SCHEME AND SYLLABUS OF EXAMINATION FOR THE PURPOSE OF FILLING UP THE POST OF RADIO THERAPY TECHNICIAN UNDER THE SIKKIM STATE SUBORDINATE ALLIED AND HEALTHCARE SERVICE.

The examination will consist of 2 papers : -

PAPERS	SUBJECT	FULL MARKS	TIME ALLOWED
PAPER - I	GENERAL ENGLLISH & GENERAL KNOWLEDGE	80 MCQ& CONVENTIONAL	02 : 00 HOURS
PAPER - II	MAIN PAPER	120 MCQ & CONVENTIONAL	03 : 00 HOURS
TOTAL 200 MARKS			

Paper – I & Paper – II will be objective type (OMR) and Conventional Mode.

1. **PAPER – I : (a) GENERAL ENGLISH (MCQ/ CONVENTIONAL MODE)**

The question will be designed to test the candidate's understanding and command of the English language. The pattern of questions would be broadly as follows:-

1. Comprehension of given passage
2. Grammar
3. Usages and vocabulary
4. Essay writing
5. Reporting writing

(b) GENERAL KNOWLEDGE :-

i. Current events of local, national and international importance
ii. National level schemes & projects undertaken by government of India/ State Government.

PAPER – II :MAIN PAPER (MCQ/ CONVENTIONAL MODE)

III. SYLLABUS FOR WRITTEN EXAMINATION FOR RADIO THERAPY TECHNICIAN: -

Sl. No.	Course	
01	02	03
01	**Human Anatomy - & Physiology**	1. General Anatomical Terms and Regions of the body
		2. Description of a typical animal cell: Cell mitosis; genes; sex cell; ova and spermatozoa. Fertilization of the ovum. Broad lines of embryonic development. Cell function and differentiation of tissues.
		3. Structure of General Tissues: Epithelium; simple and, complex epithelial glands; skin. Connective tissue; fibrous tissue; cartilage; bone; Haversian systems; blood; numbers and types of cells in blood; clotting of blood. Muscle tissue; involuntary, voluntary and cardiac muscle. Nerve tissue.

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		4. Bones, joints and locomotors system: General description of bones, their main processes and attachments, 'including the skull with emphasis on the skull as a whole. Development of bones, Primary and secondary bone centres; diaphyses and epiphyses. Position and function of main joints. Some common diseases and injuries of bones and joints; Healing of fractures.
		5. Thorax and Abdomen: Structure of thoracic cage, abdominal cavity; diaphragm and mediastinum.
		6. Heart and Blood Vessels: Structure and function of the heart, pericardium, peripheral vascular system; names of main arteries and veins, circulation. Common terms used in connection with diseases of this system.
		7. Respiratory system: Nasal passages and accessory nasal sinuses, pharynx and larynx, trachea, bronchi and lungs; pleura, nature and function of respiration. Common terms usedn connection with diseases of this system.
		8. Lymphnode Groups: Lymph and tissue fluid, main lymphatic gland groups and drainage areas, lymphoid tissue and tonsil.
		9. Reticulo-Endothelial system: Spleen and liver, bone marrow, extent and nature, physiology of the red and white blood corpuscles.
		10. Alimentary system: Mouth, tongue and teeth, salivary glands, pharynx and esophagus, stomach, small and large bowel, liver and biliary tract, pancreas, motility of the alimentary tract; digestion, absorption and metabolism, nutrition and dietetics, common terms used in connection with diseases of this system.
		11. Urinary tract: Kidneys, ureters, bladder and urethra; urine formation and excretion, common terms used in connection with diseases of the system.
		12. Reproductive system: male genital tract; testes; epididymis, seminal vesicle and prostate; female genital tract; uterine tubes, ovaries, uterus, vagina and vulva, the mammary glands; menstruation, pregnancy and lactation; common terms used in connection with diseases of this system.
		13. Endocrine glands: anatomy and function of pituitary, thyroid, para thyroids, adrenal,thymus, pancreas and gonads as endocrine organs; common terms used in connection with diseases of this system.
		14. Nervous system: brain: main subdivisions and lobes; ventricular system, spinal cord, concept of motor, sensory and reflex pathways; meninges and cerebrospinal fluid; its circulation; autonomic nervous system; common terms used in connection with diseases of this system.
		15. Special sensory organs; structure and function of the eye; structure and function of the ear; structure and function of the skin.
		16. Surface markings and topographical relations; radiography anatomy.
02	**Basic Physics, Radiation Physics & Basics of clinical radiography/imaging.**	1. Structure of Matter: Constituents of atoms, atomic and mass, energy units, electron shells, atomic energy levels, Nuclear forces, Nuclear energy levels. Atomic structure-Nucleus, - Electromagnetic spectrum, Energy quantization, Relationship betweenwavelengths, Frequency, Energy.

