DIPLOMA COURSE

CONDUCTED BY DIRECTORATE OF MEDICAL EDUCATION

MEDICAL COLLEGE.P.O, THIRUVANANTHAPURAM

DIPLOMA IN RADIODIAGNOSIS AND RADIOTHERAPY TECHNOLOGY

(DRRT)

Directorate of Medical Education,

Medical College PO, Thiruvananthapuram

DIPLOMA IN RADIODIAGNOSIS AND RADIOTHERAPY TECHNOLOGY (DRRT)

Course Code:

1. COURSE CONTENTS

1. 1	Title of the course	**DIPLOMA IN RADIODIAGNOSIS AND RADIOTHERAPY TECHNOLOGY (DRRT)**
1. 2	Aim of the course	Radiodiagnosis and Radiotherapy are fast developing branches of medicine and these departments require well trained medical imaging technologists/Radiographers/Radiotherapy technologists for their efficient functioning with adequate knowledge in radiation safety.
1. 3	Objective of the Course	To teach and train students in Radiodiagnosis and Radiotherapy technology with adequate knowledge in Radiation safety
1. 4	Medium of instruction	English
1. 5	Duration	The duration of the course shall be 3 years. The course shall be conducted under the department of Radiodiagnosis and Radiotherapy. There shall be theory classes along with practical training and resident duty during the course.
1. 6	Academic eligibility	A pass in the Higher Secondary Examination of the Board of Higher Secondary Education of Kerala or equivalent examinations conducted by any board in India recognized by any of Universities in Kerala with Physics, Chemistry and Biology as optional subjects and a minimum of 50% marks of these subjects put together.
1. 7	Nationality	Indian citizen of Kerala origin is eligible for admission.
1. 8		The Candidate should be in the age group of 17-25 years. 5 years relaxation in the upper age limit for SC/ ST candidates is allowable.
1. 9	Strength/batch	30 students per batch
1. 10	Reservation	As per existing Government guidelines
1. 11	Admission requirement	Selection to the course shall be made by the Director of Medical Education. Selection will be made on merit basis, based on the marks obtained in the qualifying examination and as per the Government guidelines on reservation. Selection to the management quota in the self-financing institution where the DRRT Course is granted and approved by the Government of Kerala, shall be made by the respective management with transparency.
1. 12	**Subjects of study**	

1. 12. 1	**First Year (Part-1)**	
	Paper-I	General & Radiation Physics
	Paper-II	Anatomy
	Paper-III	Physiology & Pathology
1. 12. 2	**Second year (Part-II)**	
	Paper-I	Physics of Medical Imaging & Radiotherapy
	Paper-II	Radiography Techniques
	Paper-III	Basics of Radiotherapy
1. 12. 3	**Third year (Part-III)**	
	Paper-I	Radiation Safety in Radiodiagnosis & Radiotherapy
	Paper-II	Advanced Medical Imaging Technology
	Paper-III	Advanced Radiotherapy

2. DISTRIBUTION OF HOURS

	Part-1: Paper-1 General & Radiation Physics 150 Hrs.		**Part-1: Paper-II Anatomy-130 Hrs**		**Part-1: Paper-III Physiology & Pathology 260 Hrs**	
A	General Physics	Hrs	Anatomy	Hrs	Physiology	Hrs
1	Mathematics, Units and Dimensions	3	General Anatomy	10	General Physiology	15
2	Magnetism	5	Regional & Imaging Anatomy	15	Physiology of CNS	10
3	Electrostatics	5	Central Nervous system	10	Physiology of CVS	10
4	Current Electricity	5	Cardiovascular System	10	Physiology of Respiratory System	10
5	Electromagnetic Induction	5	Skeletal System (Osteology)	20	Physiology of Muscular skeletal system	15
6	Alternating Current	6			Physiology of Gastrointestinal Tract	15
7	Transformers	6			Physiology of Genitourinary system	15
8	Measuring Instruments	6			Physiology of Reproductive System	10
9	Electronics	6			Endocrinology	10
10	Modern Physics	12			Physiologic Laboratory	20
11	Electromagnetic Radiation	6				
12	Radioactivity	10				
	TOTAL	75		65		130
B	Radiation Physics		Anatomy		Pathology	
1	X-Ray Production	15	Respiratory System	10	Introduction	4

2	X-ray Generator Circuits	15	Gastrointestinal System	10	Cell injury, cell death, Adaptation	10
3	X- ray sspectrum	10	Genitourinary system	10	Inflammation and Repair	10
4	Interaction of Radiation with matter	10	Endocrine system	5	Circulatory Disturbances	10
5	Charge Particle interaction	5	Radiographic Anatomy and Laboratory	30	Immunology	8
6	Quantities and Units of Radiation	5			Neoplasia (Including malignancies of bone, lung, brain, FGS, skin)	25
7	Radiation Detection and Measurements	15			Environmental and Nutritional Disorders	8
8					Infections	10
9					Congenital Malformations	8
10					Miscellaneous conditions	6
11					Haematology	10
12					Blood Bank	5
13					Clinical Pathology	8
14					Cytology	10
	TOTAL	**75**		**65**		**130**
	GRAND TOTAL	**150**		**130**		**260**

	Part-II: Paper-1 Physics of Medical Imaging & Radiotherapy-150		**Part-II: Paper-II Radiography Techniques 150**		**Part-II: Paper-III Basics of Radiotherapy-150**	
A	**Physics of Medical Imaging**					
1	Radiological Image formation	10	History of Radiography and Imaging, Care ad Ethics in Radiology & Patient care,	10	Ethics, Epidemiology and Prevention of cancer	5
2	Physics of Fluoroscopy	8	Positioning and techniques for various Projections	45	Oncopathology	10
3	Dental Radiography	5	Dental radiography	7	Cancers of various sites	40
4	Digital Imaging	8	Trauma Care	5	Methods of Cancer Management	10

5	Mammography	6	Operation Theatre radiography	5	Radio biological basis of Radiotherapy	10
6	Computed Tomography	10	Record keeping in radiology	3		
7	Magnetic Resonance Imaging physics	10				
8	Physics of Ultrasound	5				
9	Nuclear Medicine	8				
10	Digital subtraction Angiography and Xero radiography	5				
	Total	75		75		75
B	**Physics of Radiotherapy**		**Section B**		**Section B**	
1	Clinical radiation generators.	4	Special investigations (Conventional Radiography)	55	Treatment planning	15
2	Teletherapy Machines	8	Paediatric Radiography	10	Radiotherapy Techniques for various tumours	35
3	Linear Accelerator	8	Imaging Investigation Techniques of CT, Ultrasound, MRI. (Basics Only)	5	Brachytherapy Techniques	10
4	Dose distribution and scatter analysis	10	Digital Radiography and Advances in Medical Imaging	5	Modern radiotherapy (introduction only) and Nuclear medicine	15
5	Imaging Modalities and networking systems in radiotherapy	6				
6	Patient positioning Simulation and Mould Room Techniques	10				
7	Electron Beam therapy	4				
8	Brachytherapy	10				

9	Modern Radiotherapy Techniques	15				
	TOTAL	**75**		**75**		**75**
	GRAND TOTAL	**150**		**150**		**150**

	Part-III: Paper-1 Radiation Safety in Radiodiagnosis & Radiotherapy 150 hrs		**Part-III: Paper-II Advanced Medical Imaging Techniques-150 hrs**		**Part-III: Paper-III Advanced Radiotherapy 150 hrs**	
A	**Radiation Safety in Radiodiagnosis**	Hrs		Hrs		Hrs
1	Basic Radiation Physics	2	Digital Radiography – CR, DR	15	Introduction	4
2	Interaction of radiation with matter,	3	Mammography Technique	10	Prevention and early detection	3
3	Radiation quantities and units.	3	Ultrasound equipment	10	Tumour Biology	15
4	Biologic Effects of Radiation	4	Computed Tomography (CT scan equipment)	30	Tissue structure and radiation effects and Fractionation	15
5	Detection and measurements of radiation.	3	Dual energy CT	10	Application of radiation in benign condition	3
6	Radiation Hazard evaluation and control in Diagnostic radiology.	10			Principles of positioning and immobilization	5
7	QA in Diagnostic Radiology	10			Image acquisition and verification	5
8	Regulatory Requirements	10			Patient setup	5
9	Radiation safety considerations in diagnosis radiology and dose indexes	10			Simulation procedures of various cancers	10
10	Demonstration and practical	20				
11	Total	75	total	75		75
B	**Radiation safety in Radiotherapy.**		**Section B**		**Section B**	
1	Radiation Hazard Evaluation and Control(radiotherapy)	10	Nuclear Medicine	**10**	Clinical Radiation Oncology of various sites	**40**

2	Basic radiation therapy physics.	10	MRI Equipment – structure and operation	35	Recent Advances in radiotherapy	10
3	QA in Radiotherapy	10	PACS	10	Brachytherapy	20
4	Radiation Emergency Preparedness	10	DSA – equipment and operation	10	Duties and Responsibilities	5
5	Regulatory Requirements	10	Interventional Radiology	10		
6	Demonstration and practical	20				
	Total	75	**Total**	75	**Total**	75
20	**GRAND TOTAL**	**150**		**150**		**150**

