

M.Sc Radiology & Imaging Technology

Curriculum and Syllabus 2024 Regulation

Based on Choice Based Credit System (CBCS)

and

Outcome Based Education (OBE)

Effective from the Academic year2024-2025

School of Allied Health Sciences

1. SHORT TITLE AND COMMENCEMENT:

These regulations shall be called "Specific Regulations for the M.Sc. Radiology and Imaging Technology course of Vels Institute of Science Technology and Advanced Studies, Deemed to be University u/s3 of UGC act 1956.These Regulations are applicable to the students who are admitted to the B.Sc. Radiology and Imaging Technology in this University.

As per the decision of the Academic Council of this University, these regulations have been prepared by adopting the regulations of the VISTAS.

2. AIMS

The aim of the course is to

a) Prepare graduates to assume responsibilities as professional, competent Technicians in providing promotive, preventive, curative and rehabilitative services.

b) Prepare students to diagnose and treating diseases with the help of image techniques such as x-rays, ultrasounds, magnetic resonance imaging (MRI), computed tomography, positron emission tomography, etc.

3. OBJECTIVES

On completion of the four years M.Sc. Radiology and Imaging Technology Programme the graduates will be:

1. Discover the radiologist combines clinical knowledge and skills with technology to impact the clinical care of the patient.

2. Apply knowledge gained on clinical service to complete reflection questions for each subspecialty site.

3. Recognize the normal anatomic structures on imaging studies and how the appearance is altered due to disease.

4. Exhibit professional behavior and appearance while on service including when interacting with residents, technologists, patients, and support personnel.

5. Explore the clinical care areas of the radiology department and interact with personnel by interviewing an attending radiologist, resident, radiologic technologist, and patient in each subspecialty

6. Provide the profession and community with trained qualified technologist/ lecturer.

7. Provide education and comprehensive program that promotes problem solving, critical thinking and communication skills in the clinical environment

8. Demonstrate quality patient care skills including professionalism and ethical behavior as specified in the code of ethics

4. ELIGIBILITY FOR ADMISSION

A Candidate desiring to join the M.Sc. Radiology and Imaging Technology should have completed B.Sc Radiology/ Radiography from any recognized university.

No upper age limit for Admission

A candidate is required to obtain 50% in the Entrance exam conducted by the VISTAS

5. DURATION OF THE COURSE:

The duration of the B.Sc. Radiology and Imaging Technology Degree course shall be 2 Years full-time programme comprising 4 Semesters under Choice based Credit System.

6. MEDIUM OF INSTRUCTION:

English shall be the medium of instruction for all subjects of study and examinationswill be conducted only in English.

7. COMMENCEMENT OF THE COURSE:

The course shall commence on August of the academic year.

8. WORKING DAYS IN A SEMESTER:

Each semester shall consist of not less than 100 working days and each academicyear shall have a total of 200 working days

9. REGISTRATION

A Candidate admitted to the course shall be registered by remitting the prescribed fees along with the Application form for registration duly filled with in the stipulated dates.

10. COMMENCEMENT OF THE EXAMINATIONS:

Regular Semester Examinations will commence from last week of November and lastweek of April

If the date of commencement of the examination falls on Saturday, Sunday or declared Public Holidays, the examination shall begin on the next working day.

M.Sc – RADIOLOGY & IMAGING TECHNOLOGYCURRICULUM

SEMESTER 1

Sl.No.	Category	Course Titles	Hours/Credits							Maximum Marks				
			Lecture		Tutorial		Practical		Total	IA		UA		Total
			Hours	Credits	Hours	Credits	Hours	Credits	Credits	Theory	Practical	Theory	Practical	
1.1	Program Core Theory	Radiological Physics	45	3	30	1	-	-	4	25	-	75	-	100
1.2	Program Core Theory	Conventional Radiological and Imaging Equipment	45	3	30	1	-	-	4	25	-	75	-	100
1.3	Program Core Theory	Radiographic and Imaging Techniques	45	3	30	1	-	-	4	25	-	75	-	100
1.4	Program Core-Lab	Radiological Physics	-	-	-	-	60	2	2	-	50	-	50	100
1.5	Program Core-Lab	Conventional Radiological and Imaging Equipment	-	-	-	-	60	2	2	-	50	-	50	100
1.6	Program Core-Lab	Radiographic and Imaging Techniques	-	-	-	-	60	2	2	-	50	-	50	100
1.7	Program Elective	Epidemiology	30	2	-	-	-	-	2	100	-	-	-	100
								Total	**20**			**Total**		**700**