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		2. Physics Units and measurements- Force, Work, Power, energy- temperature and heat- SI units of above parameters. Atomic Number, Mass No., electron orbit and energy levels- Periodic table-Isotopes-Isobars-Ionization and excitation. Electromagnetic radiation.
		3. Electricity and magnetism: Electric charges, Coulomb's law-Unit of charge-Electric potential, unit of potential-Electric induction, capacitance and capacitors, series and parallel connection-electric current, unit, resistance, ohm's law, electric power, Joule's law Magnetism: Magnetic induction-magnetic properties-Hysteresis-magnetic effect of current- Electrical instruments, Galvanometer, voltmeter, ammeter and multimeter.
		4. X-Rays: Electromagnetic waves -quantum theory of radiation - visible light -fluorescence. X-Rays – Production of X-rays: The X-ray tube, Physics of X-ray production, continuous spectrum, characteristic spectrum,–Basics of X-ray Circuits -measurement of high voltage – control of KV circuit –MA circuit - Distribution of X-rays in space, specifications of beam quality, Measurement of beam quality, filters –the quality and intensity of x-rays–the Current affecting quality and intensity
		5. Radioactivity: Natural and artificial radioactivity-alpha decay-beta decay and spectra – gamma emission positron decay electron capture and internal conversion-Exponential decay-Half life-Unit of activity-specific activity. Nuclear Fission-Nuclear reactor. Radiation sources- Natural and artificial-production of radio isotopes-reactor produced isotopes-Fission products-Gamma ray source for Medical uses.
		6. Interaction of X-and Gamma rays: Attenuation of X-ray or Gamma rays-absorption and scattering-Half value layer-Coherent scattering-Photo electric absorption-Compton scattering-Pair production and photoelectric disintegration. X-Ray transmission of through Medium, Linear and mass attenuation coefficients. HVT, TVT and interaction of charged particle and neutrons with matter. Interaction of X-and Gamma rays in body-fat-soft-tissue-bone-contrast medium-LET- Total attenuation coefficient Relative important of different types of interactions.
		Imaging in oncology
		7. Radiographic Image: Primary radiological image formation, use of contrast media. Density- contrast – brightness –X-ray film construction and film characteristics – exposure to x-rays – developer – effect of temperature and development time –constituents of developer-film processing methods- Optical density measurements. Image quality - Unsharpness, Resolution – Fog and noise.
		8. Fluoroscopy: Direct fluoroscopy – fluoroscopic image – Fluorescent screen in Radiology-factors affecting the Fluoroscopic image. Image intensifiers – principle construction and function regarding intensified image. The television process – The Television camera tube – the Cathode ray tube – Television image.

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		9. Tomography: Theory of tomography – multi section radiography- tomographic equipment Computed tomography – Scanning principle – Reconstruction of image – storing the image – viewing the image – evaluation of the image . Equipment for computed tomography – Table, scanning gantry X-Ray generator – image quality.
		10. M.R.I. - Magnetic Resonance imaging – Basic principle – Imaging methods – Slice section – Image contrast – Factors affecting Image quality - Difference CT and MRI images – Instrumentation.-Imaging sequences Bio-effects of MRI.
		11. SPECT and PET CT –Basics, Protocols in relevant to Oncology Imaging & Planning.
03	**Radiotherapy Physics & Principles of Radiotherapy**	1. Nuclear Transformation: Natural and artificial radioactivity, Decay constant, Activity, Physical and Biological Effective half-lives, Mean life, Decay processes, Radioactive series, Radioactive equilibrium
		2. Interaction of radiation with matter: Attenuation, scattering, absorption, Transmission, Attenuation coefficient, Half Value (HVL), Energy transfer, Absorption and their coefficients, Photoelectric effect, Compton effect, Pair production, relative importance for different attenuation processes at various energies. Electron interactions with matter: Energy loss mechanism - Collision losses, radioactive losses, Ionisation, Excitation, Heat production, Delta rays, Polarization effects. Scattering, stopping power, absorbed dose, secondary electrons. Interactions of charged particles: Ionization vs. Energy, stopping power, Linear Energy Transfer (LET), Bragg curve, Definition of particle range.
		3. 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 phantom 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.
		4. Beam Therapy: Various sources used in Radiotherapy and their properties- Physics of Photons, Electrons, Protons and Neutrons in Radiotherapy. Physical Parameters of dosimetry- Phantoms – percentage depth dose – Factors affecting percentage depth dose – Tissue air ratio- Back scatter factor, Tissue maximum Ratio – Factors affecting TAR & BSF, TMR. SSD technique and SAD technique – Rotation technique- Conversion of percentage depth dose from one SSD to another – Time and Dose calculations in SSD, SAD and Rotation techniques- Worked examples.

