MEWAR UNIVERSITY

(A University u/s 2(f) & 12 (B) with right to confer degrees u/s 22(1) of the UGC Act 1956 and Established by Rajasthan State Govt. Act No. 4 of 2009)

(NAAC ACCREDITED)

MEMBER, ASSOCIATION OF INDIAN UNIVERSITIES (AIU)

SYLLABUS

BACHELOR OF RADIATION TECHNOLOGY

University Campus: NH- 48, Gangrar, Chittorgarh, Rajasthan – 312901
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FIRST YEAR

S.NO.	SUBJECT	DISTRIBUTION OF MARKS				
		THEORY	INTERNAL	PRRACTICAL		TOTAL
				TH	INT	
1	Gross Radiological & surface Anatomy of human body.	80	20	-	-	100
2	Physiology and Pathology of human body systems.	80	20	-	-	100
3	Radiographic Techniques &Dark Room Procedures	80	20	-	-	100
4	Basic Radiation Physics & Principles of Radiotherapy	80	20	-	-	100
5	**PRRACTICAL**	-	-	75	25	100
TOTAL		**320**	**80**	**75**	**25**	**500**

SECOND YEAR

S.NO.	SUBJECT	DISTRIBUTION OF MARKS				
		THEORY	INTERNAL	PRRACTICAL		TOTAL
				TH	INT	
1	Modern Imaging with Recent Advances	80	20	-	-	100
2	Apparatus of Imaging, Radiotherapy & Quality Assurance	80	20	-	-	100
3	Physics of Radiotherapy	80	20	-	-	100
4	Radiation Protection & Monitoring	80	20	-	-	100
5	**PRRACTICAL**	-	-	75	25	100
TOTAL		**320**	**80**	**75**	**25**	**500**

THIRD YEAR

S.NO.	SUBJECT	DISTRIBUTION OF MARKS				
		THEORY	INTERNAL	PRRACTICAL		TOTAL
				TH	INT	
1	Special Radiological Procedures & Contrast Media	80	20	-	-	100
2	Radiotherapy Planning & Techniques	80	20	-	-	100
3	Radiation Dosimetry- Principles & Applications	80	20	-	-	100
4	Hospital Practice & Patient Care	80	20	-	-	100
5	**PRRACTICAL**	-	-	75	25	100
TOTAL		**320**	**80**	**75**	**25**	**500-**

BACHELOR OF RADIATION TECHNOLOGY

I YEAR

1. **Gross Radiological & surface Anatomy of human body.**
2. **Physiology and Pathology of human body systems.**
3. **Radiographic Techniques &Dark Room Procedures**
4. **Basic Radiation Physics & Principles of Radiotherapy**

II YEAR

1. **Modern Imaging with Recent Advances**
2. **Apparatus of Imaging, Radiotherapy & Quality Assurance**
3. **Physics of Radiotherapy**
4. **Radiation Protection & Monitoring**

III year

1. Special Radiological Procedures & Contrast Media

2. Radiotherapy Planning & Techniques

3. Radiation Dosimetry- Principles & Applications

4. Hospital Practice & Patient Care

I YEAR

PAPER I: Gross Radiological & surface Anatomy of human body.

Introduction to Anatomy as a whole, Skeleton-bones & joints, formation of bones, structure of bones, classification of bones according to shape, Developmental classification, Regional classification, structural classification & growth of skeleton. Centre of ossification, type of bone, type of joints. Gross structure of human long bone, parts of young bone. Medico-legal & anthropological aspects of skeletal system, Estimation of age, sex, stature (height) and race. Classification & characters of joints, structural, functional & regional. Applied anatomy of joints, dislocation of joints. embryology, cell division, fertilization, development of embryo, gamete formation, menstrual cycle, formation of germ layers, development of embryonic disc, Placenta, formation of tissues, organs &systems of human body, congenital malformations.

PAPER II: PHYSIOLOGY & PATHOLOGY OF HUMAN BODY SYSTEMS.

The Respiratory System

Organs: Position and structure

Nose and nasal cavities

Functions: respiratory, Olfactory

Pharynx

Larynx-Functions: respiratory, vocal

Trachea, Bronchi, lungs: lobes lobules, pleura

a) Types of cells, tissues, bones and joints. Introduction to system and cavities of the body.
b) Heart and blood vessels (Circulatory system)

Blood vessels: arteries, veins, capillaries, sinusoids, structure and functions.