SEMESTER 2

Sl.No.	Category	Course Titles	Hours/Credits							Maximum Marks				
			Lecture		Tutorial		Practical		Total	IA		UA		Total
			Hours	Credits	Hours	Credits	Hours	Credits	Credits	Theory	Practical	Theory	Practical	
2.1	Program Core Theory	Radiographic Procedure and Positioning	45	3	30	1	-	-	4	25	-	75	-	100
2.2	Program Core Theory	Advanced Technique & instrumentation of CT	45	3	30	1	-	-	4	25	-	75	-	100
2.3	Program Core Theory	Advanced Technique & instrumentation of MRI	45	3	30	1	-	-	4	25	-	75	-	100
2.4	Program Core-Lab	Radiographic Procedure and Positioning	-	-	-	-	60	2	2	-	50	-	50	100
2.5	Program Core-Lab	Advanced Technique & instrumentation of CT	-	-	-	-	60	2	2	-	50	-	50	100
2.6	Program Core-Lab	Advanced Technique & instrumentation of MRI	-	-	-	-	60	2	2	-	50	-	50	100
2.8	Program Elective	Hospital management	30	2	-	-	-	-	2	100	-	-	-	100
					5			**Total**	**20**			**Total**		**700**

SEMESTER 3

Sl.No.	Category	Course Titles	Hours/Credits							Maximum Marks				
			Lecture		Tutorial		Practical		Total	IA		UA		Total
			Hours	Credits	Hours	Credits	Hours	Credits	Credits	Theory	Practical	Theory	Practical	
3.1	Program Core Theory	Quality Assurance and Quality Control in Diagnostic Radiology and Imaging	45	3	30	1	-	-	4	25		75	-	100
3.2	Program Core Theory	Newer Imaging Modalities	45	3	30	1	-	-	4	25		75	-	100
3.4	Program Core-Theory	Principles of Epidemiology, Research Methodology, Biostatistics and Medical Ethics	45	3	30	1	-	-	4	25		75	-	100
3.5	Program Core-Lab	Quality Assurance and Quality Controlin Diagnostic Radiology andImaging	-	-	-	-	60	2	2	-	50	-	50	100
3.6	Program Core-Lab	Newer ImagingModalities	-	-	-	-	60	2	2	-	50	-	50	100
3.7	Program Core-Lab	Principles of Epidemiology, Research Methodology, Biostatistics and Medical Ethics	-	-	-	-	60	2	2	-	50	-	50	100
3.8	Program Elective	Patient care	30	2	-	-	-	-	2	100	-	-	-	100
								Total	**20**				**Total**	**700**

SEMESTER 4

Sl.No.	Category	Course Titles	Hours/Credits							Maximum Marks				
			Lecture		Tutorial		Practical		Total	IA		UA		Total
			Hours	Credits	Hours	Credits	Hours	Credits	Credits	Theory	Practical	Theory	Practical	
4.1	Program Core	Radiation protection in diagnostic imaging and Nuclear Medicine imaging techniques, Post processing techniques in radiology	45	3	30	1	-	-	4	25		75	-	100
4.2	Program Core	Intervention Radiological Techniques and Patient Care	45	3	30	1	-	-	4	25		75	-	100
4.3	Program Core- Lab	Radiation protection in diagnostic imaging and Nuclear Medicine imaging techniques, Post processing techniques in radiology	-	-	-	-	60	2	2	-	50	-	50	100
4.4	Program Core-Lab	Intervention Radiological Techniques and Patient Care	-	-	-	-	60	2	2	-	50	-	50	100
4.5	Program Core-Lab	Seminars, Journal Clubs and Group Discussions	-	-	-	-	120	4	4	-	50	-	50	100
4.6	Program Core-Lab	Dissertation/Project	-	-	-	-	120	4	4	-	50	-	50	100
								Total	**20**				**Total**	**600**

11. SUBMISSION OF LABORATORY RECORD NOTE BOOKS:

At the time of practical examination, each candidate shall submit to the examiners his / her laboratory note books duly certified by the Head of the Department as a bonafide record of the work done by the candidate.

12. INTERNALASSESSMENT:

a) A minimum of two written internal assessment examinations shall be conducted in each subject during a semester and the Best / Average marks of two examinations shall be taken into consideration for the award of internal marks.

b) A model practical examinations shall be conducted in each subject (wherever practical have been included in the curriculum) shall be taken into consideration for award of internal marks in practical.

c) Tests will be conducted giving sufficient time for preparation.

d) No repeat, reschedule and postponement of the assessment date is permitted. Students shall compulsorily attend any three continuous assessments

13. ATTENDANCE REQUIRED FOR ADMISSION TO EXAMINATIONS:

(a) No candidate shall be permitted to appear for the University examinations, unless he/she attends the course for the prescribed period.

(b) Every candidate is required to put in a minimum of 80% of attendanceboth in theory and practical separately in each subject for admission tothe examination.

(c) A candidate lacking in the prescribed attendance in any subject in theoryand /or practical shall not be admitted to the entire examination.

14. CONDONING LACK OF ATTENDANCE

1. Condoning of shortage of attendance up to a maximum of 10% in the prescribed eligible attendance for admission to year end examination rests with the discretionary power of the Vice Chancellor. A Candidate lacking in attendance should submit an application in the prescribed form and remit the stipulated fee, 15 days prior to the commencement of the theory examination, The Head of the Department should satisfy himself on the reasonableness of the candidate's request while forwarding the application of the candidate to the Controller of Examinations, who would obtain the Vice – Chancellor's approval for admission to the examination. No application would be accepted if it is not forwarded through properchannel.