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		5. Treatment planning Concepts: Physics of Bolus & Phantom material-Isodose Curves- Comparison of isodose curves measurementofisodose curve – factors affecting the isodose distribution –Wedge filters –Design of wedge filters – application of wedge filters in radiotherapy, and compensating filters–Shielding Blocks, Patient immobilization devices, Port film, Processing and development-Dose calculations with isodose curves and wedge fields.
		6. Pharmacokinetics & pharmacodynamics of the Cytotoxic and other drugs used for the management of cancer - patient with disease kidneys /liver etc which may result in alternation in metabolism/excretion of the drugs; rationale use of available drugs.
04	**Patient care & Medical Ethics:**	Patient vital signs - temperature, pulse, respiration and blood pressure - normal values and methods of taking and recording them. Development of communication skills with patient- general comfort and reassurance to the patient-patient education and explaining about the study-drugs used in the preparation of the patient. Handling of an unconscious patient-shifting of patients - hazards of lifting and maneuvering patients - rules for correct lifting-transfer from chair/wheel chair or trolley to couch and vice-versa - safety of patient and worker while lifting & shifting of patients- handling of geriatric, pediatric and trauma patients -handling female patients-pregnant women. Communicable diseases - hygiene in the department-cross infection and prevention-handling of infectious patients in the department -application of asepsis. Ethics of medical practice- Radiography professionalism-essential qualities of the radiographer-improving professional and personal qualities-Radiographer as a part of Hospital /Organization-responsibilities. Medico-legal considerations - radiographers clinical and ethical responsibilities-misconduct and malpractice.
05	**General Principle of Hospital Practices**	Modern hospital treatment is based on team work; it is essential that the student should appreciate the technologists role and that the importance of co-operation with wards and other departments. The students should be attached to wards or the accident and emergency department for a definite training period, the length of time being suited to the individual hospital.
		1. Hospital procedure: Hospital staffing and organization; records relating to patients and departmental statistics; professional attitude of the technologist to patients and other members of the staff; medico- legal aspects; accidents in the departments appointments organization; minimizing waiting time; out-patient and follow-up clinics; stock-taking and stock keeping.

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		2 Care of the patient : FIRST contact with patients in the department; management of chair and stretcher patients and aids for this, management of the unconscious patient; elementary hygiene; personal cleanliness; hygiene in relation to patients (for example clean linen and receptacles , nursing care; temperature pulse and respiration; essential care of the patient who has a tracheostomy; essential care of the patient who has a colostomy; bedpans and urinals; simple application of a sterile dressing.
		3. First aid: Aims and objectives of first aid; wounds and bleeding, dressing and bandages; pressure and splints, supports etc. Shock; insensibility; asphyxia; convulsions; resuscitation, use of suction apparatus, drug reactions; prophylactic measures; administration of oxygen; electric shock; burns; scalds; hemorrhage; pressure points; compression band. Fractures; splints, bandaging; dressing, foreign bodies; poisons
		4. Infection: Bacteria, their nature and appearance; spread of infections; auto-infection or cross-infection; the inflammatory process; local tissue reaction, general body reaction; ulceration; asepsis and antisepsis.
		5 Principles of asepsis: Sterilization - methods of sterilization; use of central sterile supply department; care of identification of instruments, surgical dressings in common use, including filamented swabs, elementary operating theatre procedure; setting of trays and trolleys in the radiotherapy department (for study by radiotherapy students only)
		6 Departmental procedures: Department staffing and organization; records relating to patients and departmental statistics; professional attitudes of the technologist to patients and other members of the staff, medico-legal aspects accidents in the department; appointments; organization; minimizing waiting time; out-patient and follow-up clinics; stock taking and stock keeping.
		7 Drugs in the department: Storage: classification; labelling and checking, regulations regarding dangerous and other drugs; units of measurement, special drugs, anti depressive, anti-hypertensive etc.
06	**Tumor Pathology and Radiotherapy applications**	1. Introduction: Basic functioning of various organ systems, central of vital functions, pathophysiological alternation in diseased states, interpretation of symptoms & sign in relation to pathophysiology- Pathological changes in various organs associated with tumors -Scope of radiotherapy, growth, the cell, Reproduction of cell, Tumours, benign and malignant, cause of cancer, spread of cancer in the body, Lymphatics, Metastasis, other uses of Radiotherapy, Biopsy purpose and method.
		2. Pathology related to Onco-Radiotherapy practice: therapeutic intervention, possible distinction between different types of tumors, grading immunological effects & genetic alterations - various microorganisms - their pathogenic potential, important organism commonly seen - levels of therapeutic interventions possible in preventing and /or eradicating organism. Volume doubling times, potential volume doubling times, repopulation, and accelerated repopulation