Heart: Position, structure and functions.

Circulation of blood: Pulmonary, systemic, portal, main blood vessels, their origins and distribution.

Blood:Composition&functions.Anaemia,Leukaemia, Thrombocytopenias.

The lymphatic system

Parts of the lymphatic system.

Lymph channels: Capillaries, vessels ducts structure and functions.

Lymph nodes: position structure and functions.

Lymphatic tissues: tonsils, adenoids, intestinal nodules

Spleen: position, structure and functions, diseases and conditions of the system.

The digestive system

Elementary tract structure:

Mouth, pharynx, salivary glands, esophagus, stomach, liver, gall bladder, small intestine, large intestine: Position, structure and functions of these organs.

The Urinary System

Parts of urinary system.

Position, structure and functions.

Kidneys, ureters, urinary bladder and urethra.

Formation and composition of urine.

Water and electrolyte balance.

The reproductive system

Females reproductive system

External genitalia: position, structures and functions. Perineum. Internal organs: positions and structures. Vagina, uterus, uterine tunes, ovaries. Breasts (Mammary glands)

Male reproductive system

Scrotum, testis, epididyms: position, structure and functions.

Spermatic cords, seminal vesicles, Egaculatory ducts: position, structure and functions.

Prostate gland: Position

Urethra and penis: position, structure and functions

The Endocrine system

Endocrine glands:

Pituitary and hypothalamus: Position and structure

Thyroid gland, parathyroid glands

Adrenal (Supra renal) glands,

Pancreas: Position, types of cells

The organs of sense

Hearing and the ear

External, middle and inner ear.

Physiology of hearing and diseases of ear.

Sight and the eye: Position, structure, sclera, cornea, choroids, cilliary body,

Iris, lens, retina, optic nerves.

Sense of smell

Olfactory nerves, origins, distribution.

Sense of taste.

The Nervous system

Neurons: Structure, types and properties.

Central nervous system: Neurons, neurolgia meninges.

Ventricles of brain, C.S.F.

Brain, spinal cord: Structures, functions peripheral nervous system.

Spinal and cranial nerves: origin distribution and functions.

Automatic nervous system:

Sympathetic and Para-sympathetic: origin distribution and functions.

The Skin

Structure of skin

Epidermis, dermis

Functions of skin

Cell injury, immune system-components& disease, oedema & its types, Haemodynamic disorders, imbalance of electrolytes, Hyperaemia, congestion, Haemorrhage, Thrombosis, Embolism, Ischaemia. Infarction, Inflammation causes, types of inflammation, pathogenesis & inflammatory cells of inflammation, sepsis, asepsis, abnormalities of tissue ulceration.

PAPER III: RADIOGRAPHIC TECHNIQUES & DARK ROOM PROCEDURES

Section III (A): Radiographic Techniques of whole body

Individual bones of skeletal system of human body. Special projection whenever required and indicated as in **skull & neck** including petrous, temporal, mastoids, nasal sinuses, foramina and mandible, TM joint, open mouth & close mouth, optic foramina, sella turcica, internal auditory canal, sphenoid bone, soft tissue neck, nasopharynx, larynx, teeth intra-oral and extra-oral projections, occlusal view.

Chest & Thorax Bones:-Chest-PA, lordotic view(Apicogarm), oblique lateral, thoracic inlet view, decubitus view

Abdomen:-general preparation of patient, positioning for fluid and air levels, plain film exam, principle advantage, techniques and applications.

Upper limb:-fingers, hands, carpal-tunnel view, wrist-projections, Projections for scaphoid, forearm, elbow, humerus, shoulder joints, acromio-clavicular joint, sterno-clavicular joint, clavicle & scapula.

Lower limb:-toes, feet, calcaneum, ankle joint, leg bones, different views of knee patella, inter condyler notch, and femur.

Vertebral Column:-Atlanto occipital joint, odontoid, cervical spine, cervico-thoracic spin, dorsal spine, thoraco lumbar spine, lumbosacral spine, sacrum, coccyx, scoliosis, kyphosis, flexion extension, and both oblique views of spines.