SYLLABUS

Part I – Paper I
General and Radiation Physics

Section A
General Physics

1. Mathematics: Proportions-Direct and inverse proportions, Inverse Square law, Graphical ropresentation of parameters that obey linear and exponential law Units and Dimensions: Fundamental units, derived Units, Systems of units.
2. Magnetism: Introduction, Magnetic poles, coulombs law, permeability, magnetic field, flux and flux density, magnetic induction, Webber and Tesla, Magnetic Properties, Intensity of magnetization, Types of magnetic materials, ferromagnetic, paramagnetic and diamagnetic, magnetic susceptibility, hysteresis.
3. Electrostatics: Electric charges, coulombs law, dielectric constant, electric filed strength, conductors and insulators, electric potential and potential difference, volt, electric capacitance, Farad, capacitors, capacitors in series and parallel, capacitors in DC circuits, capacitors in radiography.
4. Current electricity: Ampere, Resistance, Ohms law, electrical energy, joule and watts, Electrical power, kWh, power losses in cables, Cable resistance and X-ray exposure.
5. Electromagnetic Induction: Magnetic effects due to electric currents, solenoid, Eddy Current, Fleming s left hand rule, electromagnetic relays, self and mutual induction, Faraday`s laws, Lenz's law, Henry, electric motors and generators.
6. Alternating currents: Meaning of AC and its advantages over DC, AC generators, peak, RMS, effective and average values of currents and voltages, phase difference, LC Circuit, RC Circuit, LR Circuit, LCR circuit, LCR circuits series and parallel, three phase AC connections, application of star and delta connections in x-ray technology.
7. Transformers: Introduction, Transformer turns ratio, step up, step down and even ratio transformer, efficiency, transformer losses, constant voltage transformer, transformer rating, auto transformer, mains voltage compensation, transformers used in X ray circuits.
8. Measuring instruments: Introduction, Galvanometer, moving coil galvanometer, voltmeter, ammeters, shunts, conversion of galvanometer to ammeters and voltmeters, multi meters, meters used in X-ray circuits, mains Voltmeter, pre reading KV Meter, mA meter and mAs meter.
9. Electronics: Introduction, Triode and gas filled diodes, Thyratron tubes, Semi-conductors-intrinsic and extrinsic Semi-conductors, N type and P type, PN junction, biasing, Semiconductor diode, Zener diode. Transistors and their applications (basics only), MOSFET, Rectifiers- half wave and full wave bridge rectifiers, rectifier circuits used in x ray technology, Introduction to digital electronics- gate circuits, AND, OR, NAND, NOR or NOT gates.
10. Modern physics: Introduction, atoms and molecules, Atomic structure, atomic number, mass number, atomic weight, periodic table, Avogadro number, atomic mass unit, mass defect, mass energy equivalence, Electrons- electron shells, binding energy, distribution of orbital electrons, atomic energy levels, Band theory and band structure, ionization and excitation, characteristic and continuous spectrum. LASER, Super conductivity, super conducting magnets, Fluorescence, Phosphorescence, Scintillation, Nuclear Physics -

nuclear structure, Protons, neutrons, nuclear forces, Isotopes, Isobars, isomers.

11. Electromagnetic radiations: Introduction, nature of electromagnetic radiation, wave length, frequency, energy and their relations, inverse square law, quantum nature, particle nature, electromagnetic spectrum, Examples of electromagnetic radiations and their applications.
12. Radio activity: Introduction, Radioactive disintegration, radioactive emission- alpha, beta and gamma emission and their properties, electron capture, internal conversion, auger electrons. exponential law of radioactive decay, decay equation, half-life, average life, decay constant, natural radioactive materials, radioactive equilibrium. Artificial radio activity, nuclear reactions, neutron bombardment, proton bombardment, nuclear fission and fusion, nuclear reactor and cyclotrons. Production of artificial isotopes.

Section B
Radiation Physics

1. X-Ray Production: Introduction, discovery of X rays, production and properties of x rays- thermionic emission, space charge effect, Interaction of electrons with tube target, process of x ray generation, anode, cathode, focal spot, fine and broad focus, Line focus principle.
2. X-ray tubes: Introduction, different types of x ray tubes, -gas tube, Coolidge's tube, stationary and rotating anode tubes, grid-controlled X ray tubes, specifications of x ray tubes, anode heel effect, off focus radiation, diagnostic and therapy x ray tubes, tube housing, aperture diaphragms, collimators, cones and cylinders, testing of light beam and x ray beam alignment, functions of beam restrictors, tube shielding and high voltage cables, tube cooling, defects in x ray tubes.
3. X Ray generatoror circuits: Introduction, transformers used in X-ray machine, high tension, filament and auto transformer, Rectifiers, self-rectified, half and full wave rectifiers, single and three phase generators, Filament Circuit, Kilo voltage Circuit, selection of kVp, mA and mAs, constant potential x ray generators, High frequency generators. Exposure switching-primary and secondary switching, Exposure timers, hand timer, synchronous timer, electronic timer, mAs timer, ionization Timer, AEC, testing of timers. Rating of x ray tubes -power rating and thermal rating, rating charts.
4. X-ray spectrum: Introduction, bremsstrahlung and characteristic x-rays, Intensity of x ray beam, factors affecting quality and quantity, efficiency of X-ray production, effect of KV and target material on x ray spectrum, Duane Hunt theory- Duane Hunt limit, Spatial distribution of X-rays.

   Filters- Introduction, Inherent filtration, added filtration, filter thickness, effect of filters on patient exposure, effect of filters on exposure factors, wedge filters heavy metal filters, molybdenum filters, beam hardening, HVL, TVT.

4 Interactions of Radiation with Matter: Introduction, X and Gamma ray interactions, coherent scattering, Photo electric effect, Compton effect, Pair production, photo disintegration, attenuation, attenuation coefficients and Cross sections, Linear and mass attenuation coefficients, factors affecting attenuation coefficients. Relative importance of interactions in Diagnostic Radiology and Radiotherapy, HVT, TVT, scatter radiations- factors affecting scatter radiation.

5 Charged particle interactions: LET, range, stopping power, interactions of electrons, interactions of heavy Particles, interaction of proton, Bragg Peak, Interaction of neutron.

6 Radiations quantities and units: Introduction, Activity-curie, bbecquerel,

Rutherford, Flux, Fluence, Exposure- Roentgen and C/Kg, Absorbed dose-gray, rad, KERMA, Equivalent Dose - quality factor, rem, Sievert, Effective Dose, CEMA, Integral dose.

7 Radiation Detection and Measurements: Introduction, Principles of radiation detection, effects of energy absorption- physical, chemical and biological effects, Types of detectors and efficiency, primary secondary and tertiary dosimeters, Gas filled detectors, Solid state detector, free air ionization chamber, measurement of exposure, Ionization chamber, Thimble chamber, Farmer chamber, condenser chamber, chamber sensitivity, correction factors, electrometer, parallel plate chamber, GM counters, Proportional Counters, Scintillation counters, Gamma ray spectrometers, pocket dosimeters, Contamination monitors, Survey meters, Isotope calibrators, film dosimeters- radiographic and radio chromic films, Film Badges, Thermoluminescence dosimeters, TLD badges, Chemical dosimeters. OSLD, Biological Dosimeters.

Part I-Paper II

Anatomy

Section: A

1. General Anatomy – Introduction, Cell, Epithelium, Connective tissue, Cartilage, bone, joints, vascular tissue, Lymphatic tissue, Muscular tissue, Nervous tissue, skin.
2. Regional and Imaging Anatomy.
3. Central Nervous system – Spinal cord, cerebrum, cerebellum, brainstem, white matter, ventricles, blood supply.
4. Circulatory system – Thoracic wall & thoracic cavity, Pericardium, heart, chambers great vessels from heart, vascular system, lymphatic system.
5. Skeletal system – Upper limb bones, Lower limb bones, vertebral column, sternum, ribs, skull, joints.

Section: B

1. Respiratory system – Nasal cavity, Larynx, Trachea, Bronchial tree, alveoli, Pleura, lungs, blood supply
2. Gastro Intestinal System – Oral cavity, dentures, tongue, Pharynx, Oesophagus, Stomach, small intestine, large intestine, rectum & Anal canal, salivary glands, liver, gall bladder, pancreas, spleen, peritoneum.
3. Genito urinary system – Kidney, Ureter, Bladder, urethrae, male reproductive organs, female reproductive organ.
4. Endocrine system (basics only) – Pituitary gland, thyroid gland, parathyroid, adrenal glands, Pancreas (Islets), Ovaries, Testis
5. Radiographic Anatomy and Laboratory - Details of Demonstration–Radiographic Anatomy of CNS, Demonstration of CNS, Radiographic anatomy of CVS, Demonstration of CVS,
6. Radiographic Anatomy of RS, Demonstration of RS, Radiographic Anatomy of Skeletal system,
7. Demonstration of Bones, Radiographic Anatomy of GIT, Demonstration of GIT,
8. Genitourinary Radiographic Anatomy, Genitourinary demonstration.