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		3. Introduction to malignant tumor: Basic pathology- Carcinoma, Sarcoma &Lympoma- Pattern of Spread, Biopsy/Investigations related to malignant tumor-staging work up and TNM. Introduction of different malignant tumor treated in radiotherapy department including TNM Skin-lip-oral cavity & Para nasal sinus-nasopharynx-orophaynx-hypopharynx-larynx-thyroidpostcricoid – oesophagus-mediastinum- lungs-pancreas-liver-breast-cervix-body of the uterus-vagina-valvakidney,ureter,bladder,rectum-prostate,penis,testis-poreticulamtissuebone marrow-CNS ,eye, orbit-soft tissue & bone-paediatric tumor, retinoblastoma, Wilmstumor, rhabdomyosarcoma
		4. Tumor localization Radiological diagnostic procedures – X-ray, ultrasound, CT scan, MRI, Mammogram-Radionuclide investigation Tumor localization & check film and application of simulation in radiotherapy. Benign diseases- Radiotherapy in non-malignant diseases Application of radiotherapy in malignant condition
		5. Biological effects of Radiation: Effects of various radiation on normal tissues and malignant tumor: Early and late reaction on Skin, Mucous membrane, GI tract, Genito urinary system, respiratory system, CNS - Effects of radiation on living cell, action on cancer tissue - Radio-sensitivity of different tissues, skin reaction and their treatment, Reaction on muscle membrane, Late effects on workers, effects on blood, effects on reproductive organs, effects on other organs, Radiation sickness. Effect of low LET and high LET radiation on cell. Cell survival curves. Effect of sensitizing and protective agents. Dose modifying factors and their determination. Variation of response with growth and the progression of cell through the phases of cell cycle. Hyperthermic and photodynamic injury. Biological hazards of irradiation - effects on the embryo and the fetus, life shortening, leukaemogenesis and carcinogenesis, genetic and somatic hazards for exposed individuals and population. Biological basis of radiological protection.-Importance of correct dosage, Blood supply, time factor, fractionation, Quality-Radical and palliative treatment.
		6. Factors influencing radiation response. Physical factors: dose, dose quality, dose rate temperature - Chemical factor: Oxygen, radio sensitizers, radio protectors- Biological factors: Type of organism, cell type and stage, cell density and configuration, age, sex.- Host factors: Partial and whole body exposure.
		7. Methods of Treatment of Malignant Disease: Principle affecting the treatment of malignant disease; Chemotherapy, Hormone therapy, Radiotherapy and surgery in management of malignant disease, relative value of each method for individual tumors or tumor sites.

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		8. Choice of treatment: Anatomical site, relation to other tissue, extent of tumor and histology, place of previous treatment, place of radical and palliative therapy.
		9. Choice of Radiotherapy: Tumor sensitivity, anatomical site, relation to other structure availability of equipment.
07	**Radiotherapy Equipments, Applications & Maintenance**	1. Radiotherapy Equipments; Historical developments in Radiotherapy- Kilo voltage Unit- Grenz Ray Therapy-contact therapy- superficial therapy-Deep therapy Megavoltage therapy- Vande Graff generator –Physical components of Linear accelerator- Betatron- microtron – Cyclotron- Heavy particle beams. Radio Isotope units –Physical Components of Cobalt 60 unit- source housing beam collimation and penumbra – Caesium 137 units – Advantages and Disadvantages – Gamma Knife unit –Simulator and its descriptions.
		2. Co-60 units: Comprehensive description of the unit, Safety mechanism, source capsule.
		3. Linear accelerators: History, development, detailed description of modern, dual mode linear accelerator, Physical components of Linear accelerator- Betatron-microtron – Cyclotron Linac head and its constituents, safety mechanisms, computer controlled Lilacs, record and verify systems - accuracy of mechanical or digital readout for gantry, couch, and collimator rotation. Beam symmetry - jaw symmetry - uniformity checks - field flatness - wedges - wedge angle checking - mechanical safety - collision devices check Equipment - Radiation field analyzer - film densitometry - Relative merits and demerits of Co- 60 and Linac units.
		4. Acceptance testing of teletherapy machines - telecobalt,- beam congruence test – isocenter check - laser alignments - timer error - shutter error - periodic output calculations – monthly checks - quarterly checks - annual checks
		5. Simulators: Need for them, detailed description of typical unit, CT Simulator – Mechanical movements - isocentre - gantry - collimator couch check - beam congruence of field delineators and collimators. Mechanical safety devices - installation of collision devices – auto centering of image intensifier camera
		6. Teletherapy Beams Characteristics of photon beams: Quality of beams, Difference between MV and Me, Primary and scattered radiations. Percentage depth dose, Tissue-Air Ratio, Scatter Air Ratio, Tissue-Phantom Ratio, Tissue Maximum Ratio, Scatter Maximum Ration, Back Scatter Factor, Peak Scatter Factor, Off-Axis Ratio, Variation of these parameters with depth, field size source-skin distance beam quality or energy, beam flattering filter, target material .Central axis depth dose profiles for various energies.- Equivalent square concept, surface dose (entrance and exist), skin sparing effect, Output factors.- Practical applications: Co-60 calculations (SSD and SAD technique), Acceleration- calculations (SSD and SAD technique)-Beam profiles, Iodise curves, Charts Flatness, Symmetry, Penumbra (Geometric-Transmission and Physical), Field size definition.