Hips & Pelvis:-Pelvis with both hip joints in different positions, internal and external rotation, frog position, SI Joint.

Ward mobile radiography:-electrical supply, radiation protection, instruction to be followed for portable radiography.

Operation Theatre technique:-General precautions. Asepsis in techniques. Selection of exposure risks, radiation protection.

Others:-Dental radiography, macro & micro radiography, Cine radiography, localization of foreign body, battery operated units (conducer), mass miniature radiography, other emergency radiography.

Section III (B): Dark Room Procedures

• The photographic process: Introduction, visible light, images produced by radiation, light sensitive photographic materials.
• Image characteristic: Real and mental images, reflected, transmitted and emitted light images Photographic emulsions. The photographic latent image. Positive process
• Construction of x-ray film & its cross over effect.
• Sensitometry: Photographic density, characteristic curves,
• The storage of film materials and radiograph;
• Intensifying screens and cassettes. Luminescence: fluorescence and phosphorescence. Construction of an intensifying screen.
• Fluorescent materials. Types of intensifying screens
• types of cassettes
• Film processing: Development. The nature of development-manual or automatic. The PH scale.
• The constitution of developing solutions both in manual and automatic processing and properties of developing chemicals.
• Film processing: Fixing and role of a fixing solution. Constitution of the fixing solutions and properties of the constituents. Factors affecting the quality of fixer.
•Development procedure, laser & bright procedure.
• Processing equipment: Materials for processing equipment, processors for
manual operation, hangers, control of chemicals temperature by heating and thermostat, immersion heaters as well as cooling methods.
• Dark Room: Layout and planning.
• Type of entry, door design. Dark room illuminations - white light and safe lighting

PAPER IV: Basic Radiation Physics & Principles of Radiotherapy.

SI Units, Force, mass, momentum, work, energy, power, density, pressure, heat, sound, wave and oscillations.

Atomic structure: Atom, nucleus, Bohr theory of hydrogen atom, atomic mass and energy units, distribution of orbital electrons atomic energy levels, nuclear forces, nuclear energy levels, particle radiations, electromagnetic radiations, electricity and magnetism.

Nuclear Transformations : Radioactivity, decay constant, activity half life, mean life, radioactive series, radioactive equilibrium, modes of decay : α-decay, β-decay, electron capture, internal conversion & isomeric transition.

Nuclear reactions: (α,*p*) reaction, (α, n) reaction, proton bombardment, deuteron bombardment, neutron bombardment, photodisintegration, fission, fusion, activation of nuclides, nuclear reactors

Interaction of radiation with matter: ionization and excitation, various types of interaction processes (photoelectric effect, Compton scattering, pair production etc.) Interaction of charged particles and neutrons with matter. Comparative beam characteristics.

Production of X-rays: X-ray tube, anode, cathode construction and working principles of transformers

and autotransformers used in x-ray circuits, voltage rectification and measurements in x-ray circuits. Physics of x-ray production (Bremsstrahlung and Characteristic x-rays).

Properties of matter, heat, light, magnetism, electricity and electromagnetism. Principles and working of x-ray tube. Measuring instruments voltage or KV meters. Measurement of tube current Principles of thermionic emission and rectification in x-ray technology. High voltage circuits in x-ray Units.
Electrical hazards and safety. Tube rating in imaging and therapy x-ray tube and thermal safety. Intensity of radiation and its variation with distance,KV,MA. Introduction to electro-magnetic spectrum, definition of wave length
and its quantum relationship with peak kilovoltage. Physical principles of radiation. Exponential and trignometric functions used in radiological calculations.

Introduction to

i) Malignant and non-malignant tumours treated by radiotherapy.

ii) Radioactivity and ionizing radiations used in treatment of malignancy, sources and techniques.

iii) Tissue tolerance, tumour lethal dose, therapeutic ratio and radiosensitivity.

iv) Units of exposure and radiation, prescription of radiation treatment.

v) Radiation reactions and normal tissue tolerance.