2. Condoning lack of attendance should be taken up for consideration under the following circumstances:-

a) Any illness affecting the candidate – Candidates should submit a medical certificate from registered medical practitioners.

b) Any unforeseen tragedy in the family. The parents/ guardian should give in writing about what had happened.

c). Participation in National Service Scheme and other co-curricular activities representing the University.

15. RE-ADMISSION AFTER BREAK OF STUDY:

A separate regulation is available for all the UG/PG courses of this universityfor the readmission of candidates after a break of study.

16. YEAR END EXAMINATIONS

1. Commencement of the Examination will be in November /April

2. If the date of commencement falls on Saturdays, Sundays or declared public holidays, the examination shall begin on the next working day.

3. The duration of the examination of each subject is 3hours.
4. Minimum pass marks shall be 50 % in each of the theory and practical papers separately except in Internal papers.
5. Minimum Pass marks in Internal papers Shall be 50%.

6. Carryover of failed subjects.

a. A candidate has to pass in theory and practical examinations separately in each of the subject.

b. If a candidate fails in either theory or practical of the subjects, he/she has to reappear for both the Theory and Practical.

c. The candidate if fails can be permitted for admission to next year.

d. The candidate shall have to clear all the previous examination before appearing for the Sixth Semester examination.

19. REVALUATION / RETOTALLING OFANSWER PAPERS:

There is provision for revaluation of the answer papers of failed candidates in any examination. However, the failed candidates cannot apply for retotaling.

20. CREDITS

Credits will be assigned on the basis of the lectures (L) /tutorials (T) Clinical Training (CR) /laboratory work (P) /Research Project (RP) and other form of learning in a 15-20 week schedule.

- L- One credit for one hour lecture per week (1 credit = 15 hours)
- P/T – One credit for every two hours of laboratory or practical (1 credit = 30 hours)
- CR – One credit for every two hours of Clinical Training/Clinical Rotation/Posing (1 credit = 30 hours)
- RP – One credit for every two hours of Research Project per week – Max Credit 20-25 (1 credit =30 hours)

21. GRADING SYSTEM

All assessments of a course shall be done on absolute marks basis. However, for the purpose of reporting the performance of a candidate, letter grades, each carrying certain points, will be awarded as per the range of total marks (out of 100) obtained by thecandidate, as detailed below:

Letter Grade	**Grade Point**	**Range of Marks***
O (Outstanding)	10	86-100
A+ (Excellent)	9	70-85
A (Very Good)	8	60-69
B+(Good)	7	55-59
B (Above Average)	6	50-54
C (Average)	5	45-49
D – (Pass)	4	40-44
F (Fail) / RA (Reappear)	0	Below 40
AB (Absent)	0	-
NC- not completed	0	-

After results are declared, Grade Statement will be issued to each student which will contain the following details:

- The college in which the candidate has studied
- The list of subjects enrolled during the semester and the grades scored.
- The Credits awarded and accumulated.

- The Grade Point Average (GPA) for the semester and
- The Cumulative Grade Point Average (CGPA) of all subjects enrolled from first semester onwards.

GPA is the ratio of, the sum of the products of the number of credits of subjects (C) and the grade points scored in those subjects (GP),to the sum of the credits of all the subjects in that semester.

$$GPA = \frac{\text{Sum of } [C \times GP]}{\text{Sum of } C}$$

CGPA will be calculated using the above formula, considering all the subjects enrolled from first semester onwards. “RA”, “NC” and “Ab” grade will be excluded for calculating GPA and CGPA.

22. CLASSIFICATION OF SUCCESSFUL CANDIDATES

The CGPA arrived at the completion of the course shall be the criteria for the classification of successful candidates as below:

Cumulative Grades and Grade Points

Letter Grade	Grade Point	CGPA
O (Outstanding)	10	9.01 – 10.00
A+ (Excellent)	9	8.01 – 9.00
A (Very Good)	8	7.01 – 8.00
B+ (Good)	7	6.01 – 7.00
B (Above Average)	6	5.01 – 6.00
C (Average)	5	4.51 – 5.00
D (Pass)	4	4.00 – 4.50

a) Successful candidates who secure 75% marks and above as a course aggregate in the first appearance taking University theory, practical, project / dissertation evaluation and viva shall alone be awarded Distinction. This will also apply for award of University rank.

b) Successful candidates who secure 60% marks and above as a course aggregate in the University theory, practical, project / dissertation evaluation and viva shall be awarded First Class.

c) All others who secure 40-59% in gross percentage will be classified to have passed in Second Class.

23. PATTERN OF QUESTION PAPER FOR UNIVERSITY EXAMINATION:

EXAMINATION QUESTION PAPER PATTERN

Essay	**2 x 15**	**= 30 Marks**
Short Notes	**7 x 5**	**= 35 Marks**
Short Answers	**5 x 2**	**= 10 Marks**
Total		**75 Marks**

Internal Split up – Theory

1. Continuous Assessment: 10 Marks

S.no	Continuous Assessment	Marks
1	Attendance	5
2	Assignment	5

2. Internal Assessment: 15 marks Two

Sessional Exams per Course

Internal Split up – Practical

1. Continuous Assessment: 20 Marks

S.no	Continuous Assessment	Marks
1	Group Project	10
2	Record note Book	10

2. Model Practical Examination: 30 Marks

25. GRACE MARKS

Maximum of 5 grace marks for each subject is permitted, and grace marks should not exceed 8 marks in total marks for one academic year in theory paper only.