Part I-Paper III

Physiology & Pathology

Section A

Physiology

1. General Physiology: Cell Physiology, Transport across cell membrane, Extra cellular and intra cellular fluids – relative properties of each, classification, measurement of body fluids. Blood function, composition, properties. Plasma proteins – types, quantity functions. RBC – functions, properties – PCV, ESR, Osmotic fragility. Definition and normal values. RBC Count – normal values, variation. Erythropoiesis– different stages, factors regulating blood indices. Anaemia – definition, classification, WBC – morphology, normal differential counts variations, total count. Normal values, functions. Platelets–normal count, stages in the development of platelets, function – blood coagulation – anticoagulants bleeding time, clotting time. Blood groups – Landsteiner's law,. determination of blood group, Rh system, cross matching, Blood transfusion, transfusion reaction – Erythroblastosis Foetalis, Tissue fluid – Lymph formation, circulation. Skin and temperature regulation function of skin.
2. Physiology of CNS: Nervous system – Functional anatomy, physiology of neuron. Synapses, receptors. Spinal cord – structure, ascending and descending tract. Brain – sensory and motor areas cerebral cortex. Functions of cerebellum, brainstem Reflexes, cranial nerves. EEG, Cerebrospinal fluid. Sensory and motor pathways. Special sense vision – functional anatomy of eye ball – Image formation in eye, near response. Accommodation, near point, far point. Refractive errors, photochemistry of vision. Visual pathway and its lesions- colour vision, ERG. Audition –structure, physiology of hearing deafness, auditory pathway. Taste sensation – reception, pathway basic taste, modalities – olfaction – receptors, pathway, and abnormalities. Autonomic nervous system
3. Cardiovascular system: Functional anatomy of heart and blood properties of cardiac muscle. Conducting system of heart – origin and spread of cardiac impulse. Cardiac cycle definition, phases of cardiac cycle. Heart sounds – causes, character abnormalities, genesis of murmurs. Cardiac output – definition, normal values, valuation factors affecting cardiac output method of measurement, Fick principle, heart rate and its regulation. Blood pressure – definition, normal value, variation determinants of blood pressure – regulation of blood pressure, local and systemic mechanism, both neural, hormonal. ECG – normal ECG pattern. Arterial Pulse – definition, characters of pulse. Regional Circulation: Cutaneous Circulation, coronary, cerebral, pulmonary, renal and splanchnic Circulation.
4. Respiratory system: Define respiration. Physiological anatomy of respiratory system, functions. Mechanism of ventilation. Breath sounds, surfactant, pressure changes during respiratory cycle. Lung volumes and capacities. Alveolar ventilation, Respiratory dead space. Mechanism of gas exchange. Structure of blood gas barrier, factors affecting diffusion across respiratory membrane. Transport of O_2 and CO_2. Regulation of respiration. Hypoxia – definition, chemical features types, Cyanosis, treatment, Artificial Respiration.
5. Muscle and nerve: Distribution of ions in ECF and ICF, resting membrane potential. Action potential. Muscle – comparison between skeletal, cardiac and smooth muscle. Electrical properties of muscle. Neuro-muscular junction and transmission, Mechanical properties, Excitation, Contraction coupling.
6. Gastrointestinal System: Functional anatomy of gastrointestinal tract, enteric nervous system. Saliva – composition, functions, regulation of secretion, Conditioned and unconditioned reflexes. Gastric juice– composition function, regulation phase, peptic

ulcer, its management. Pancreatic secretion – composition, regulation of secretion, pancreatic function tests. Liver–composition, functions of bile, regulation of secretion, enterohepatic circulation. Gall bladder-functions, filling and emptying. Small intestinal juice – Composition, functions, movement of GIT –mastication, deglutition, gastric movements, vomiting, movement of small intestine. Secretions of large intestine. Absorption of carbohydrate, protein, fat. Special tests of gastrointestinal function, barium studies.

7. Genitourinary System: Renal System – Functional anatomy of kidney, blood supply. Composition of urine. Process involved in urine formation. Glomerular filtration, Definition, factors affecting glomerular filtration. Tubular function – absorption and secretion. Re absorption of sodium, glucose, urea, water. Clearance – definition, method of measurement. Formation and concentration of urine-counter current system. Renal function tests, Micturition. Dialysis, Renal Disorders, Diuresis, acid-base balance.
8. Reproductive system: Functions of female reproductive organs. Functions of breast. Female sexual cycle. Pregnancy, parturition. Functions of placenta. Functions of male reproductive system. Male fertility. Methods of contraception in males and females.
9. Endocrinology: Endocrine glands in human body, Hormone – definition, mechanism of action. Hypothalamic hormones. Pituitary glands. Hormone function disorders. Thyroid gland–synthesis of hormones, functions disorders. Parathyroid glands- function, disorders. Endocrine Pancreas – Secretion, regulation, Pancreatic Function Tests, Glucose tolerance test. Pineal gland hormones, Prostaglandins, G.I Hormones, Local hormones.
10. Demonstration of Experiments in Human Physiology: Microscopic examination of blood. Haemoglobin estimation. Estimation of packed cell volume. ESR estimation. Osmotic fragility. RBC count. WBC count. Determination of blood groups. Bleeding Time. Clotting time, determination of blood pressure, blood indices.

Section B.
Pathology

1. Introduction.
2. Cell injury, cell death and adaptation- Atrophy, hypertrophy, hyperplasia and metaplasia. Cell injury – types and causes. Necrosis - definition and types with examples. Pigmentation – classification and description with examples, Pathological calcification. Gangrene – Types and features
3. Inflammation and repair: Definitions, features and signs, Types – acute and chronic in detail, Exudate and transudate, Wound healing and fracture healing including factors affecting wound healing and complications
4. Circulatory disturbances: Hyperaemia and congestion, Oedema, Thrombosis, Embolism and infarction, Shock.
5. Immunology: Hypersensitivity reactions mainly anaphylaxis, Auto immune disease with examples, Amyloidosis, AIDS
6. Neoplasia (Including malignancies of Bone lung brain FGS and skin): Definition, benign and malignant tumours, differences, examples with details of each organ tumour classification, bone, lung, brain, FGS, Skin in detail. Primary vs secondary tumour appearance, Different nomenclature, Hamartoma, Cyst, polyp, cystadenoma, teratoma. Basic histological classification, Carcinoma, Squamous cell carcinoma– major sites, Adenocarcinoma – major sites, Sarcomas, Premalignant lesions, Carcinogenesis with

emphasis on radiation carcinogenesis, Metastasis - routes, Tumour markers, Paraneoplastic syndromes, Staging and grading of cancer.

7. Environmental and Nutritional disorders: Radiation injury, Protein energy malnutrition – Kwashiorkor and marasmus, Vitamin deficiency diseases (Night blindness, Rickets, scurvy and beriberi), Infections, Acute infection
8. Infections: Pyogenic Infections- General clinical features, Common organ vice examples like meningitis, pneumonia, lung abscess, empyema, osteomyelitis in detail, Typhoid, Chronic infections, Granulomatous Tuberculosis, in detail, Syphilis and Leprosy, Fungal infections, Viral Infections.
9. Congenital malformations: Major lesions like agenesis of various organs, Cong adenomatoid malformation, Cysts of kidney, Meckel's diverticulum, cryptorchidism.
10. Miscellaneous conditions: Pleural effusion, Pneumothorax, Calculi of various organs
11. Haematology: Anaemia – classification, iron deficiency anaemia, megaloblastic anaemia, Agranulocytosis, Polycythaemia, Leukaemia–acute and Chronic. Lymphoma – Hodgkin's and NHL – an overview, Haemophilia
12. Blood banking: Blood grouping & cross matching.
13. Clinical Pathology: Hb, TC, DC, ESR, PCV, Blood smear, thick smear preparation, Urine examination, motion examination, sputum examination, LE cell test.
14. Cytology – Exfoliative cytology, Types, Sample collection, FNAC, Guided & Non guided, Fixative. Preparation and transportation.

Part II- Paper I
Physics of Medical Imaging and Radiotherapy

Section A
Physics of Medical imaging

1. Radiological image formation: X-ray Films-Construction, Emulsion, Types of film, double emulsion film, screen film, non-screen film, single coated film, Latent image, formation, Film processing- film development, developing solutions, replenishment, fixing fixing agents, processing cchemistry, action of developer, fixer, steps in film processing, automatic processing. Characteristic of Film- characteristic curve, optical density, contrast, gamma speed, latitude.

   Intensifying screen- Introduction, construction and action, type of screens, intensifying factors, rare earth screens, resolving power, phosphor technology, emission spectra, quantum mottle, screen unharness.

   Grids- Introduction- basic principles, terminology-grid ratio, grid factor, grid pattern, types of grid-linear grids, moving grid, Potter Bucky grids, Lines per inch, Bucky factor, grid cut-off, grid selection, air gap techniques.

   Image Quality – Introduction, resolution, noise, line spread functions. Geometryy of Image- Magnification, true and geometric magnification, distortion, penumbra, unharness, contrast, contrast media.
2. Physics of Fluoroscopy: Introduction, Direct vision fluoroscopy, dark adaptation, limitations, Image Intensifier-Principles and operation, Imaging characteristics-contrast, lag, distortion, viewing and recording of images. Capacitor discharge and high frequency sets, Mobile IITV, C-ARM

   Modern Fluoroscopic Imaging Systems- Fluoroscopic Equipment, Pulsed fluoroscopy, AEC, Digital Fluoroscopy, Electronic magnification. Performance of Imaging Systems, Contrast, Noise, Sharpness, Artefacts

   Application specific fluoroscopic systems- Remote Fluoroscopic Systems, Vascular and Interventional radiology systems, Fluoroscopic systems used in Cardiology, Neuro-radiology, Portable and mobile Fluoroscopes, spot film devises, Patient Dose in Fluoroscopy
3. Dental Radiography: Dental Radiography units, self-rectified tubes, grid control tubes, dental equipment, cones, filters, factors OPG and cephalo units, tubes, applications.
4. Digital Imaging: Introduction, Image encoding and display, Digital Imaging Systems, Digital Image Receptors-Computed Radiography, Charged Couple Devices, Digital Radiography, Artefacts of Digital Images.

   Digital Imaging Management- PACS, DICOM, Radiology Information System, Image Compression, Image Post processing and analysis- spatial filtering, noise removal, edge ridge and shape detection, Quality management-QMS, QA. QC, Quality standards and good practice, networking, image compression,
5. Mammography: Equipment, Mammogram X-ray tube, filters, film screen combinations. Magnification Mammography, Digital mammography.
6. Computed Tomography: Introduction, Physics of Computed Tomography, Hounsfield units, CT number, CT imaging system, Types of CT scanners and CT Generations, collimation, filtration, detectors in CT, Spiral and multi slice CT, CT Imaging Systems-Image reconstruction and Processing, Filtered back projection, Image acquisition,

Scanned Projection radio graphs, Axial CT, Helical CT, MDCT, Cardiac CT, CT Fluoroscopy, Artefacts in CT.