Definitions and basics of teletherapy techniques.

i) Orthovoltage and megavoltage machines.

ii) Teletherapy machines – cobalt and linear accelerator.

iii) Basic principles and clinical applications of beam direction and modification devices.

iv) Clinical application of mould room techniques

Principles of basic radiobiology.

i) Cell cycle.

ii) Cell survival curve.

iii) LET, RBE and OER.

iv) Time dose and fractionation.

v) Acute and chronic radiation effects.

Brachytherapy

i) Definition and basic principles.

ii) Radium and its substitutes used.

iii) Interstitial implantation.

iv) Intracavitary and intraluminal brachytherapy.

v) Surface Moulds.

DEMONSTRATION

1. Cobalt machine – parts and functioning.
2. Linear accelerator – parts and functioning.
3. Beam direction devices.
4. Beam modification devices.
5. Lead bench and radium safe.
6. Mould room techniques and cast making.
7. Interstitial implantation – HDR microselectron.
8. Intracavitary application – MDR & HDR selectron machine.
9. Surface mould.
10. Radiation safety devices.

II YEAR

PAPER I: Modern Imaging & Recent Advances

Recent advances in imaging technology-: Detailed knowledge of ultrasound, colour Doppler, different types of transducers, their principles, applications & role in medicine & cross sectional anatomy.

CT scan, conventional, spiral (helical), Multislice-: Historical development, its principle and applications, various generations& definition of terms and cross sectional anatomy& use of diagnostic methods.

Magnetic Resonance Imaging (MRI)-: Principle, application, its advantage over computed tomography or ultra sonography. Its limitations, uses & cross sectional anatomy.

Spectroscopy-: Principle, application and uses.

Computerised Radiography-: Principle, application, advantage & technique.

Digital Radiography-: Principle, scanned projection radiography, digital substraction angiography application, definition,advantages & techniques.

DSA-: Uses, application, techniques & principle

Picture Archiving Communication System (PACS)-: Basic knowledge of PACS, application, principle & image transmission.

Mammography-: Principle, application, advantage in soft tissue radiography, physics, filtration, QA & QC.

Orthopantamogram-: Application, principle technique and uses & advantages.

Positron Emission Tomography (PET)

Basic priciple,clinical application & advantages.

Different types of cameras e.g. laser, photography *etc*-: principle, processing & applications.

Radio isotopes-: Principles of Scanner, Rectilinear scanner, gamma camera.

DEXA: Principles, applications and instrumentation.

Fundamentals- Applications of computers in Radiology.

PAPER II: Apparatus of Imaging, Radiotherapy & Quality Assurance

Electrical system and Mains supply:
The electrical system, generation of electricity, distribution of electric energy, use of electric energy.
High Tension Generators - Rectifications - Types of rectifier - valve and solid state. Self rectified high tension circuit. Half wave, four valve full wave, three phase, full wave rectified circuit, voltage wave forms in high tension generators. Constant potential circuit programmed generators and modular generators
The X-ray Tube; Historical developments including General features of the X-ray tube. The fixed anode, rotating anode x-ray tube. Rating of X-ray tubes, focal spot sizes. Methods of heat dissipation in x-ray tubes, common tube faults. Developments in the rotating anode tube. Tube stands and ceiling tube supports. Mammography tubes and equipment, accessories. Different types of tubes and choice of an x-ray tube.
Components and controls in the X-ray circuits:
The high tension transformer, the rectification of high tension. The control of kilovoltage, kilovoltage indication. The filament circuit and control of tube current. Milliamperes indications. Main voltage compensation. Mains supply and the x-ray set.
Exposure Switches and Exposure Timers: Switching systems timing system, exposure switching and its radiographic applications
The control of scattered Radiation:
Significance of scatter. Beam limiting devices-cones, diaphragm (collimeters).
Beam centring devices. Grid: its types, components of grid, grid movements. The assessment of grid functions, grid-errors, other scatter reduction methods - air gap technique.
Portable and mobile X-ray Units
Fluoroscopic Equipment:
Structure of a fluorescent screen. The fluoroscopic image. The fluoroscopic table, spot film devices and explorators. Protective measures and physiology of vision, image quality.
Image Intensifiers (I.I.T.V. system):
An Image intensifier tube, its design, its application.

angiographic tables, contrast medium injection device.
Equipment for cranial and Dental Radiography:
The skull table, general dental X-ray equipment, specialized dental X-ray equipment.
Equipment for mammography - general or dedicated
Care, Maintenance and tests of X-ray equipment;
General care; functional tests; testing the performance of exposure timers, assessing the MA settings, testing the available KV, measurement of focal spot of an x-ray 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.
Telegamma Units: Sources and their properties, preparation of telegamma sources Co-60 units: source housing, source movement mechanisms. Fixed Gantry units, isocentric units, Beam collimation and penumbra. Head leakage in on/off position, collimator leakage in on position. QA procedures of telegamma units.