26. MINIMUM MARKS REQUIRED FOR PASS IN ALL OTHER SUBJECTS

a) Students should get 50% of marks in the subject where internal evaluation alone is conducted.

b) Students should get 50% of marks in university Theory & Practical examination and 50% internal evaluation in the subject.

SEMESTER -I

Paper: I

Radiological Physics

UNIT -I

X-rays: Discovery of x-rays-X-ray production and properties: Bremsstrahlung radiations-Characteristics X-Rays, factors affecting X-ray emission spectra, X-ray quality and quantity, HVL measurements, heel effect, soft and hard X-Rays, added and inherent filtration, reflection and transmission targets.

UNIT -II

Interaction of ionizing radiation with matter-Types of interactions of X-and gamma radiation, Photoelectric & Compton, Pair production, annihilation radiation.

UNIT -III

Interaction of X and gamma rays: Transmission through matter, law of exponential attenuation, half value layer, and linear attenuation coefficient-coherent scattering-photonuclear disintegration-Particle interactions. Interactions of X rays and Gamma rays in the body; fat-soft tissue-bone-contrast media-total attenuation coefficient-relative clinical importance.

UNIT -IV

Exponential attenuation (linear/mass attenuation coefficients), Half Value Thickness (HVT), Tenth Value Thickness (TVT), dependence on energy and atomic number

UNIT -V

Radiation intensity and exposure, photon flux and energy flux density.

UNIT -VI

LET, range of energy relationship for alpha, beta particles with X-Rays.

UNIT -VII

X-ray tube: historical aspects, construction of X-ray tubes, requirements for X-ray production(Electron source, target and anode material), tube voltage, current, space charge, early X-ray tubes(Coolidge tubes, tube envelop and housing) cathode assembly, X-ray production efficiency, advances in X-ray tubes, anode angulation and rotating tubes-line focus principle-space charge effect, tube cooling-Modern X-ray tubes-stationary anode, rotating anode, grid controlled X-ray tubes, heel effect, off focus radiation, tube insert and housing-Tube rating-Quality and intensity of x-rays-factors influencing them.

UNIT -VIII

Grid controlled and high speed tubes, focal spot size, speed of anode rotation, target angle, inherent filtration, radiation leakage and scattered radiation) Interlocking and X-ray tube overload protection.

UNIT -IX

Heat dissipation methods, tube rating, heat units, operating conditions and maintenance and Q.A procedures.

UNIT - X

Filament current and voltage, X-ray circuits (primary circuit, auto transformer), types of exposure switch and timers, principle of automatic exposure control (AEC) 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-high frequency generators-falling

load generators, Capacitors discharge and grid control systems.

UNIT -XI
X-ray generator circuits: Vacuum tube diodes-semi-conductor diodes-transistor-Rectification-half and full wave-self rectification-X-ray generator; filament circuit-kilo Voltage circuit-single phase generator-three phase generatorconstant potential generator-Fuses, switches and interlocks-Exposure switching and timers-HT cables- earthing.

UNIT – XII
Physical quantity, its unit and measurement: Fundamental and derived quantity, SI unit, various physical/radiation quantity used in Diagnostic Radiology and its unit (for example, KVp, mA, mAs, Heat unit (HU).

UNIT XIII
Radiation quantities and units: Radiation intensity-exposure, roentgen, its limitations-kerma and absorbed dose electronic equilibrium-rad, gray, conversion factor for roentgen to rad-quality factor-dose equivalent-rem, Sievert. Quality factor, dose equivalent, relationship between absorbed dose and equivalent dose.

UNIT- XIV
Radiation detection and measurements: Principle of radiation detection-Basic principles of ionization chambers, proportional counters, G.M counters and scintillation detectors. Measuring system: free ionization chamber-thimble ion chamber-condenser chamber- secondary standard dosimeter-film dosimeter-chemical dosimeter-Thermo Luminescent Dosimeter-Pocket dosimeter.

UNIT- XV
Picture archiving and communication system (PACS)

Text Books:

- Physics for Radiography - Hay and Hughs
- Ball and mores essential physics radiographers, IV edition, Blackwell publishing.
- Basic Medical Radiation physics – Stanton.
- Christensen's Physics of Diagnostic Radiology – Christensen.
- New Understanding physics for advanced level – Jim Breithauput.
- Advanced Physics for you by Keith Johnson, Simmons hewett, Sue holt, John miller
- Christensen's Physics of diagnostic Radiology by Thaomas S. Curry III, M.D., Robert C Murry, Jr. Phd., Dow Dey, Phd.
- Applied Electronics, A. Subramanyam, The National Publishing co., Madras (1996).
- Design and Development of Medical Electronic Instrumentation, David Prutchi and Michael Norris, John Wiley & Sons (2005). Allied Health Sciences Radiology & Imaging Technology

Paper - II
Conventional Radiological and Imaging Equipment

UNIT -I

Production of x-rays: X-ray tube, gas filled x-ray tube, construction working and limitations; stationary anode x – ray tube; construction, working, 0methods of cooling the anode, rating chart and cooling chart; rotating anode x – ray tube: construction, working rating chart, speed of anode rotation, angle of anode inclination, dual focus and practical consideration in choice of focus, anode heel effect, grid-controlled x - ray tube; effect of variation of anode voltage and filament temperature; continuous and characteristics spectrum of x - rays, inherent filter and added filter, their effect on quality of the spectrum.