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		7. Beam directing devices: Different types of collimators-penumbra trimmers-Front and backpointer-pin and arc. Tissue compensation-Field blocks-field shaping-multileaf collimator-IMRTconcept-separation of adjacent fields. - Electron contamination – penumbra and penumbratrimmers – front and back pointer- pin and arc-their application in radiotherapy.
		8. Treatment planning system: Quality assurance - accuracy of data - percentage depth dose - tissue maximum ratio - scattered factors - collimator factors - etc - accuracy of interpolation techniques - accuracy of input and output devices such as digitizer, printer, plotter.
		9. Beam therapy data: Phantom and bolus-Build up and dose maximum-percentage depthdose-tissue air ratio-back scatter factor- Equivalent square field concept-Scatter air ratio- Irregular field concept-tissue phantom ratio-tissue maximum ratio SSD and SAD techniquerotation technique--Time and dose calculations in SSD,SAD and rotation therapy. Worked examples for cobalt-60 and Linac treatments Electron beam therapy-interactions-energy specification-calibration-characteristics of electron beams.
		10. Brachytherapy: Radioactive sources – exposures rate constant – calibration of –Brachytherapy sources-Brachytherapy methods-mould –Implant –intracavitary-radiography examination of implant – radiographic examination of intracavitary application and implant dosimetry –Radiographic verification of implant-Orthogonal verification of intracavitory application- dose calculation in intracavitary application- dose calculation methods. After loading systems- BARC Cs-137 kit-LDR remote after loading system and HDR remote after loading system- Physical components of LDR, HDR Brachy unit. Various type of sources used in brachytherapy and their properties.
		11. QC in Brachytherapy: Aim - manual after loading - intracavitary sources - leak tests - uniformity of activity checks - auto radiograph swipe test - source identity - activity calibration - applicators - quality control of applicators - Interstitial sources - source uniformity - auto radiograph - activity calibration - source identity - Remote after loading - source calibration - commissioning and acceptance of remote after loading equipments - source movements - pneumatic system air pressure check.
		12. Treatment planning concepts: Isodose chart-Measurement of isodose curves-parameters of isodose curves. Wedge filters-Wedge field techniques-Combination of radiation fields- Isocentric techniques-tumor dose specification. Simulator-treatment verification-Correction for contour irregularities-Corrections for tissue in homogeneities. Treatment planning system external beam planning-brachytherapy planning
		13. Test cases - periodic checks of decay correction of output - repetition of quality assurance tests after software up gradation - speed of processor. Measurement of entry and exit doses - doses to critical organs.