Linear accelerator : Block diagram and design of LINAC, power supply, modulator, electron gun, magnetron/kylstron, wave guide system, accelerator tube (traveling wave and standing wave type), flattening filters, scattering foil, complete QA procedures of the LINAC. Heavy charged particle beam generators. Neutron generators : D-T generator, cyclotron. Proton and heavy ions generators and negative pions generators.

Simulator : Design, construction types and uses of Simulator in Radiotherapy.

Quality Assurance Tests for Simulator

Aim of quality assurance in medical care and Radiodiagnosis.
Regulations and Accreditation.
Purchasing Equipment
Identification of imaging requirements
Developments of equipment specifications.
Selection of equipment

Installations & Acceptance testing of equipment
Continuing education
Monitoring Equipment Performance
Routine checks of all radiological and imaging equipment including CT & MRI
Routine checks of film processing systems
Processor Monitoring, External beam evaluation
Routine checks of Diagnostic radiographic system like - focal spot size
determination, half value layer, collimator, check, central ray and Bucky tray
accuracy, Distance and centering indicators accuracy, Angulator or protector
accuracy, KV accuracy, MA accuracy, exposure timer accuracy, resolution, exposure
reproduceability.
QA tests and procedures in manual brachytherapy.

QA tests and procedures of HDR and PDR units.

QA tests and procedures of TPS and gamma knife and x-knife units.

PAPER III: PHYSICS OF RADIOTHERAPY

Unit – I. Radiation Units: Activity, Becquerel (Bq), exposure,

roentzen, absorbed dose, rad, Gray, dose-equivalent, rem, Sievert, KERMA. Relation between absorbed dose, exposure and KERMA. Calculation of absorbed dose from exposure, Absorbed dose to air, Absorbed dose to any medium, Bragg-Gray theory. Stopping power. Transfer of absorbed dose from one medium to another of photons, electrons. Exposure from radioactive sources, exposure rate constant.

Unit – II. Dose distribution and scattering in medium: Properties of phantom materials and various types of phantoms, depth dose distribution, dose build-up, percentage depth dose and its influencing factors. Back scatter factor, tissue-air-ratio and influencing factors. Relation between TAR and PDD. Scatter-air-ratio. Dose calculation of irregular fields using Clarkson's method.

Unit – III. Dosimetric calculations: Dose calculation parameters, collimator scatter factor (Sc), phantom scatter factor (Sp), Tissue phantom ratio (TPR), tissue maximum ratio (TMR), and their influencing factors. Relationship between TMR and PDD. Scatter maximum ratio (SMR). Dose calculations for linear accelerator and Co-60 unit using Sc, Sp factors for SSD and SAD methods, irregular fields, asymmetric fields etc.

Unit – IV. Isodose distribution of phantom beam: Isodose charts, measurement of isodose curves, parameters of isodose curves: beam quality, source size, SSD and SDD – penumbra effect, collimation and flattening filter, field size, Wedge filters: wedge angle, wedge transmission factor, wedge systems, effect of beam quality, design of wedge filters. Bolus, tissue compensators, shielding blocks.

Unit – V. Electron beam therapy: Electron interactions, rate of energy liss, collisional losses (ionization and excitation) radiation losses (bremsstrahlung), polarization, stopping power, absorbed dose, electron scattering, most probable energy, mean energy, energy at depth. Determination of absorbed dose, output calibration, phantom, reference depth and field size, absorbed dose calculation, depth dose distribution, central axis depth dose curves, isodose curves for different electron energies. Field flatness and symmetry, beam collimation, field size dependence, electron source, x-ray contamination.