UNIT-II

High tension circuits: H.T. generator for x-ray machines, three phase rectifier circuits, three phase six rectifier circuit, three phase 12 rectifier circuit, high and medium frequency circuits; capacitance filter control and stabilising equipment; mains voltage compensator, mains resistance compensator, compensation for frequency variation, control of tube voltage, kV compensator; high tension selector switch, filament circuit, control of tub current, space charge compensation.

UNIT-III

Meters and exposure timers: Moving coil galvanometer: construction and working/conversion to milliammeter, ammeter and voltmeter, meters commonly used in diagnostic x-ray machines, pre reading kV meter and milliammeter, digital panel meters. Clockwork timers, synchronous motor timer, electronic timers, photo metric timers (fluorescent and photoelectric effect as applied in timers), ion chamber based timers, integrated timer.

UNIT-IV

Interlocking circuits: Relays: description and working, use of relays in diagnostic machines for over load protection, circuit diagram; simplified circuit and block diagrams illustrating sequence of events from mains supply to controlled emission of x-rays.

UNIT-V

Control of scattered radiation: Beam limiting devices: cones, diaphragms, light beam collimator, beam centring device, methods to verify beam centring and field alignment; grids; design and control of scattered radiation, grid ratio, grid cut-off, parallel grid, focused grid, crossed grid, grided cassettes, stationary and moving grid potter bucky diaphragms, various types of grid movements; single stroke movement, oscillatory movement and reciprocatory movement.

UNIT-VI

Fluoroscopy: Fluorescence and phosphorescence - description, fluorescent materials used in fluoroscopic screens,
construction of fluoroscopic screen and related accessories, tilting table, dark adaptation. Image intensifier -

UNIT VII

Construction and working, advantages over fluoroscopic device, principles and methods of visualising intensified image, basic principles of closed-circuit television camera and picture tube. Vidicon camera, CCD. Automatic brightness control, automatic exposure control, chamber selection during fluoroscopy. Serial radiography: Manual cassette changer, rapid automatic film changer, basic principles of cine fluoroscopy and angiography use of grid controlled x-ray tube.

UNIT-VIII
Portable and mobile x-ray units, dental x-ray unit, skull unit.

UNIT-IX
Mammography unit- Technical aspects of Mammography

UNIT-X
General care; functional tests; testing the performance of exposure timers, assessing the MA settings, testing the available KV, measurement of focal spot of an xray tube, testing the light beam diaphragm, practical precautions pertaining to Brakes and locks, H.T. cables, meters and controls, tube stands and tracks as well as accessory equipment.

Text Books:

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

Advanced Radiographic and Imaging Techniques
UNIT -I
1. Skeletal system:

a. Upper limb: Technique for hand, fingers, thumb, wrist joint carpal bones, forearm, elbow joint, radio ulnar joints and humerus supplementary techniques for the above. eg. carpal tunnel view, ulnar groove, head of the radius, supracondylar projections.

b. Lower limb: Technique for foot, toes, great toe, tarsal bones, calcaneum, ankle joint, lower leg, knee, patella & femur. Supplementary techniques: Stress view for torn ligaments,Subtalar joint and talo calcaneal joint. .Inter condylar projection of the knee.ibial tubercle, Length measurement technique.

c. Shoulder girdle and thorax: Technique for shoulder joint, scapular, clavicle, acromio clavicular joints, sternum, ribs, sterno-clavicular joint. Supplementary projections and techniques for recurrent dislocation of shoulder. Traumatic dislocation of shoulder. Cervical ribs.

d.Vertebral column: Technique for atlanto-occipital joint, cervical spine, cervico thoracic spine, thoracic spine, thoracolumbar spine, lumbo sacral spine, sacrum and coccyx. Supplementary techniques to demonstrate: Scoliosis, Kyphosis, Spondylolisthesis , disc lesion, Union of spinal graft. Adaptation of techniques to demonstrate specific pathologies.

e. Pelvic girdle and hip region: Technique for whole pelvis. Ilium, ischium, pubic bones, sacro

iliac joint, symphysis pubis, hip joint, acetabulum neck of femur, greater and lesser trochanter.

Supplementary techniques to demonstrate Congenital dislocation of hip joints, Epiphysis of femur, Lateral projections for hip joints to show femoral head and neck relationship.

f. Skeletal survey: Skeletal survey for metabolic bone disease, metastases, hormonal disorder, renal disorders.

g. Skull: Basic projections for cranium, facial bones, nasal bones and mandible. Technique for Petrous temporals for mastoids, Internal auditory canal, Accessory nasal sinuses,Tempero - mandibular joint, Orbits and optic foramen, Zygomatic arches,Styloid process, Pituitary fossa, Jugular foramen.