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		14. The care and use of Equipment and responsibilities: Observation of all apparatus (including timing and measuring devices) The reporting of faults – care and use of accessory equipment – Beam directional devices – Applicators and diaphragms – lead rubber- skin. Marking – Ink – bolus bags – Immobilisation devices. Management of Radiotherapy machines – records supervision of patients work in other departments – administration – some legal points.
08	**Radiotherapy Techniques**	1. Principles of Treatment Planning Treatment planning for photon beams: ICRU 50 and NACP terminologies. Determination of body contour and localization: Plain film, Fluoroscopy, CT, MRI, ltrasonogaphy, Simulator based. - Methods of correction for beams oblique incidence, and body in homogeneities- SSD technique and Isocentric (SAD) technique: Description and advantages SAD technique. - Combination of field: Methods of field addition, Parallel opposed fields, Patient thickness vs. Dose uniformity for different energies in a parallel opposed setup, multiple fields- Integral Dose. Wedge field technique, rotation Therapy.
		2. Limitations of manual planning. Description of a treatment planning system (TPS): 2D and 3D TPS - Beam data input, Patient data input - simple contour, CT, MR data, Dose calculation and display -Point dose, Isodose curves, Isodose surfaces, color wash-Dose-Volume Histograms - BATHOS as applied to linear accelerator calculations modified BATHOS as applied to clinical radiotherapy - Alignment and immobilization.
		3. Importance of Immobilization in radiotherapy, mmobilization methods - Method of beam alignment - Treatment execution-Treatment verification -changes in patient position, target volume and critical volume during course of treatment.
		4. Body in homogeneities: Effects of patient contour, Bone, Lung cavities, Prosthesis on dose distribution. Dose within bone /lung cavities, Interface effects, Electronic disequilibrium
		5. Beam modifying and shaping devices: Wedge filters and their use, wedge angle , Wedge Factors , Wedge systems - Wedge Isodose curves Bolus, Build-up material, Compensators, Merits and Demerits.- Shielding of dose limiting tissue: Non-divergent and Divergent beam blocks, Independent jaws- Multileaf collimators, Merits and Demerits.
		6. Electron Beam Therapy Production of electron beams: using accelerators-Characteristics of electrons. Surface dose, percentage depth dose, beam profiles, Isodose curves and charts, Flatness and symmetry. Beam collimation, variation of percentage depth dose and output with field size, and SSD, photon contamination. Energy spectrum-Energy and field size choice, air gaps, and obliquity, Tissue in homogeneity lung, bone, air filled cavities. Field junctions - External and internal shielding. Arc therapy, use of bolus in electron beam. - Total skin Electron Irradiation, Intraoperative Radiation Therapy.

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		7. External beam therapy practical experience Technique of fixed beam treatments- single field, parallel fields, multiple fields, regional fields. The use of wedge filters, compensators and shaping blocks, diaphragms and applicators. Immobilization of the patient- Rotation and arc therapy- beta ray and electron beam therapy. Care of machine-Set up single, multiple fields-Use of wedges, shields and tissue ompensators-Use of beam directional devices, methods of patient mmobilization-Knowledge of technique involving electron beam therapy-moving beam therapy-conformal therapy-stereo tactic radio surgery and radiotherapy-Handling emergencies in Teletherapy
		8. CT planning-MRI planning-Interpretation of treatment prescription-Record keeping relevant to planning – patient position, support, immobilization, Land marks Mould room techniques and immobilization. Treatment positioning in radiotherapy to various cancers; CNS-benign- ituitarycraniopharyngioma etc. Malignant tumor-primary and secondary; orbit-eye –middle earparotid-buccal mucosa-tongue-hard palate-maxillary antrum- naso pharynx- oropharynx- hypo pharynx- larynx- oesophagus-media sternum- lung- bladder- prostate-penis- testis-cervixbody of the uterus—vagina-vulva-lymphoma
		9.Mould room technique: Construction of casts-Construction of applicator and moulds-Construction of shields
		10.Physical Principles of Brachy therapy Historical background: Radiation and Dose units: Properties of an ideal Brachy therapy source, Activity used, Exposure, Absorbed Dose, Mg-hr curie, Radium equivalent, roentgen, rad, gray. Source strength specification, Brachytherapy Dose calibration. source used in Brachy therapy: Ra-226, Cs- 137, Ir-192, Au-198, Co-60, I-125, Sr-90/Yt-90, Ru-106, Ta-182 and other new radio nuclides. Their physical properties. Radium hazards comparative advantages /disadvantages of these radio nuclides. Pre-loaded, after loading (manual and remote) , Merits and Demerits - Interstitial , Intracavitary, Intraluminal, Intravasularbrachy therapy, Low, Medium , High and Pulsed dose rates. Radiation safety: Planning of Brachytherapy facility , rooms and equipment, storage and Movement control, source inventory, Disposal , Regulatory requirements. Unsealed radionuclides : Concept of uptake , distribution and elimination, activities used in clinical practice, estimation of dose to target tissues, and critical organs , procedures for administering radionuclides to patients.
		11. Chemotherapy-Chemo-radiation- concepts of combined modality treatment and the significance of radiation and chemotherapy in comprehensive management of cancer. Sequelae associated with multimodality therapy and their management