7. Magnetic Resonance Imaging physics: Basic Physics of MRI- NMR, relaxation and tissue contrast-T1 and T2 relaxation, Spatial encoding and basic pulse sequences-slice selection, frequency and phase encoding, gradient echo imaging, spin echo imaging, multi-slice imaging. MRI equipment and Hardware, gradient coil, common imaging options, image acquisition and reconstruction-gradient echo sequences, spin echo sequences, inversion recovery sequences, MR angiographic sequences, flow measurements, MR spectroscopic sequence, Multi-slice imaging, 3D imaging. Image Quality and Artefact in MRI- Motion, aliasing, metal objects, chemical shift, truncation, system related artefact, Bio safety in MRI.
8. Physics of Ultrasound: Physics of Ultrasound, Production of ultrasound waves, interaction of ultrasound waves, Ultrasound systems, Image Display, Doppler Effect-Doppler Scanning principles. Continuous wave Doppler, Pulsed wave Doppler, Electronic focusing and beam steering, three- dimensional and four-dimensional imaging, Quality Assurance in Ultrasound, Bio effects of ultrasound.
9. Nuclear Medicine: Physics of Nuclear Medicine, Isotopes used in Nuclear Medicine-Production and Properties, Biological and Effective half-lives, Radio pharmaceuticals, Uptake studies, Scanners, Nuclear Medicine instrumentation, Gamma camera, Radio Immuno-Assay, SPECT, PET. PETCT.
10. Xeroradiography and DSA- General principle-photo conduction xeroradiography system, Patient exposure. DSA- Introduction, principle, Techniques, DSA systems and patient dose,

Section B
Physics of Radiotherapy

1. Clinical radiation generators: introduction. Kilo Voltage Machines, Van de Graaff generators, Betatron, Cyclotron, Synchrotron, microtron, Neutron Generators.
2. Teletherapy Machines: Introduction, machines using radionuclides, production and properties of telecobalt sources, telecobalt units, source housing, shutter mechanisms, beam collimation, penumbra, source transport mechanism, advantages and disadvantages of telecobalt machines.
3. Linear accelerators: Introduction, linear accelerator systems, Construction, production of electron and X-ray beam, magnetron, Klystron, treatment head, penumbra, target, scattering foil, beam flattening filter, beam collimation, gantry, Electron cones, FFF. Laser systems.
4. Dose distribution and scatter analysis: Phantoms, Inverse Square Law, depth dose parameters, percentage depth dose, tissue air ratio, backscatter factor, tissue maximum dose tissue phantom ratio, scatter air ratio, variations with field size, depth, quality of beams, penumbra, equivalent square Fields, SSD and SAD techniques, simple Treatment calculations, Beam Modifying Devices -Wedge filters, wedge factors. Bolus, beam shaping blocks, Irregular fields, radiation field analyser. Introduction to treatment planning- 2D and 3D planning, isodose charts, isodose curves, combination of radiation field, parallel opposed fields, edge effect multiple fields, ICRU volumes-GTV, CTV, PTV, computerized treatment planning systems, tissue Compensators, correction for contour irregularities and tissue inhomogeneity, Total body irradiation

5. Imaging Modalities and Networking System in Radiotherapy: Patient data acquisition-body contours, localization of internal structures, devices- CT, MRI, ultrasound, SPECT, PET, treatment verification –port films, electronic portal imaging, cone beam CT-kVCBCT, MVCBCT, Networking systems -PACS, DICOM
6. Patient positioning, Simulation and Mould room techniques: Patient positioning-general guidelines, the XYZ method of patient setup.
Treatment simulation-conventional simulators, CT simulator, Virtual Simulation, Target Driven Simulation,
Immobilization devises and Mould Room techniques- Introduction- need for immobilization-accuracy and reproducibility, Immobilization devices. Preparation of moulds, Thermoplastic masks, Bolus, Compensator, Electron cut out, Shielding Blocks-Customized Field shaping, Styrofoam Cutter Machine.
7. Electron Beam therapy: Introduction, electron beam characteristics, treatment planning, field shaping, electron arc therapy, total skin irradiation.
8. Brachytherapy - Introduction, Brachytherapy sources production and properties, types of sources needles, tubes and wires, source specifications. Classification of Brachytherapy techniques - surface mould, intra cavitary, interstitial and intra luminal, Intra operative. Endovascular techniques, remote after loading.
Calculation of dose (basic only), implant dosimetry systems-Patterson parker system, Quimby system, memorial system, Paris system, dose specification for cancer of cervix-Manchester system, ICRU system.
Low dose rate (LDR), Medium Dose rate (MDR) high dose rate (HDR) and pulsed dose rate (PDR) brachytherapy. HDR units, prostate implants
9. Modern Radiotherapy Techniques:
3D Conformal radiotherapy-introduction, imaging data, 3D CRT techniques
IMRT-Introduction, IMRT systems-fixed gantry angle, Tomotherapy, IMRT with rotating cone beams. Stereotactic Radiotherapy and radio surgery- Introduction, SRS techniques, X knife. Gamma knife.
IGRT-Introduction, IGRT technologies, management of respiratory motion.
Proton therapy- Introduction, basic physics, Bragg peak, Proton beam delivery systems,

Part II – Paper II
Radiography Techniques
Section A

1. History of Radiography and Imaging, Care and Ethics in Radiology:
Introduction, hhistory of radiography, x ray room, ventilation and temperature of X-ray room, dark rooms, safe light storage shelves, cabinet, loading bench, hangers, solution tank, defects occurring in films while processing, viewing – Illumination and care of viewing boxes.
Medical law and ethics, Psychological approach to patient ethics followed in imaging female patient, organization to avoid delay, waiting and rest rooms, handling of fracture cases, stretcher and bed patient, method of dealing with helpless patient, Awareness of cross infection, general hygiene, special apparatus for children, neck and head injury patient, casualty management.

2. Positioning and techniques for various Projections - A Summary of the factors involved in radiographic positioning-introduction to radiographic techniques, general awareness about x ray techniques like details of Xray table, collimation, anatomical land

marks, immobilization, postural variations respiratory movement, regional densities, preparation, positioning terminology.

Radiographic technique for individual system-

Upper limb –Technique for hand, Wrist, fingers, thumb, scaphoid, carpal bones, carpal tunnel, forearm, elbow joint, humerus, shoulder Coracoid Process, Acromio-clavicular joint, clavicle, sterno-clavicular joint, Glenohumeral joint, scapula.

Lower limb – Leg Alignment, -Technique for foot, Subtalar joint, toes, great toe, calcaneum, ankle joint, leg, knee joint, patella, femur, Hip joint, Sacro-iliac joint, upper third of femur.

Vertebral column – Vertebral caves and Vertebral Levels, Atlanto-occipital articulation, cervical vertebra, Cervico-thoracic vertebra, swimmer's view, thoracic vertebra, thoraco-lumbar vertebra, lumbar vertebra, lumbo-sacral vertebra lumbo-sacral articulation, sacrum, coccyx. Bones of the thorax–techniques for ribs–upper and lower, sternum.

Skull–Cranium, Sella turcica, optic foramen, Jugular foramina. Temporal bones–Mastoids, petrous bone, Nasal bones, Mandible, Techniques for mandible, Temporo-mandibular joint.

Paranasal sinus - Techniques for frontal – maxillary, ethmoid, sphenoid, Facial bones

Thorax, Pharynx, Larynx and Trachea

Respiratory system and Heart – Technique for trachea, lungs, mediastinum, Sub-diaphragmatic conditions – erect and supine chest x ray – projections relative to collapse.

Chest, Abdomen, Pelvic Cavity, Acetabulum

3. Dental Radiography: Introduction-vertical and horizontal positioning abnormalities, use of general and dental units, dental request formula identification and handling of films, use of dental film holders, Technique for full mouth, edentulous subjects, children, intra oral and extra oral crowns, occlusal views, localization. Intra-oral radiography, occlusal radiography, extra oral radiography- oblique lateral view.
4. Trauma Care - Bedside Radiography – techniques for acute chest, intestinal obstructions – abdominal perforation – vertebral injuries, skull injuries – spine fractures – Thomas splint, Plaster cases etc.
5. Operation Theatre Radiography–Theatre Techniques, Techniques of Asepsis-anaesthetic dangers – precautions.
6. Record keeping in Radiography– Register of X-ray examinations, Despatch register, Film accounts, Machine Log book Maintenance.

Section B

1. Special investigations (Conventional Radiography)- Introduction to Contrast Media - Types, Positive, Negative, water soluble, water insoluble, ionic, non-ionic, Structure of Contrast media, Patient Preparation, Route of Administration, Toxicity and Complications in Radiography, CT and MRI.
2. Special Investigation of individual systems-

   a. GI Tract- Contrast media – Basic principles – Barium Sulphate, Pharynx and oesophagus, – erect and supine posture – – stomach, duodenum, small intestine, colon and rectum, fluoroscope – compression techniques. single and double contrast techniques, enteroclysis.

b. Urogenital System – IVU– principles – contrast medium – preparation of patient – children – Serial radio-graphs, variation of time intervals depending on suspected pathology, value of compression – precautions and contra indications. Retrograde pyelography (RGP), RGU. MCU. Approximating cysto-urethrogram.

c. Hysterosalpingography (H. S. G) – Principles – contrast media, method for injection –reactions – fluoroscopy- technique.

d. Sialography – Sialography – contrast medium – method of injection and techniques, Technique following injection of opaque medium.

e. Salivary Glands – Demonstration of opaque salivary calculus, techniques for parotid, sub mandibular-sublingual-glands and ducts.

f. Liver and spleen – Technique of PTC, SPV. Gall bladder – Technique for oral cholecystography – PTC – preparation of patient – contrast medium, and intravenous cholangiogram, T Tube Cholangiogram

g. Nervous system– special care of neurological patient - myelogram Ventricles – Ventriculography, Encephalography

h. Bronchography – Lymphatic system – lymphangiography,

i. Breast -ductography techniques

j. Lacrimal ducts

k. Angiography- Principle-contrast media, method of injection, DSA, Venogram

l. Fistulogram and Sinusogram

m. MMR, Soft issue Radiography.