UNIT-II

Dental Radiography: Technique for intra oral full mouth, Occlusal projections, Extra oral projections including
orthopantomography,Supplementary techniques.

UNIT-III

Upper respiratory tract:Technique for post nasal airways, larynx, trachea, thoracic inlet,Valsalva manoeuvre,Phonation.

UNIT-IV

Lungs and Mediastinum:Technique for routine projections,

UNIT-V

Supplementary projections: Antero-posterior, obliques, lordotic, apical projection, use of penetrated posteroanterior
projection, Expiration technique,Technique for pleural fluid levels and adhesions.

UNIT-VI

Abdominal viscera:Technique for plain film examination.- Projection for acute abdomen patients.- Technique to
demonstrate: Foreign bodies, Imperforate anus.

UNIT-VII

Radiography using mobile Xray equipment: Radiography in the ward: Radiography in the specialised unit, such as:
Intensive care unit, Coronary care, Neonatal unit,Radiography in the operating theatre.

UNIT-VIII

Macroradiography: Principle, advantage, technique and applications.

UNIT-IX

Stereography: Procedure, presentation, for viewing, stereoscopes.

UNIT-X

High KV techniques: Principle and its applications.

UNIT-XI

Soft tissue Radiography including Mammography : its techniques, equipment , advancements and applications.

UNIT-XIII

Localization of foreign bodies: Various techniques

UNIT-XIV

Operation theatre techniques: General precautions, Aspesis in techniques,Checking of mains supply and functions of equipment, selection of exposure factors, explosion risk, radiation protection and rapid processing techniques.

UNIT-XV

Trauma radiography/Emergency radiography,

UNIT-XVI

Neonatal and Paediatric Radiography,

UNIT- XVII

Tomography and Tomosynthesis

UNIT-XVIII

Dual energy X-ray absorptiometry

UNIT-XIV

Forensic Radiography

Text Books:

1. Clark's Positioning in Radiography, A. Stewart Whitley, Charles Sloane, Graham Hoadley, Adrian D. Moore,12th edition, CRC Press, 2010.

2. Diagnostic Radiography, Glenda Bryan, 4th edition, SPCK Publishing, 1991.

PRINCIPLES OF EPIDERMOLOGY & RESARCH METHODOLOGY BOSTATICTS & MEDICAL ETHICS

UNIT I

EPIDEMIOLOGY Introduction: Historical aspects and evolution of epidemiology, definitions and concepts in Epidemiology. Natural history of disease. Approaches in Epidemiology. Descriptive and Analytical Epidemiology, Disease burden and Measures of risk and death. Epidemiological Investigations

UNIT-II

Principles of Research study designs, Sampling Methods, Sample size Estimation, Protocol writing and Measures of Association. Introduction to Operations Research.

UNIT III

Fundamentals of Biostatistics: Introduction, Types of data, Tabular and graphical presentation of data. Measures of location, dispersion and correlation: Measures of central tendency. Mean mode, median, GM, HM, quartiles Measures of dispersion—Range, Standard Deviation, Variance, Coefficient of Variation. Probability and statistical inference: Concept and probability distribution. Normal distribution— density curves, applications and statistical tables. Concept of significance tests, parametric and nonparametric tests, standard error and confidence intervals. Inferential statistics: Probability and distributions – Poisson, Binomial and Normal distribution – Chi-square test – Hypothesis test - Student's t-test – Correlation and Regression – ANOVA.

UNIT IV

Bioethics and Medical ethics: Historical perspectives & Introduction to Bioethics, Nuremberg Code, Declaration of Helsinki, Principle of essentiality, informed consent, confidentiality, minimisation of risk, accountability and responsibility. Ethics of clinical trials: Drug trials, vaccine trials, Clinical Trials with medical devices/surgical procedures/radioactive materials, Research in transplantation and stem cell therapy. Regulatory framework and guidelines for conduction of human research: Review processes, Institutional ethical committees, composition of committees, review procedures, WHO, UNESCO and ICMR guidelines.

References :

1. Epidemiology: An Introduction. Kenneth J. J. Rothman. Latest edition / Pub. Date: May 2002. Publisher: Oxford University Press.
2. Epidemiology. Leon Gordis. Latest edition / Pub. Date: November 2004. Publisher: Elsevier Health Sciences.
3. Diseases and Human Evolution. Ethne Barnes. Latest edition / Latest edition / Pub. Date: March 2005. Publisher: University of New Mexico Press.
4. Epidemiology: Beyond the Basics. F. Javier Nieto, Moyses Szklo. Latest edition / Pub. Date: November 2003. Publisher: Jones & Bartlett Publishers, Inc.
5. Basic and Clinical Biostatistics. Beth Dawson, Robert G. Trapp, Robert Trapp. Latest edition / Pub. Date: March 2004.