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		12. Care of the patient : Care of inpatients, out patients, day care, isolation, special clinics, terminally ill patients and maintenance of case records for both in & out patients General welfare of the patient during and after treatment, including the care o f any inherent disease (for example Diabetes, Tuberculosis, Arthritis)or disabilities (such as Tracheostomy)- Diet and fluid intake – The observation and reporting of any change in the signs and symptoms of patients receiving treatment- the use of blood in the control of certain treatments – the care of local and systemic reactions- local reactions should include those in the ear, nose, throat, and eye, and those arising from treatment given to the low4er part of the pelvis the absolute necessity of accuracy in every aspects of each individuals treatment- the keeping of records and their significance.
09	**Recent Advances in Radiotherapy Techniques**	1. Introduction to Special techniques in Radiotherapy such as SRS, SRT, IMRT, IGRT & Helical Tomotherapy, and Volumetric modulated arc therapy, Robotic radiotherapy, PET in radiotherapy treatment planning, Particle therapy with proton beam and heavy ions and Challenges in technologists job due to the introduction of new technologies.
		2. Conformal radiotherapy ((CRT): Principles, Advantages over conventional methods Virtual Simulation: Principles, CT-simulation, TPS based simulation, Differences, Merits and Demerits, Practical considerations- Essential requirements for conformal radiotherapy- Various methods of CRT Modulated Radiation Therapy (IMRT) - Using 3 D compensators-Static IMRT-Dynamic 3. IMRT - Dynamic arc IMRT-Micro-MLC-Tom therapy methods- Time gated (4 D) radiotherapy- Merits and demerits of IMRT
		4. Stereo tactic irradiation methods: Physics principles- Merits and demerits, stereo tactic Radio surgery (SRS) and stereo tactic Radiotherapy (SRT), whole body stereo tactic frame.
		5. Combination Radiation-Surgery Pre , post and intra-operative radiation -Rationale, radiobiological factors, current clinical results.
		6 Combination Radiation –Chemotherapy Definitions of radio sensitizers, synergism, potentiation, antagonism-adiosenistzers-type mechanism
		7. High LET Radiation Comparison and contrast with low LET radiation.-Neutron source and boron neutron capture Advantages and disadvantages of neutrons, RBE values, hazards of low dose and low energyneutrons, RBE values, hazards of low dose and low energy neutron, use inradiotherapy, combination with low LET, current clinical results.Other high LET particles: protons, high energy heavy nuclei, application to radiotherapy,current clinical results.
		8. Hyperthermia Sources, rationale, advantages and disadvantages, thermo tolerance. Cellular damage: comparison and contrast with radiation, thermal and non-thermal effects of ultrasound, microwaves, radiofrequency, etc General host responses Use along with radiotherapy and chemotherapy: optimum sequencing of combined modalities. Current imitations to the clinical use of hyperthermia

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		9. Immunotherapy -Monoclonal antibody therapy- Radioimmunotherapy
		10. Radio-active isotopes used for diagnosis and therapy
		11. Molecular and Genetic Oncology Somatic correction of gene defect- Genetic pro-drug activation- Genetic immunomodulation . Gene Therapy -Molecular therapy- Cancer vaccines.
		12. Information Technology /Networking in radiotherapy: Networking of planning and treatment units in a radiotherapy department including picture Archival Communication System (PACS), Advantages, Patient Data Management.
		13. Know the Cancers prevalent in Indian subcontinent
		14. Basics of Palliative & supportive care–Care of Terminally ill cancer patients. Specializedoncology care pertaining to the needs of cancer patients – Palliation - Pain management- Patient's and relatives counselling on end stage management.
10	**Patient Care Relevant to Radiotherapy**	1. Preparation of patients for general radiotherapy procedures- departmental instructions to outpatients or ward staff- use of aperients; enemas and colonic irrigations flatulence and flatus, causes and methods of relief principles of catheterization and intubation, premedication. its uses and methods; anesthetized patients; diabetic patients special attention to food hazards of trauma. Preparation of the patients of biopsy and trolley set up; trolley set up for ENT examination, preparation of the patients for pelvic examination and trolley set up, general welfare of the patients during and after the treatment including the care of any inter current diseases (diabetes, tuberculosis, arthritis), diet and fluid intake.
		2. The observation and reporting any change in the signs and symptoms of patients receiving treatment, the use of blood count in the control of certain treatment, the care of blood counts, the care of local and systematic reaction, local reaction showed include those in the ear, nose, throat and eye and those arising from treatment given to the pelvis, instrumentation, the absolute necessity for accuracy in every aspects of each individual treatment, the terminal care of dying patients.
		3. Care of Patients receiving R.T: General welfare of the patient during and after the treatment including the care any intercurrent disease (diabetic, tuberculosis, arthritis). Diet and fluid intake. The observation and reporting any change in the signs and symptoms of patients receiving treatment... - Identification and care of radiation reaction (Mucositis, Dermatitis, Cystitis, and proctitis) – Use of blood counts - Diet and nutrition - Communication and counselling. - Management of special procedures (Tracheostomy, Colostomy, Ileal bladder, Breast prosthesis). The use of blood count in the control of certain treatment. The care of local and systemic reaction.
		4. Organization of radiotherapy, department practice, appointment organization in the planning room, treatment area. Management of waiting patients.