PAPER IV: Radiation Protection & Monitoring

Unit – I. Radiation protection quantities and units: exposure, absorbed do

equivalent (H_T), effective dose equivalent (H_E), Equivalent dose ((H

Sources of radiation exposure: Natural sources and human made so

Standards and regulations, philosophies of exposure limit, occupati

Unit – II. Biological effects of radiation: Direct and indirect action of radiation, cell cycle effect, somatic and genetic effects. Effects on tissues and organs: Stochastic and non-stochastic (deterministic) effects, acute effects, late effects, effects of radiation on Embryo & fetus: lethal effects, organ malformation, growth impairment, mental retardation, cancer induction, genetic effects, Late (delayed) effects: cataract formation, organ function, cancer induction.

Unit – III Personal dosimetry devices: Film badges, TLD badges, pocket ic counting statistics, distributions, standard deviation. Standard error,

UNIT-IV. Basics of Radiation protection principles and Practice.

Quantities and Units relevant to radiological protection
Exposure, absorbed dose, kerma/air kerma, integral dose, equivalen
Detection and measurement of Ionizing/radiation: Field survey instr
devices film badge, TLD, pocket dosimeter, pulsed optically stimul
Radiation Protection Procedures for Patients and Personnel
Advisory Groups & Regulatory Agencies - ICRP, NCRP, UNSCEA
Limiting exposure to ionizing radiation - Dose limits, ICRP recomm
Protection of Personnel - Principles of personnel exposure. redu
protective devices.
Protection of the patient
Beam limitation, technique selection, general shielding, grids, imag
Radiation exposure and pregnancy - ALARA and Pregnancy, t
exposure standards

III YEAR

PAPER I: Special Radiological Procedures & Contrast Media

-Special procedures of various body organs under folowing points:

1.Indications

2.Contraindications

3.Contrast media used.

4.Equipments

5.Preparation of patient.

6.Techniques

7.Filming

8.Aftercare of patient

-Trolley setup for various radiological procedures

ContrastMedia:

Classification,indications,contraindications,chemical structure,adverse reaction & its managenent.

Special Radiological Procedures:

*1.*Sialography

2. Lacrymal system

3.Bronchography

4.Arthrography

5.Hysterosalpingography

6.Myelography

Radiological Investigations for Renal system:

1. I.V.P./I.V.U./Antegrade/Retrograde cystogram
2. M.C.U.
3. Nephrostogram
4. Infusion Pyelogram

Radiological Investigations for Hepatobiliary system.

1.Intarvenous cholangiography

2.T-tube Cholangiography

3.Peropatartive Cholangiography

Radiological Investigations for GIT:

1.Barium swallow,water soluble contrast swallow

2.Barium meal-single contrast,double contrast

3.Barium Meal Follow Through

4.Small Bowel Enema(Enteroclysis)

5.Barium Enema.

Angiography-:

1.Cerebral Angiography

2.Cardiac Angiography

3.Abdominal Aortogram

4.Renal, General and Selective Arteriogram.

5.Splenoportovenography

6.Peripheral arterial and venous Angiography

Interventional radiological procedures-:

1.PTC

2.ERCP

3.DSA

4.Fine needle Aspiration Cytology,

5. Percutaneous Nephrostomy.

Cardiac catheterization:

1Embolization

2.Angioplasty

3.Drainage procedures

4.Stenting.

-MRI, US & CT Guided Procedues

PAPER II: RADIOTHERAPY PLANNING & TECHNIQUES

Unit I. –Isodose curves, isodose charts, measurements of isodose curves. Influency parameters of isodose curves: beam quality source size, SSD, SDD, penumbra, collimation & flattening filter, field size. Wedge filters: wedge angle, wedge factor, wedge systems, effect of beam quality, design of wedge filters. Combination of radiation fields: (1) parallel opposed fields; patient thickness Vs dose uniformity, edge effect (lateral tissue damage), integral dose. (2) Multiple fields: three fields, four field's box technique, four fields cross fire technique. Isocentric techniques (1) stationary beams & (2) rotation therapy. Wedge field techniques. Definitions of following terms according to ICRU-50. Gross tumour volume (GTV), clinical target volume (CTV), planning target volume,

irradiated volume cold and hot spots.