3. Pediatric Radiography- Introduction to pediatric radiography, Paediatric rradiography ttechniques, safety considerations in pediatric radiography, portable radiography in pediatrics.

Part II – Paper III
Basics of Radiotherapy
Section A

1. Ethics, epidemiology, prevention of cancer: Principles of ethics in health care, enforcing standards in health profession promoting quality care, Professional ethics in patient care delivery, ethical principles related to radiation oncology. Maintenance of radiation treatment charts and treatment records. How to interact with a patient getting radiation treatment, Life saving measures (first aid) in emergency situations, how to answer common doubts of patients getting treatment, role of radiotherapy technologist as a radiotherapy team member.
2. Epidemiology, cancer registry, prevention of cancer, early detection.
3. Oncopathology: Introduction, Pathological classification of malignancies, grading, staging, Importance for relevant staging for selection of radiation treatment techniques.
4. Cancers of various sites: Head and neck- Larynx, Hypopharynx, nasopharynx, oropharynx, oral cavity, ear, parotid, maxillary antrum, orbit, thyroid, Lungs, oesophagus, stomach, rectum, anal canal, breast, CNS tumours, pancreas, Cervix Endometrium, Vulva, vagina, Prostate, Penis, testicular malignancy, Urinary bladder, Lymphomas – Hodgkin's, NHL, sarcomas. Paediatric tumours like Wilm's tumour, Medulloblastoma, Neuroblastomas. etc

5. Methods of Cancer Management- Medical Oncology, Chemotherapy, Neoadjuvant, adjuvant, concurrent chemo- Radiotherapy (terms only), Surgical Oncology, Radiation oncology
6. Radio-biological Basis of Radiotherapy: Introduction, radiobiology – cell killing, DNA breaks, lethal damage, sub lethal damage, oxygen effect, Cell survival curve, Cell cycle, radio sensitivity. Normal tissue reactions to radiation – Early, late reactions of various organs – skin, Buccal mucosa, heart, lung, kidney, spinal cord, brain, intestine, rectum, bladder, testes, ovary, eye. Tolerance dose general ideas.

Section B

1. Treatment planning- Introduction, clinical aspects of Teletherapy, Brachytherapy, treatment simulation– conventional and CT Simulation, treatment planning. 2-D, 3-D planning, brachytherapy treatments –interstitial, intracavitary and mould treatments, after loading techniques. At the time of treatment execution, the radiation oncologist must teach the students how it is carried out, familiarize the students with various medical terms relevant to radiation treatment
2. Radiotherapy Techniques for various tumours- head and neck- Larynx, Hypo pharynx, nasopharynx, oropharynx, oral cavity, ear, parotid, maxillary antrum, orbit, thyroid, Lung, oesophagus, stomach, rectum, anal canal, Breast, CNS tumours, Pancreas uterine cervix, endometrium vulva, vagina.
   Prostate, Penis including mould treatment, testicular malignancy, urinary bladder.
   Lymphomas – Hodgkin's, NHL. Sarcomas-mantle fields, subtotal irradiation, IFRT). Sense organs.
   Paediatric tumours like Wilm's tumour, medulloblastoma, neuroblastomas etc. Palliative irradiation
3. Brachytherapy: Introduction, brachytherapy techniques-Interstitial, intracavitary, Intraluminal and mould applications.
   Clinical application of Brachytherapy on various cases.
4. Modern Radiotherapy (basics only) and nuclear medicine: 3D Conformal Radiotherapy- familiarize the students with advances in radiation treatment like 3D, CRT, IMRT, Stereotactic irradiation, IGRT etc
   Nuclear Medicine- Introduction, clinical aspects of nuclear medicine, applications of nuclear medicine for cancer diagnosis and treatment, isotopes used. Radioiodine uptake study, Thyroid malignancy-classification of thyroid malignancies, general outline of treatment of various thyroid malignancies, Radioiodine treatment and its indications.

Part III – Paper I

Radiation Safety in Radiodiagnosis and Radiotherapy

1. Basic Radiation Physics: Atomic structure, Nucleus, Atomic number, mass number, Electron Orbit and energy levels, isotopes and isobars, radioactivity, radioactive decay, half-life, Particle radiation, Electromagnetic radiation, Production of X-Rays, Continuous X-Ray Spectrum, Bremsstrahlung radiation, Characteristic X-rays, Filters, Quality of X-rays, Effect of voltage and current on the intensity of X-rays, Properties of X-rays.
2. Interaction of Radiation with matter- Photoelectric effect, Compton Effect, Pair Production, Ionization of matter, Energy absorbed from X-rays, X-rays scattering, X-rays

transmission through the medium, linear and mass attenuation coefficient, HVT and TVT, Interaction of charged particle and neutrons with matter.

3. Radiation Quantities and Units: Radioactivity, Flux, Fluence, Kerma, Exposure, Absorbed Dose, Equivalent Dose, Weighting Factors, Effective Dose, Natural Background radiation, Occupational Exposure limits, Dose limits to public.
4. Biological Effects of radiation-The Cell. Effect of ionizing radiation on cell, chromosomal aberration and its application for the biological dosimetry, Somatic effects and hereditary effects, stochastic and deterministic effects, Acute exposure and chronic exposure, $LD_{50/60}$
5. Detection and Measurement of radiation & measuring instruments- Ionisation of gases, Fluorescence, and phosphorescence, Effect of photographic emulsion, Ionisation chambers, Proportional counters, G M counters, Scintillation Detectors, Liquid scintillator, Pocket Dosimeters, TL Dosimeters and their uses in personnel monitoring badges. Advantages and disadvantages of various detectors, appropriateness of different types of detectors for different types of radiation measurement
6. Radiation Hazard evaluation and control (Diagnostic radiology)

   Philosophy of Radiation Protection, Effect of Time, Distance and Shielding, Calculation of workload, calculation of weekly dose to the radiation worker and general public, good work practices in diagnostic radiology, Planning consideration for radiology installation including workload, use factor & occupancy factors, effect of different shielding material.
7. QA in Diagnostic Radiology

   QA programs for X-ray tubes and generators, screen film radiography, Digital Radiography, CT, Mammogram, Verification of optical and 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 and Digital Radiography.
8. Regulatory requirements:

   National Regulatory Board, Responsibilities, organization, Safety Standards, Codes and Guides, Responsibilities of Licensees, registrants and employers and Enforcement of Regulatory requirements, Role of technologist in radiology department, Dose limits
9. Radiation safety considerations in diagnostic radiology

   Principle of Justification and Optimization, ALARA, Radiation safety consideration in Conventional radiography and Digital radiography, Radiation safety consideration in Mobile radiography, Radiation safety consideration in Mammography, Radiation Safety considerations in Dental Radiography, Radiation safety consideration in Fluoroscopy, Radiation safety consideration in CT. Medical exposure, Dose indexes, CTDI etc.
10. Demonstration/Practical

    Time, Distance and Shielding, measurement of HVT & TVT.

    Familiarization of radiation survey meters and their functional performance check.

    Radiological Protection Survey of Diagnostic X-ray installation.

    Familiarization with QA equipment and QA tools in diagnostic radiology

    Quality Assurance of conventional X-ray equipment

    Quality Assurance and radiation protection survey of a CT Scan installation

    Demonstration for checking the shielding adequacy of protective accessories (lead apron/mobile protective barriers MPB), Investigation of reported excessive exposure of

Section B

Radiation Safety in Radiotherapy

1. Radiation Hazard evaluation and control (Radiotherapy)- Philosophy of Radiation Protection, Effect of Time, Distance and Shielding, Calculation of workload, calculation of weekly dose to the radiation worker and general public, good work practices in radiotherapy practices including Teletherapy and Brachytherapy, Planning consideration for radiotherapy installation including workload, use factor & occupancy factors, effect of different shielding material.
2. Basic Radiation therapy Physics: Historical Developments in Radiotherapy, Physical components of Telecobalt Unit/Linear Accelerator Unit/ Remote After loading Brachytherapy Unit/ Gamma knife Unit/ Simulator and their descriptions. Various types of sources used in Radiotherapy and their properties, Physics of photons, electrons, protons and neutrons in radiotherapy, physical parameters of dosimetry such as Percentage Depth Dose, Tissue Air Ratio, Tissue Maximum Ratio, Physics of bolus and phantoms materials, compensators, wedges, shielding blocks, patient immobilization devices, port film, processing and development, special techniques in Radiotherapy such as SRS, SRT, IMRT, IGRT and Tomotherapy.
3. QA in Radiotherapy: Accessories and tools used for QA tests in Radiotherapy such as Front pointer, Back pointer, Laser alignment etc, Optical and radiation field congruence, Beam shaping blocks, Beam shaping jaws, Delineator/ Diaphragm movements, Isocentre alignment, Patient support system, Beam on and off mechanisms, Technician's role in QA tests on telecobalt/ linear accelerator/ brachytherapy/ gamma knife/ simulator/ CT simulator machines.
4. Radiation Emergency Preparedness: Safety and security of radiation sources, case history of emergency situations and preparedness, equipment and tools including role of Gamma Zone Monitor, Regulatory requirements and prevention of emergency, Preventive maintenance and safety culture, Role of technicians in handling radiation emergencies.
5. Regulatory requirements: National Regulatory Body, Responsibilities, organization, Safety Standards, Codes and Guides, Responsibilities of Licensees, registrants and employer and Enforcement of Regulatory requirements.
6. Demonstration: Time, Distance and Shielding, measurement of HVT & TVT. Familiarization of radiation survey meters and their functional performance checks Radiotherapy Simulator/ CT Simulator installations QA on X-Ray, Simulator and Radiotherapy equipment. Procedures followed for calibration of measuring and monitoring instruments.