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		5. Drugs used in Radiotherapy Basic knowledge on drugs used in the dept.
11	**Quality assurance, Radiobiology & Radiation Safety in Radiotherapy**	1. Quality Assurance in Radiotherapy-Definition and practical advantages, Construction, Development and Implementation of Quality System-Quality Assurance of Simulator, TPS, Co-60, linear accelerator-Acceptance testing of simulator, TPS, Co-60, linear accelerator. - Accessories tools used in for QA tests in Radiotherapy such as front pointer, Back pointer, Laser alignment etc, Optical and field congruence , Beam shaping blocks , Beam shaping Jaws , Delineator/Diaphragm movements Isocentric alignment, Patient support system, Beam ON & OFF mechanisms, Technicians role in QA test on Tele Cobalt/ Linear Accelerator/ Brachy therapy/ Gamma Knife/Simulator/ CT Simulator machines.
		2. Biological Effects of radiation & Radiobiology of Radiotherapy work: 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, LD50/60 -Types of radiation excitation and ionization- Radiation chemistry - direct and indirect effects, free radicals, oxygen effect and free radical scavengers- LET and RBE theory, dual action theory, intracellular repair, general knowledge of repair models. Fractionation: rationale, factors involved - Time, dose, and fractionation relationship- Is effective formulae- split dose treatments. Brachytherapy- low dose rate, high dose rate and pulsed treatments. combination therapy (adjuvant surgery or chemotherapy), hyperthermia, hypoxic cell radio-sensitizers, high LET radiation. Photodynamic therapy. The volume effect, general principle and current hypotheses. Shrinking Field technique.
		3. Protection mechanisms: Time, Distance and shielding. Concept of "As Low As Reasonable Achievable" (ALARA)
		4. Radiation Quantities and Units Radioactivity, Flux, Fluence, Kerma, Exposure, Absorbed dose, Equivalent Dose, Weighting Factors, Effective Dose Radiation intensity-exposure, roentgen, its limitationskerma and absorbed dose-electronic equilibrium-rad, gray, conversion factor for roentgen to rad-RBE-LET-quality factor-dose equivalent-rem, sievert. Natural Background Radiation, Occupational Exposure Limits, Dose limits to public.
		5. Measurement of radiation: Radiation Detectors: Gas. Solid state, Scintillation, Thermoluminescence, Visual Imaging (Film, Flurorescent screens) and their examples. Measurement of exposure (Free are chamber, Thimble chamber,) Victorian Electrometer – Secondary standard dosimeters-Calibration of therapy beams: Concepts, Phantoms, protocols- dose determination in practice– Advantages & disadvantages of various detectors & its appropriateness of different detectors for different type of radiation measurement

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		6. Personnel and Area Monitoring: Need for personnel monitoring, Principle of film badge.- TLD badge used for personnel monitoring. Pocket dosimeter, Need for area monitoring,- Gamma Zone Monitors, Survey meters. Pocket dosimeter-Radiation survey meter- wide range survey meter, zone monitor-contamination monitor, their principle, function and uses.
		7. Radiation Protection and Regulatory Aspects Principle underlying international Commission on Radiation- recommendations. ICRP and National radiation protection rules, Atomic Energy Regulatory Board (AERB) standards- Organizations, Safety standards, Codes & Guides, Responsibilities of licenses, Registrants and employers and Enforcement of Regulatory requirements. Effective dose limits - Regulatory consent: NOCs, periodical report to AERB and Radiological Physics and Advisory Division of Bhabha Atomic Research Centre (BARC).
		8. Radiation Emergency Preparedness Safety and security of radiation sources, case history of emergency situations and preparedness, equipments, tools, including role of Gamma zone monitors, Regulatory requirements and prevention of emergency. Preventive maintenance and safety culture, role of technicians in handling radiation emergencies.
		9. Planning and setting up specialty department of radiotherapy and oncology and interaction with government machinery-Procedural steps for installation and commissioning of a new radiotherapy facilitiy (Teletherapy and Brachytherapy). Type approval of unit. Site plan, Layout of installation / Associated facility: Primary, Secondary barriers, leakage and scattered radiation. Regulatory requirement in procurement of teletherapy /bachytherapy sources(s). Construction of building, qualified staff, Procurement of instruments and accessories of unit and performance tests, Calibration of units, RP & AD approval for commissioning of the unit.

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