6. Discovering Statistics Using SPSS. Andy Field. Latest edition / Pub.
Date: April 2005. Publisher: SAGE Publications.
7. Arora PN & Malhon PK (1996). Biostatistics Imalaya Publishing House, Mumbai.
8. Sokal & Rohif (1973). Introduction to Biostatistics, Toppan Co. Japan.
9. Stanton A & Clantz, Primer of Biostatistics — The McGraw Hill Inc., New York.
10. Government of India. Good Clinical Practices for Clinical Research in India.
New Delhi: 2001
11. Indian Council of Medical Research. Ethical Guidelines for
Biomedical Research on Human Subjects. New Delhi: 2000

SEMESTER-II
PAPER -I
Special Radiographic/Radiological procedures
UNIT-I
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.

UNIT-II
Gastrointestinal Tract: Barium swallow, pharynx and oesophagus. 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 - eg. gastrograffin studies.Including CT,US and MRI Special Imaging Techniques.
UNIT-III
Salivary glands: Routine technique, procedure - sialography.
UNIT-IV
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 MRI Special Imaging Techniques.

UNIT- V
Urinary system: Intravenous urography, Retrograde pyelography. Antegrade pyelography. Cystography and micturating cystouresthrography. Urethrography (ascending) Renal puncture. Including CT,US and MRI Special Imaging Techniques.
UNIT-VI
Reproductive system: All the Techniques relating to Male and Female reproductive system including Hysterosalpingography.
UNIT-VII

Breast Imaging: Mammography: Basic views, special views, wire localization. Ductography, Tomosynthesis, ABVS, Various Biopsy Techniques including Prone Table Biopsy, CT, US and MRI Special Imaging Techniques

UNIT-VIII

Respiratory system: - Bronchography: Including CT,US and MRI Special Imaging Techniques.

UNIT-IX

Sinography:Routine technique and procedure.

UNIT-X

Central Nervous System: Myelography. Cerebral studies.Ventriculography etc including CT, US and MRI Special Imaging Techniques.

UNIT-XI

Venography: Peripheral venography.Cerebral venography.Inferior and superior venocavography.Relevant visceral phlebography.

Text Books:

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

PAPER -II

Advanced Technique & Instrumentation Computer Tomography

UNIT-I

Imaging principles in computed tomography 12 Instrumentation of CT scan Advances in Detector technology, Slip ring technology Helical CT, Single slice and Multi slice CT Scan system. 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-II

Protocols for adult Whole-Body CT 12 Protocols for pediatric Whole-Body CT, Documentation Common and specific artifacts in Helical CT images. HRCT of Lungs Technical aspects Volumetric HRCT Expiratory HRCT HRCT protocols Artifacts

UNIT-III

CT angiography 11 CT fluoroscopy Multidimensional reformations MPR, Curved MPR, MIP 3D imaging & 4D CT. CT Perfusion scanning. CT colonoscopy CT bronchoscopy
CT coronary angiography CT calcium scoring Myocardial Imaging. Care, Maintenance and tests General care, Functional tests Quality assurance program Acceptable limits of variation, Corrective action.

Text Books:

Computed Tomography – Physical Principles , Clinical Applications & Quality Control by

Euclid Seeram
Computed Tomography by Stewart C. Bushong
The essential physics of medical imaging – Bushberg
Clinical Computed Tomography for the Technologist – Chiu.L.C

PAPER -III
Advanced Technique & Instrumentation Magnetic resonance Imaging

UNIT-I
MRI- Basic Principles: Spin – precession – relaxation time – pulse 12 cycle – T1 weighted image – T2 weighted image – proton density image.
UNIT-II
Pulse sequence: 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 – Advanced pulse sequences
UNIT-III
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 – MR Spectroscopy – functional MR
UNIT-IV
MRI imaging – Head and Neck ,Thorax, Abdomen, Musculoskeletal System 12 imaging - Clinical indications and contraindications- types of common sequences effects of sequence on imaging - Protocols for various studiesslice 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 un co-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. Techniques of Fusion and hybrid Imaging Technology including PET CT, PET MRI, PET Ultrasound, MRI, CT, Fluoroscopy, Hybrid Imaging as well as Advanced Interventional suite

Text Books:
MRI physics for Radiologist - Alfred Horowitz
Fundamentals of MRI – Stark & Bradley
MRI in Practice – Catherine brook
The essential physics of medical imaging – Bushberg

SEMETER -III
Paper I
Quality Assurance and Quality Control in Diagnostic Radiology and Imaging

UNIT-I
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.
UNIT-II
Quality Assurance activities: Equipment selection phase; Equipment installation and acceptance phase; Operational phase; Preventive maintenance.

UNIT-III

Quality assurance programme in the radiological faculty level: Responsibility; Purchase; Specifications; Acceptance; Routine testings; Evaluation of results of routine testing automatic; Consideration for storage of film and chemicals; Faults tracing; Accuracy of imaging- image distortion for digital imaging devices. LASER printer calibration

UNIT-IV

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-V

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.

UNIT-VI

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-VII

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.

