocols-clinical applications display methods –quality image reproducible extend -assurance to patients.

**3. Mammography system:** History - Imaging requirements- Mammography system - construction/types accessories - tube, compression, grids, AEC etc.- nature of X-Ray beam suitable – accessories for immobilization - film processing - image quality - image recording devices - interventional procedures – accessories-biopsy equipment attachments - radiation dose- - mammo tomogram-Sonomammography-future developments.

**4. Mammography:** The Mammography as a clinical diagnostic tool- immobilization and identification techniques-positioning techniques for various projections - exposure factors-

Conventional & Digital studies- quality and advantage- diagnosis and screening- Characteristics of benign and malignant lesions – patient care – female attendant - interventional procedures - radiation dose- recent advances in mammography techniques -mammo tomogram & Sonomammography procedures- advantages & limitations.

### **5. Recent Advances in Imaging**

3D/4D Sonography systems

Image processing & Display systems-Recent advances, concepts and applications in processing of images in digital form using computer based systems.

## **THIRD YEAR**

### **PAPER I : COMPUTED TOMOGRAPHY**

#### **1. CT scan systems:**

History- generations of scanners-CT technology -helical/spiral & multi slice C.T- ultra fast scanners- system components - performance parameters - image quality and methods of image reconstruction- radiation dose measurements and technical aspects of Q.A -calibration and image acquisition-

#### **2. CT scan studies acquisition/ protocols /techniques:**

CT of head and neck – thorax – abdomen – pelvis – musculo skeletal system – spine – PNS. Anatomy – clinical indications and contraindications – patient preparation – technique – contrast media-types, dose, injection technique; timing, sequence - image display – patient care – utilization of available techniques & image processing facilities to guide the clinician-CT anatomy and pathology of different organ systems.

#### **3. Recent Advances in Imaging**

Dynamic CT studies

128 slice & higher slice C.T equipments.

Image processing & Display systems-Recent advances, concepts and applications in processing of images in digital form using computer based systems.

**4. Picture Archiving and Communication Systems (PACS)**-newer advancements – updates - systems designs-transfer restrictions.

## **PAPER-II MAGNETIC RESONANCE IMAGING**

**1. MRI Scanners:** History - basic physical principle - Physical principles -NMR signals– instrumentation- hard ware-MR system components- magnet system- Magnetic shielding- RF shielding- bioeffects of MRI- site selection and safety -reconstruction system - different coils used - NMR signals advantage -imaging methods – pulse imaging sequences - spectroscopy parameters - calibration and image acquisition - reconstructions- 3D images- - image contrast– factors affecting image quality - artifacts - difference between CT and MRI images- host computer -viewing archiving- hard copy - image formation and storage device.

### **2. MRI Scans:**

Methods of MRI imaging methods – Head and Neck ,Thorax, Abdomen, Musculoskeletal System imaging - Clinical indications and contraindications- types of common sequences-effects of sequence on imaging - Protocols for various studies- slice section- patient preparation-positioning of the patient -patient care-calibration - paramagnetic agents and dose, additional techniques and recent advances in MRI - image acquisition-modification of procedures in an unconscious or unco-operative patient - plain studies- contrast studies -special procedures- reconstructions- 3D images- MRS blood flow imaging, diffusion/perfusion scans - strength and limitations of MRI- role of radiographer.

### **3. Recent Advances in Imaging**

Dynamic MRI studies

Per operative application of various imaging systems including detector probes application in Nuclear Medicine

3 Tesla & higher T MRI scanners

Image processing & Display systems-Recent advances, concepts and applications in processing of images in digital form using computer based systems.

## **PAPER III : ANGIOGRAPHY & INTERVENTIONAL RADIOLOGY**

### **1.Basic principle and hardware**

Angiography equipments history –Conventional angiography X-Ray equipment - Equipment construction-principle - DSA system basics - digital techniques -subtraction process-procedures for subtraction - care, choice and installation of the equipment – equipment, pitfalls and complications -

pressure injectors- contrast media -accessories-catheters, guide wires-uses of serial imaging devices- cine camera - video-recorder -film processing-radiation protection.

## **2. Angiography and Cine Studies /DSA**

Conventional / DSA studies- Abdominal, visceral, peripheral, cerebral and cardiac angiography - arterial/venous anatomy, physiology-clinical indications and contraindications - patient preparation- positioning of the patient -patient care-contrast media - types of contrast - dosage - accessories catheters, guide wires- pressure injection- control of radiographic and fluoroscopic equipment - exposure factors for serial programmes-programming-injection protocols- outline on each radiological procedure- radiographer's role- patient management before -during and after the procedure - venography- interventional angiography in hepatobiliary, GIT, urology and vascular system- coils/stents etc- indications and contraindications - role of radiographer-radiation safety.

**3. Interventional Radiology:** Practical interventional radiology in the diseases of the Hepatobiliary, GIT, Urology and Vascular System (non Neuro/Cardiac).

Indications and contraindications, equipment, pitfalls and complications, role of radiographer in the team.

# **PAPER IV : NUCLEAR MEDICINE**

## **1. Nuclear Medicine Equipments**

Nuclear Physics - basics in Nuclear Medicine- Nuclear medicine equipments - Gamma Cameras- rectilinear scanners- radioisotope generators-SPECT-CT & PET-CT- introduction-basic physics and principle involved- equipments basic structure—differences- fusion techniques- image formation- storage devices— advantages-limitations.

## **2. Nuclear Scintiscan procedures:**

SPECT-CT & PET-CT studies, protocols, Basics of common clinical Nuclear Medicine procedures/techniques—comparison with different structural imaging studies-advantages and limitations.

## **Books for reference**

- 1) Anatomy and Physiology for Radiographers- C.A. Werrick

- 2) Imaging Atlas of Human Anatomy – Jamie Weir et al (Mosby-Elsevier)
- 3) An Atlas of Normal Radiographic Anatomy – Richard and Alwin.
- 4) Comprehensive Radiographic Pathology. [Ronald L. Eisenberg](#), NancyM. Johnson
- 5) Surface and Radiological Anatomy – Hamilton et al (Heffer)
- 6) An Atlas of normal radiographic Anatomy – Ross and Wilson.
- 7) Physics for Radiography - Hay and Hughs
- 8) Basic Medical Radiation physics – Stanton.
- 9) Christensen’s Physics of Diagnostic Radiology – Christensen.
- 10) Clark’s Handbook for Radiographers – Charles Sloane, Ken Holmes & Craig Anderson, Hodder Educations, UK
- 11) Diagnostic Radiography – A concise practical Manual – Glenda J. Bryan (4<sup>th</sup> edn), Churchill Livingstone.
- 12) Text book of radiology for residents & technicians – 4<sup>th</sup> edition, Satish K. Bhargave.
- 13) Step by Step CT; Step by Step MRI and MRI made Easy for beginners – Govind B. Chavhan – Jaypee brothers and Medical Publishers (p) Ltd, New Delhi
- 14) CT & MRI protocol – Satish K. Bhargava, CBS publishers.
- 15) Text Book of Radiology for Residents & Technicians – 4<sup>th</sup> Edition – Satish K. Bhargava CBS publishers & Distributor (p) ltd.