Part III Paper II

Advanced Medical Imaging Technology

Section A

1. Digital Radiography – Digital Radiography history and development, Direct and indirect digital radiography. Theory and principle – digital Fluoroscopy system – digitized image-digital subtraction techniques – digital image processing- future equipment developments – clinical application – PACS (Picture Archival and Communication System) – Digital Image quality – Laser film printers. Image acquisition – Digital Spot Imaging (DSI) – Digital chest radiography – future developments, CR.

2. Mammography Technique -Background, diagnosis and screening. Imaging Techniques, compression, image quality- Interventional accessories – biopsy equipment attachments, Digital Mammography.
3. Ultrasound equipment - Terminology-physical principle. Different types of machines – portable etc. Doppler, Clinical applications. Image display & recording systems-transducers (scanning probes) – types and shapes-choice, care and maintenance – recording devices, Orientation of the image –focus of the beam – sensitivity and gain – artefacts-quality control-acoustic coupling agents,
4. Computed Tomography - Historical information, Technologic considerations, Basic Principles in CT scanning- Radiation Dose, Patient preparation, Paediatric CT, Contrast Media, Filming, Despatch. Cross Sectional Anatomy related to CT Scanning, CT Techniques of Brain, Spine, Head and Neck, Chest, Abdomen, Pelvis, Extremities. Basic Principles of CT contrast Media- Oral, IV, Rectal, Intrathecal. CT Angiogram- Triple Phase CT -Pressure Injectors. CT Myelogram
HRCT- Lung, Temporal Bone, CT Cisternogram. Cardiac CT, CT Perfusion Techniques, CT Enterogram, CT Enteroclysis. Reconstruction Techniques, -VRT, MPR, Virtual Endoscopy, Navigation etc. CT artifacts, CT advantages and limitations, Future developments.
5. Dual energy CT- Dual energy CT equipment - Basic principle- clinical applications-newer developments.

Section B

1. **Nuclear Medicine**- Basic principle Instrumentation-Gamma camera, SPECT, PET, clinical applications-newer developments
2. MRI Historical information, Technologic considerations, Basic Principles in MRI scanning-Patient Preparation, MRI safety-Patient and Technologist, Patient Registration to Machine, Selection of Protocol, Selection of sequences, Contrast, Termination of studies, after care of the patients, Image Reconstruction Techniques, Filming Techniques, Despatch
Sectional Anatomy related to MR Imaging.
MR Techniques of Brain, Spine, Head and Neck, Chest, Abdomen, Pelvis, Extremities, Joints, Breast, Soft Tissues,
Routine sequences and Protocols, ASL
MR angiogram- TOF and Contrast- Venogram, Pressure Injector
Cardiac MR- Different Sequences- Spin echo Gradient Echo, Fast imaging sequences, Fat suppression, Fluid suppression, SWI, Diffusion Imaging -DWI, ADC, DTI, MR spectroscopy techniques and Applications
MR Perfusion Imaging, Functional Imaging
Artefacts in MR Imaging.
Advantages and Limitations, Future Developments.
3. PACS (Picture Archiving and Communication System) Technique of storing retrieving, presenting and sharing images like x-ray, ultrasound, CT scan and MRI. DICOM images PACS, VNAs and RIS PACS Architecture Cloud PACS
4. DSA – Basic Principles and Clinical applications, Equipment and operation, Serial imaging devices-subtraction process, accessories and choice-catheters, guide wires, Interventional Angiography: Accessories and uses e. g.: coils/stents, pressure Injectors: Types, programming, injection protocols and uses. DSA Subtraction process, injection pump, cine camera, optical system, film processing.

5. Interventional Radiology - Practical Interventional radiology in the diseases of the Hepato-biliary, GIT, Urology, Vascular System and other areas, Indications and contraindications, pitfalls and complications, role of radiographer/imaging technologist in the team. Interventional procedures – CT guided procedures: Fine needle aspiration cytology, fine needle aspiration biopsy. Fluoroscopy guided procedures: endoscopic retrograde cholangio–pancreatography (ERCP); percutaneous nephro-lithotomy; percutaneous nephrostomy; percutaneous trans hepatic biliary drainage, embolisation, liver biopsy, Vascular Intervention Techniques. Radio frequency ablations Procedures.

Part – III, Paper – III
Advanced Radiotherapy
Section A

1. Introduction: Local and general effects of tumours and its spread, carcinogenesis, Co-morbidities
2. Prevention and early detection: Epidemiology, Signs and symptoms, public awareness on early signs and symptoms, genetics. High risk groups.
3. Tumour Biology- Cell kinetics, Cell cycle, control mechanisms, pathology of tumours, staging of tumours, classification of tumours of various sites.
4. Tissue structure and radiation effects and Fractionation - Tumour control probability (TCP), Normal Tissue Complications Probability (NTCP), models, acute and late side effects of radiation, radiation sensitizers/protectors/side effect reduction. 4R in radiotherapy. Effects of radiation on normal tissues and malignant tumour- Early and late reaction on Skin, Mucous membrane, GI tract, Genito urinary system, respiratory system, CNS, Tolerance Dose of Normal structures

Fractionation in radiotherapy-different fractionation schedules etc

5. Treatment combinations –Introduction, combination of treatments, chemo radiation etc, treatment scheduling.
6. Application of radiotherapy in benign conditions
7. Principles of positioning and immobilization- Positioning aids-Breast boards, Lung boards, Belly boards, Head-and-neck fixation devices, Vacuum packs, Stereotactic systems etc, Internal organ motion control- Bite blocks, Gating systems, Active breathing control, Diaphragm compression, Prostate immobilization, Tracking systems. Laser/ positioning systems, marking systems, Reference points
8. Image acquisition and verification: Image acquisition for planning, modalities for image acquisition for planning. Treatment verification-modalities and methods of treatment verification.
9. Patient set up: Introduction, evaluation of patient setup for simple techniques, use of Beam modifying devices, such as wedges, tissue compensators, mid Line Block (MLB) in the treatment of respective sites. Customized shielding blocks, asymmetric collimators and their use
10. Simulation procedures including CT simulation of various cancers.

Section B

1. Clinical radiation oncology of various cancers: Head and Neck, Lung, GIT, Breast, CNS tumours, Genito Urinary cancers.
   Lymphomas, HL, NHL IFRT, INRT, Sarcomas, Total body Irradiation-total hemi body Irradiation. Paediatric Tumours, Palliative Radiotherapy, Priming patient for BMT, Radio immunotherapy.
2. Recent Advances in radiotherapy such as 3DCRT, IMRT, IGRT. SRS. SRT, Tomotherapy, SBRT, electron therapy, proton therapy and their clinical applications
3. Brachytherapy- HDR LDR MDR, Clinical Applications of Interstitial implantation, template based interstitial implantation, intraluminal brachy therapy, Intra cavitary Brachytherapy, Surface mould treatments, Temporary and Permanent implants, Intra operative Brachytherapy, Endovascular Brachytherapy, Different types of Brachytherapy Applicators,
4. Duties and responsibilities of radiotherapy technologies/radiographers: Introduction, ethics, approach and attitude towards patients, nursing and medical staff. Clinical care

of patients, local and systematic reactions, accuracy in treatment, handling and care of apparatus and accessories, Maintenance of records

4. Scheme of teaching and Clinical Training

First Year: General and Radiation Physics, Anatomy, Physiology & Pathology

Second Year: Physics of Medical imaging and Radiotherapy, Radiography Techniques, Basics of Radiotherapy

Third Year: Radiation safety in Radiodiagnosis and Radiotherapy, Advanced medical imaging technology, Advanced Radiotherapy

Year	Subject	No of Hours
First year	A. Theory- Part I	**540 hours (Minimum)**
	1. General & Radiation Physics	150
	2. Anatomy	130
	3. Physiology & Pathology	260
	B. Practicalls & Clinical Posting	**1000 hours (Minimum)**
	B. 1	
	1. Radiology Reception & Film Dispatch	100
	2. Dental Radiography	150
	3. X-ray dark rooms	100
	4. General X-ray Procedures	150
	TOTAL	**500 (Minimum)**
	B. 2	
	1. Radiotherapy Machines and Mould room,	100
	2. Oncology and Radiotherapy OPD	250
	3. Radiation physics and Treatment Planning	150
	TOTAL	**500 (Minimum)**
Second Year	A. Theory- Part II	450 hours (Minimum)
	1. Physics of Medical Imaging and Radiotherapy	150
	2. Radiography Techniques	150
	3. Basics of Radiotherapy	150
	B. Practicals & Clinical Posting	**1100 hours (Minimum)**
	B. 1	
	1. DR and CR	100
	2. Radiography	150
	3. CT Scan	300
	TOTAL	**550(Minimum)**
	B2.	
	1. Radiotherapy machines, reception,	325
	2. simulator, brachytherapy etc.	
	3. Radiation Physics (therapy)	200
	4. Nuclear Medicine	25
	Total	**550 (Minimum)**
Third Year	A. Theory- Part II	450 hours (Minimum)

	1. Radiation safety in Radiotherapy and Radiodiagnosis, 2. Advanced medical imaging technology, 3. Advanced Radiotherapy	150 150 150
	B. Practicals & Clinical Posting	**1100 hour (Minimum)**
	1. MRI 2. DSA and IR 3. Mammography 4. Ultrasound 5. Radiation Physics, QA, and Radiation safety(diagnosis) **Total**	300 150 25 25 50 **550 (Minimum)**
	1. Radiotherapy OP 2. Teletherapy, Linear Accelerator, Telecobalt Mould Room, Simulator, brachytherapy 3. Radiation Physics & Radiation Safety(therapy) 4. Nuclear Medicine	100 300 100 50
	Total	**550 (Minimum)**

4.1 Records/Log Book

The Practical records shall be maintained & submitted at the end of the course duly certified by the concerned Faculty and HOD.