UNIT-VIII

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 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

Text Books:

Radiologic science for technologist – 9th edition (2008) Stewart Carlyle Bushong, Mosby Elsevier, UK.

Text Book of Radiological Safety – K. Thaylan (2010) Jaypee Brothers and medical Publishers, New Delhi.

Quality Control in Diagnostic Imaging J.E.Gra

Paper II

Newer Imaging Modalities

UNIT-I

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

UNIT-II

Advanced Computed Tomography - Helical CT scan: Slip ring technology, advantages, multi detector array helical CT, cone – beam geometry, reconstruction of helical CT images, CT

artifact, CT angiography, CT fluoroscopy, HRCT, post processing techniques: MPR, MIP, Min IP, 3D rendering: SSD and VR, CT Dose, patient preparation, Imaging techniques and protocols for various parts of body, CT contrast enhanced protocols – CT angiography – (Aortogram, selective angiogram head, neck and peripheral) image documentation and Filing, maintenance of equipment and accessories.

UNIT-III

Advanced technique & instrumentation of MRI

UNIT-IV

Basic Principle: Spin – precession – relaxation time – pulse cycle – T1 weighted image – T2 weighted image – proton density image.

UNIT-V

Pulse sequence : 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 – Advanced pulse sequences.

UNIT-VI

MR Instrumentation: Types of magnets – RF transmitter – RF receiver – Gradient coils – shim coils – RF shielding – computers.

UNIT-VII

Image formation: 2D Fourier transformation method – K-space representation – 3D Fourier imaging – MIP.

UNIT-VIII

MR contrast media – MR angiography – TOF & PCA – MR Spectroscopy – functional MRI

Text Books:

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

PAPER -III

Advanced Technique & Instrumentation of Ultrasound

UNIT I

Ultrasound Properties of ultrasound Interaction of ultrasound with matter

UNIT II

Transducers Types of transducer Advances in the design of modern ultrasound transducers

UNIT III

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 Multiformat camera Laser imager Colour & video thermal printers Computer storage Pre and post processing techniques

UNIT IV

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 V

Ultrasound contrast agents

UNIT VI

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 VII

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

Text Books:

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

SEMESTER IV

PAPER -I

Radiation Protection In Diagnostic Imaging and Nuclear Medicine Imaging Techniques

UNIT-I

Introduction to Radiation protection-Need for protection, Aim of radiation protection,.

UNIT-II

Limits for radiation exposure: Concept of ALARA ,maximum permissible dose ,exposure in pregnancy, children. Occupational Exposure Limits - Dose limits to public.

UNIT-III

Radiation Protection in: Radiography, Fluoroscopy, Mammography , Mobile Radiography ,CT Scan ,DSA and Interventional Radiology.

UNIT-IV

Radiation measuring instruments: survey meters, area monitor , personnel dosimeters ,film badge, thermos luminescent dosimeter, pocket dosimeter.

UNIT-V

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-VI

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 radiosensitivity. Biological effects of non-ionizing radiation like ultrasound, lasers, IR, UV and magnetic fields.

UNIT-VII

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-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 & appropriateness of different detectors for different type of radiation measurement.

UNIT-VIII

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.

UNIT-IX

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.

UNIT-X

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 , protective devices.

UNIT-XI

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-XII

NABH guidelines, AERB guidelines, PNDT Act and guidelines 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.

Refence books:-

Physics of Diagnostic radiology – Christensen
ICRP manual 3. Radiation protection measurement – Glenn F.Knoll
Radiation protection in hospitals – R.F.Mold
Advanced medical radiation dosimetry – Govinda Rajan
Radiation protection – Medical Radiography – Sherer
Radiation protection for radiologic technologist – Frankerl Robert
Nuclear Medicine basics – Chandra.R
Principles & practice of Nuclear medicine – Early.P.J
Physics and Radiobiology of Nuclear Medicine – Gopal.
Essentials of Nuclear Medicine Imaging – Mettler
Radionucleid Imaging artifacts – Wells & Bernier

PAPER -II

Intervention Radiological Techniques and Patient Care

UNIT-I

Basic Angiography and DSA: History , technique, patient care, Percutaneous catherisation, catheterization sites, Asepsis ,Guide wire, catheters, pressure injectors, accessories, Use of digital substraction- single plane and biplane. All forms of diagnostic procedures including angiography, angioplasty, biliary examination, renal evaluation and drainage procedure and aspiration cytology under flouoro,CT,US,MRI guidance.

UNIT-II

Central Nervous System: Myelography. Cerebral studies. Ventriculography.

UNIT-III

Arthrography: Shoulder, Hip, Knee, Elbow

UNIT-IV

Angiography: Carotid Angiography (4 Vessel angiography).Thoracic and Arch Aortography. Vertebral angiography, femoral arteriography. Selective studies: Renal, SMA, Coeliac axis. Angiocardiography.

UNIT-V

Venography: Peripheral venography, Cerebral venography, Inferior and superior venocavography. Relevant visceral phlebography.

UNIT-VI

Cardiac catheterization procedures: PTCA, BMV, CAG, Pacemaker.

UNIT-VII

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.

Reference book:-

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

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