Unit – II. Acquisition of patient data: body contours, internal structures using radiographs, CT, MRI, US etc.; for 2-D & 3-D treatment planning. Treatment simulation using conventional simulator, Simulator CT, CT simulator and virtual simulator. Treatment verification using port films, electronic portal imaging devices. Corrections for surface irregularities; effective SSD method, TAR/TMR method, isodose shift method. Corrections for internal tissue in homogeneities: for beam attenuation and scattering using TAR method, power law TAR method, equivalent TAR method, isodose shift method, typical correction factor. Absorbed dose within inhomogeneity: bone, bone tissue interface, tissue surrounding bone, lung tissue, and air cavity. Tissue compensator, bolus, patient positioning.

Unit – III. Shielding blocks: block thickness, block divergence. Field shaping : custom blocking, independent jaws, multileaf collimators, skin dose; electron contamination of photon beams, dose distribution in build-up region, skin sparing effect, effect of absorber skin distance effect of field size, electron filters, skin sparing at oblique incidence. Separation of adjacent fields; orthogonal field junction, cranio-spinal fields, guidelines for field matching.

Unit – IV. Parallel opposed, small beam directed therapy and wedge fields in head and neck cancers. Treatment techniques in the treatment of brain, pituitary, oral cavity, larynx, hypo/oropharynx, maxillary antrum, nasopharynx, thyroid, tonsil, lip etc.
Treatment techniques in Carcinoma breast, esophagus, bladder, Gynecological cancers.

Unit – V. Treatment techniques in medulloblastoma, Ca Lung, bone, lymphoma, with special emphasis on mantle field irradiation, Rx techniques in Ca. prostate, ophthalmic tumours. Hemi body, whole

body, irradiation techniques using photons and electrons.

Unit – VI. Basic terminology of brachytherapy, brachytherapy sources, properties of idea brachytherapy sources, construction of Ra-226, Cs-137 & Co-60 tubes and needles and Ir-192 wires. To decay processes of brachytherapy sources, calibration of brachytherapy (mgRa), Air0Kerma0Strength, Reference-Air-Kerma, Radium mass equivalent (Ramg Eq.), apparent Activity, milligram-hours, integrated reference Air-kerma total reference-air-kerma, Exposure rate calibration.

Unit – VII Techniques of brachytherapy – 1. Surface mould and interstitial implants.

Surface mould dosimetry system: construction and distribution rules of circular, square, rectangular, sandwich, concave and convex moulds. Use of surface moulds in the treatment of various anatomical sites.

Interstitial implant dosimetry systems :

1. Manchester system: Distribution rules, dose specification and implant optimization criteria. P.P. tables for planer and volume implants.
2. Quimby system: Distribution rules, dose specification and implant optimization criteria.
3. Peris system: Distribution rules, dose specification and implant optimization criteria. Definitions of implant plane, basal dose points, reference dose/dose rate, implant length, width, hight and safety margin in single and double plane implants.
4. Stepping source dosimetry system: Distribution rules, dose specification and implant optimization criteria.

Interstitial applications:

Templates: Syed/Neblelt template, martinez universal perineal interstitial template, rectal templates prostate implant tamplates.

Intracavitory brachytherapy(Ca Cx.) dosimetry systems :

1. Stockholm system: Source placement and dose prescription rules. Type of applicators and their packing.
2. Paris system: Source placement and dose prescription roles. Type of applicators and its packing.
3. Manchester system: Definition of points. A, B and MIR point P. Manchester applicators, radium loading as per Manchester and MIR criteria. Dose/dose-rate to points Z & B for different tandem and ovoid loadings. Tolerance doses of rectum and bladder. ICRU-38: Dose rate classifications, reference height, width & length. Reference volume. Reference points of rectum and bladder lymphatic trapezoid; pelvic wall points. Concept of 60 Gy.

   Applicators of Ca Cx: Pre-loaded applicators (Stockholm, Paris etc.), Fletcher suit applicators. Henschke applicators, ring applicators, vaginal applicators. Different tools, catheters and other necessary items required for interstitial implant.