5. TEACHING /LEARNING AIDS

5.1 Text Books

1. Christensen's Physics of Diagnostic Radiology by Thomas Curry
2. Human Anatomy by B D Chaurasia's
3. Textbook of Anatomy by Dr Sreedevi's
4. Textbook of Physiology, Guyton and Hall
5. Essentials of Medical Physiology by K Sembulingam
6. Anatomy and Physiology for Radiographers - C. A. Warrick
7. Radiographic Imaging- Chesney & Chesney,
8. Care of patient in diagnostic Radiography - Chesney & Chesney.
9. Clarks Positioning in Radiography by Imaging by Stewart Whitley et al
10. Textbook of radiology for residents and technicians by Bhargava S. K
11. Diagnostic Radiography Glenda. J. Bryan (ELBS)
12. Recent advances in Radiology and Medical Imaging" Lodge & Steiner Interventional Radiology-Principles and Techniques by J Ring and Mclean
13. Radiation Protection in Hospitals. Richard F. Mould
14. Perez & Brady's Principles and Practice of Radiation Oncology
15. The Physics of Radiation Therapy Faiz M. Khan and John P. Gibbons
16. Practical Radiotherapy Planning by Dr. Jane Dobbs,, Professor Ann Barrett et al
17. Radiobiology for the Radiologist by Eric J. Hall,

Other materials to study

1. AERB safety Codes for Diagnostic Radiology, Radiotherapy, Nuclear Medicine
2. Atomic Energy Act and Radiation Protection Rules, Govt of India.

5. 2 Rreference books:

1. Gray`s Anatomy by Henry Gray.
2. Radiographic Anatomy – Meschan
3. Inderbir Singh`s text book of human Histology
4. Gross Anatomy by I B Singh
5. Gross Anatomy by Vishram Singh
6. Dutta's Textbook of Anatomy
7. Basic Anatomy and Physiology for Radiographers by MRE Dean
8. Surface and Radiological Anatomy by A Halim
9. Principles of Physiology, Debasis Pramanik
10. Ganong's Review of Medical Physiology
11. Basic Pathology by Robbins, Angell and Kumar
12. Fundamental Physics of Radiology W. J. Meredith J. B. Massey
13. Medical Imaging Physics by William R. Hendee, E. Russell Ritenour
14. MRI: The Basics, Ray H. Hashemi, William Bradley, Christopher J. Lisanti,
15. MRI basic Principles and Applications Nark A brown
16. Diagnostic Imaging by Peter Armstrong
17. Computed Tomography (Approaches Applications and Operations by Ehsabn Samuels Norbert J Pelc
18. MRI from Picture to Proton Donald W. McRobbie
19. Handbook of MRI Technique, Catherine Westbrook
20. MRI in Practice by Catherine Westbrook
21. MRI Hand Book MR Physics Patient Positioning and Protocols by Muhammed, Elmaoğlu
18. Practical approach to Angiography by Irwin. S. Johnsrude
19. Technologists Guide to mammography by Regan
20. Radiology of Anaesthesia and Critical Care by Christine H Murphy
21. Radiology in Dental Practice Herbert Frommer
22. Interventional radiology Principles and Techniques by Wilfrido R Castaneda
23. Hand Book of Interventional Radiographic Procedures by Krishna Kandarpa and John E Aruny
24. Producing quality Radiographs Angelin M Cuilnnan
25. Atlas of Roentgenographic Positioning by Merrill
26. Children's Radiographic techniques by Feshartlefyl
27. Special procedures in Radiology by Sagal
28. Synopsis of Radiological Anatomy with CT by Meschan
29. Basic Medical Techniques and patient care for Technologists by Zillam S Torres
30. Advances in Ultrasound techniques and Instrumentation by Peter Well
31. An Atlas of Normal radiographic Anatomy by Isadore Meschan
32. Radioisotopes and Bone by Franklin Mclean
33. Radiographic Examination of the small Intestine- Roentgenographic Techniques by Ross Golden
34. X ray technology by Charly A Jacobi
35. Nuclear Medicine Instrumentation by Jennifer Prekeges
36. Nuclear Medicine Technology Study Guide by Andrzej Noniuszko
37. Radio-biology for the Radiologist by Eric J. Hall, Amato J. Giaccia
38. IAEA Safety Series
39. Treatment planning & dose calculation in radiation oncology, Gunilla C. Bentel, Charles E. Nelson and K. Thomas Noell

40. Clinical Radiation Oncology Leonard L. Gunderson and, Joel E. Tepper

5. 3. **Models/Charts:** As supported and decided by the concerned Faculties.

6. **EXAMINATION:**

6. 1 **Scheme of internal assessment** –Regular internal assessment through written & practical examination shall be conducted. Minimum of 3 internal assessment & one model examination to be conducted & average of these marks (highest three out of all) are to be tabulated out of 50 and forwarded to the DME before the final examination.

6.2 Final examination

6.2.1 The Authority to conduct the examination: The Director of Medical Education, Government of Kerala

6. 2. 2. Frequency: Regular examination shall be conducted at the end of the 1st and 2nd year and 3rd year. Supplementary examination shall be conducted 6 months after the regular examination.

6. 2. 3. Eligibility

1. Minimum of 80% attendance in theory & practical is required to appear for the final examination.
2. Certificate of satisfactory completion of the course.

6. 2. 4. Schedule of Examination

1. Regular examination shall be conducted at the end of the academic year which includes theory, practical & Viva voce.
2. Total 9 Papers (3 papers in the 1st year and 3 papers in the 2nd year and 3 papers in the 3rd year)
3. Each paper shall be of duration of 3 hours with total marks of 100 each. Each paper shall have 2 sections- ***Section A & Section B.***

6. 3 Examiner: Faculty with PG and post PG teaching experience of minimum one year in the concerned course/subject are eligible to be an examiner.

6. 4. Pass Criteria:

1. Minimum of 45% of marks in each theory paper with a minimum of 50% of marks in the total theory papers
2. A minimum of 40% of marks in the oral and practical examination
3. A minimum of 50% aggregate marks of the grand total (Total theory (100), practical (50) and internal assessment (50).

First year examination	-	250 out of 500.
Second year examination	-	250 out of 500
Third Year	-	250 out of 500

6. 5. First class/Distinction/Rani

1. Candidates scoring 65% & above shall be awarded first class.
2. Candidates scoring 75% & above shall be awarded distinction.
3. Candidates who scores highest mark in the grand total (Theory, practical and internal assessment) shall be awarded the first Rank.

Revaluation: Any candidate who requires revaluation shall submit the request to do so within 14 days of the official declaration of the result.

7. MODEL QUESTION PAPERS

GOVERNMENT OF KERALA
DIRECTORATE OF MEDICAL EDUCATION
DRRT EXAMINATION

Time: 3 hours **Max. Marks: 100**

Part I - Paper-I
GENERAL AND RADIATION PHYSICS
(Answer Section A&B separately)

SECTION-A

I. Explain the following **(5x2=10 Marks)**
   a. SI units
   b. Ohms law
   c. Henry
   d. Bridge rectifier
   e. Eddy Current

II. Explain the following **(5x4=20 Marks)**
   a. Half-life. Find the activity of a cobalt 60 source after 8 Years if the present activity is 100 Curie
   b. Cyclotron
   c. Working of Moving Coil Galvanometer
   d. Working of a PN junction diode
   e. Characteristic and Continuous X Ray

III. **(2x10=20 Marks)**
   a. What are transformers and explain the different types of transformers with figure.
   b. What is rectification? Explain in detail about the different rectifiers used in X-ray circuits?

SECTION-B

I. Explain the following **(5x3=15 Marks)**
   a. Space charge effect
   b. Disadvantages of self-rectification
   c. Thermo Luminescent Dosimeterd)
   d. HVT and TVT
   e. Bragg curve

II. Answer the following **(3x5=15 Marks)**
   a. Why Tungsten is used as target in X-ray tube
   b. What is Inherent and Added filtration
   c. Mention any five radiation Quantities and their Units

III. Describe various interactions of radiation with matter and explain each interaction. **(1x20=20 Marks)**

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DRRT EXAMINATION-2019

Time: 3 hours Max. Marks: 100

Part I - Paper-II

ANATOMY

Answer all Question, Draw diagrams wherever necessary

SECTION A

I. Enumerate the parts of female reproductive tract. Describe briefly the anatomy of the ovary uterus and fallopian tubes. Mention the radiological investigation of female reproductive tract. (3 +2+2+1+2=10 Marks)

II. Enumerate the parts of Brain. Describe cerebrum cerebellum and blood supply of brain. Mention radiological investigation of the nervous system (2+2+2+2+2=10 Marks)

III. Answer briefly on (10x3 =30 Marks)

a. Stomach
b. Chambers of Heart
c. Kidney
d. Shoulder joint
e. Urinary Bladder
f. Femur
g. Cartilage
h. Lungs
i. Ear
j. Liver

IV. Write short notes on (10x3 =30 Marks)

a. Epithelia
b. Connective Tissues
c. Neurons
d. Pancreas
e. Muscular Tissue
f. Microscopic structure of Bone
g. Humerus
h. Synovial Joint
i. Gall Bladder
j. Pericardium

GOVERNMENT OF KERALA
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DRRT EXAMINATION

Time: 3 hours Max. Marks: 100

Part I - Paper-III
Section A
PHYSIOLOGY

Max. Marks: 50

I. Describe the transport of oxygen in blood. Mention the factors affecting Oxy-Haemoglobin Dissociation curve. Add a note on Hypoxia (5+2+3=10 Marks)

II. Write short notes on (5x5=25 Marks)
   a. Functions of plasma proteins
   b. Composition and functions of pancreatic juice
   c. Factors affecting Glomerular filtration rate
   d. Regulation of blood pressure
   e. Physiological actions of Thyroid hormones

III. Define the following (5x2=10 Marks)
   a. Anaemia
   b. Cardiac output
   c. Tidal volume
   d. Resting membrane potential
   e. Synapse

IV. Name the following (5x1=5 Marks)
   a. Two granulocytes in blood
   b. Normal clotting time
   c. Pacemaker of human heart
   d. Female sex hormones
   e. Receptors for vision

SECTION B

PATHOLOGY

Max. Marks: 50

I. Classify bone tumours. Describe clinical features, X-ray findings, macroscopic and microscopic findings of oestrogenic sarcoma. **(3 + 7=10 Marks)**

II. Write short notes on: - **(5 X 5=25 Marks)**

a. Radiation injury
b. Necrosis
c. Oedema
d. Rickets
e. ESR

III. Define the following: - **(5 x 2 = 10 Marks)**

a. Leukaemia
b. Hyperplasia
c. Neoplasia
d. Jaundice
e. Tumour markers

IV. Name the following: - **(5 X 1=5 Marks)**

a. Two causes of Granulomatous inflammation
b. Two examples of metaplasia
c. Two premalignant lesions
d. Two types of Acute leukaemia
e. Two cause of MCHC

GOVERNMENT OF KERALA
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D.R.R.T. COURSE EXAMINATION
PART II - PAPER-I
PHYSICS OF MEDICAL IMAGING AND RADIOTHERAPY
(Answer Section A&B separately) Time:3Hrs. Max. Marks: 100

SECTION-A

IV. Explain the following (Marks 5x4=20)
a. Colour Doppler
b. T_1 and T_2 Relaxation Time
c. Characteristic Curve of radiographic film
d. Image Intensifier
e. CT Number

V. (Marks 3x5=15)
a) Describe Automatic Film Processor
b) Explain MRI
c) Explain Fluoroscopy

VI. Describe the structure of X-Ray film and Film processing (Marks 1x15=15)

SECTION-B

I. Explain the following (5x4=20)
a) Back Scatter Factor b) RIA
c) TAR d) Penumbra
e) Simulator

II. (3x5=15)
d) Explain the Remote After loading technique in Brachytherapy
e) The PDD for a 15x15 cm^2 field size, 10 cm depth and 80 cm SSD is 58.4 for a Co-60 beam. Find the PDD for the same field size and depth for a 100 cm SSD
f) Explain the properties of radio nuclides used for Brachytherapy

III. With the help of a block diagram, explain Linear Accelerator (1x15=15)

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DRRT COURSE REGULAR EXAMINATION
Time: 3 hrs. Max. Marks: 100
Part II- Paper II
RADIOGRAPHY TECHNIQUES

(Answer Section A & B separately and draw diagrams wherever necessary)

SECTION A

I. Elaborate the Different views for Paranasal sinuses. Describe the techniques in Detail with the positioning, factors and Cantering for each **(5+10 =15 Marks)**

II. Write short notes on **(7 x 5 = 35 Marks)**

a. Ten-day rule
b. Radiographic views for Patella
c. Handling of Fracture cases
d. Ball catchers view
e. Ward Radiography
f. Views for sternum
g. SI Joint views

SECTION B

I. Draw a simple labelled diagram of the components of the human urinary system. Describe the indications, patient preparation and filming sequences for an IVU **(10+5=15 Marks)**

II. Write short notes on **(5x5=25 marks)**

a. Barium swallow
b. Sialography
c. Paediatric Radiography
d. Contrast Media reactions
e. T tube Cholangiography

III. Explain the following **(5x2=10 marks)**

a. RFA
b. NMR
c. CT number
d. PACS
e. PET

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DRRT COURSE REGULAR EXAMINATION
Time: 3 hrs Max. marks:100
Part II Paper III –BASICS OF RADIOTHERAPY

(Answer Section A & B separately and draw diagrams wherever necessary)

SECTION-A

I. Describe the Staging of Carcinoma Breast. Explain radiation treatment to a post mastectomy woman with carcinoma breast? What is APBI?

(15+10 = 25marks)

II. Write short notes on the following **(5x5 = 25 marks)**

a. Radiation toxicities of head and neck irradiation
b. Cell survival curve
c. Cranio-Spinal Irradiation (CSI)
d. Radiotherapy of Carcinoma urinary bladder
e. Brachytherapy treatment in carcinoma cervix

SECTION-B

I. Describe Staging of Carcinoma Cervix? Explain Radiation treatment of Carcinoma cervix? What are the toxicities of radiation treatment of carcinoma cervix?

(15+10=25 marks)

II. Write short notes on: **(5x5 = 25 marks)**

a. Conventional fractionation
b. Mantle field irradiation
c. oncological emergencies
d. Radio Iodine Treatment
e. Radiation toxicities of pelvic irradiation

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DRRT COURSE EXAMINATION
Part III - Paper-I
Time: 3hours Max. Marks:100
RADIATION SAFETY IN RADIODIAGNOSIS AND RADIOTHERAPY
(Answer Section A&B separately)

SECTION-A

I. Define (5x3= 15 Marks)
   a. Filters
   b. Exposure
   c. Deterministic Effects
   d. G M Monitors
   e. Optical Density

II. Write short notes on (3X5= 15 Marks)
   a. QA tools in Diagnostic Radiology
   b. AERB Safety Codes in Diagnostic radiology
   c. Role of Technologist in Diagnostic Radiology

III. Discuss
   a. Various methods for reducing patient exposures in Diagnostic Radiology and Explain Radiation safety consideration in Dental Radiology (5+5 = 10 Marks)
   b. QA tests in Mammography and DSA (5+5 = 10 Marks)

SECTION B

I. Define (5x3 = 15 Marks)
   a. HVL and TVL
   b. Equivalent Dose
   c. Tissue weighing factors
   d. LD 50/60
   e. Workload

II. Describe (3x5=15 Marks)
   a. Various types of sources used in Radiotherapy and their properties
   b. Historical Developments in Radiotherapy
   c. QA tools in Radiotherapy

III.
   a. Draw a Radiotherapy room layout and label it and explain safety aspects (5+5= 10 Marks)
   b. Explain QA tests in gamma Knife and Regulatory requirements in Radiotherapy (5+5= 10 Marks)

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DRRT COURSE REGULAR EXAMINATION
Time: 3 Hrs **Max. marks: 100**
Part II, Paper III
ADVANCED MEDICAL IMAGING TECHNOLOGY

SECTION A

I. Describe the techniques of Mammography with Patient Preparation, Positioning, views, filming and Radiation Dose **(3x5= 15 Marks)**

II. Write Short Notes **(6x5= 30 Marks)**
   a. CR cassettes
   b. Ultrasound transducer
   c. CT Angiography
   d. Digital radiography
   e. Triple phase CT
   f. Low Dose CT

III. Expand the following **(5x 1 = 5 Marks)**
   a. HRCT,
   b. VRT,
   c. CTPA,
   d. MLO view
   e. CDI

SECTION B

I. Name the Different components of MRI machine; briefly describe MRI safety Precautions for both Patients and Technicians
(5+5+5 =15 Marks)

II. Write Short Notes **(7x 5 = 35 Marks)**
   a. Seldingers' techniques
   b. Radioactivity
   c. Components of PACS
   d. Diffusion Imaging
   e. SPECT
   f. Microwave ablations
   g. MR contrast Agents

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DRRT COURSE EXAMINATION
Part III Paper-III
Time: 3hours Max. Marks:100
ADVANCED RADIOTHERAPY
Answer all questions. Draw diagrams wherever necessary.

SECTION-A

I. Describe in detail the epidemiology, clinical features, diagnosis, treatment combinations and prognosis in cancer of Breast. **(5+5+5+5+5=25 marks)**

II. Short notes. **(5X5=25 marks)**

a. TCP an NTCP
b. CT Simulator and Simulation Techniques for cancer of Tongue
c. Effects of Radiation of Normal tissues
d. Palliative care
e. Application of radiotherapy on benign conditions

SECTION-B

I. Describe in detail the epidemiology, clinical features, diagnosis, staging and radiotherapy techniques for CNS tumours. **(5+5+5+5+5=25 marks)**

II. Short notes. **(5x5=25 marks)**

a. Duties of Radiotherapy technologist in Radiotherapy.
b. IMRT for Head and Neck cancers
c. HDR Brachytherapy techniques for cancer of Oesophagus
d. Paediatric Tumours
e. Radio Immunotherapy