Unit – VIII. Dose calculations for brachytherapy sources

Exposure rate constant, exposure rate and effect of inverse square law, sievert integral to calculate exposure rate from a line source

and point source, TG-43 dose calculations methods for brachytherapy sources. Dose calculations of surface mould, interstitial implants, intra-cavitary applications using orthogonal radiographs. 2-D and 3-D planning for LDR and HDR units using orthogonal radiographs, CT Scans.

Unit – IX.

Gamma Knife, construction, design and working principles. QA procedures and different clinical applications of gamma knife. Dose prescription criteria in the treatment of gamma knife.

X-knife, modification of LINAC, necessary accessories required for X-knife, energy choice of x-ray photons in X-knife, QA procedures and application and techniques in the treatment using circular cones and their planning.

Cyber Knife: Principles and applications.

Principles and working of asymmetric jaws in radiotherapy. Techniques in which asymmetric jaws are used. Uses of of asymmetric jaw.

Tomotherapy : Principles and applications.

Design and working of MLC and MMLC. QA procedures of MLC and MMLC. Conformal radiotherapy (CRT) and intensity modulated radiotherapy (IMRT). Use of MMLC in stereotactic radiotherapy and IMRT. Inverse planning system.
Intra- operative Radiotherapy (IORT).

Uses of PDR unit in brachytherapy. Radiobiological explanation of PDR treatment techniques. Advantage and disadvantage of PDR brachytherapy. QA procedures.

PAPER III: RADIATION DOSIMETRY-principle& applications

Unit – I. Principles of gas field detectors: Characteristic curve of gas filled detectors. Regions of the characteristic curve: ionization region, proportional region, GM region. Construction of gas filled detectors and their working. GM counters resolving time, true count rate. Scintillation counters, semiconductor detectors, alpha particle monitoring, gamma & x-ray monitoring, neutron monitoring devices.

Unit – II. Measurement of ionizing radiation: exposure, roentzen, free air ionization chamber, thimble chambers, chamber wall, effective atomic number, chamber calibration – 1. Condenser chambers, chamber sensitivity, stem effect, farmer chamber electrometers: string electrometer, other electrometers special chambers. 1. Extrapolation chamber 2. parallel plate chambers. Ion collection, chamber polarity effect. Environmental conditions, measurement of exposure.

Unit – III. Principle of Bragg-Gray theory. Stopping power, chamber volume. Effective measurement points. 1. plane parallel chambers 2. cylindrical chambers. Construction and working of plane parallel and cylindrical chambers and their use in dosimetry of photon and electron beam calibration.

Unit – IV. Calibration protocols for megavoltage beams. Cavity gas calibration factor, Bragg-Gray cavity for photon beams and electron beams. Dose calibration parameters. Transfer of absorbed dose from one medium to another.

Unit – V. Measurement of absorbed dose using calorimetry, chemical dosimetry solid state methods; TLD film dosimetry.

PAPER IV: HOSPITAL PRACTICE &CARE OF PATIENT

Hospital staffing and administration, records, professional, ethics, cooperation with other staff and departments, Departmental organistion. Handling of the patients while doing radiography of following patients i.e. seriously ill,traumatized patients, visually impaired, speech and hearing impaired, mentally impaired, drug addicts and non-english speaking patients,patients on oxygen therapy. Understanding patient needs - patient dignity of inpatient and out patients.

Interaction with the patients relatives and visitors. Methods of effective communication - verbal skills, body language, professional appearance, visual contact *etc*. Elementary personal and departmental hygiene, dealing with receptacles, bed pans and urinal etc. General preliminaries to the exam. Moving chair and stretcher, patient. Unconscious patient, general comfort and reassurance for the patient. Vital signs and oxygen - patient's Homeostasis status. Body temp, respiratory rate, pulse, blood pressure, oxygen therapy, oxygen devices, chest tubes and lines. First aid - shock, electrical shock,

hemorrhage, burns, Asphyxia, fractures, loss of consciousness. Emergency treatment to the collapsed patient. Artificial respiration and resuscitation. Preparation of patient for general and special radiological examinations. Supervision of patients undergoing special examination. Administration of drugs and contrast media. Aseptic and sterile procedures. Handling of infections patients in the department or in the ward. Regulation of dangerous drugs. Trolley set up for special x-ray examinations, Radiation hazards and protective measures.