ANNEXURE-III
SCHEME AND SYLLABUS FOR THE POST OF LECTURER IN RADIOLOGICAL PHYSICS & PHYSCIST IN HM & FW DEPARTMENT

Scheme of Examination

Part-A:WRITTEN EXAMINATION (Objective Type)	No.of Questions	Duration (Minutes)	Maximum Marks
Paper-I: General Studies and General Abilities	**150**	**150**	**150**
Paper-II: Radiological Physics / Medical Physics (Post M.Sc Diploma Level)	**150**	**150**	**300**
Part-B:Interview			**50**
		Total	**500**

Syllabus

PAPER-I: GENERAL STUDIES AND GENERAL ABILITIES

1. Current Affairs: International, National and State.
2. Society, Heritage and Culture, Polity, Economy, Human Development Indices and the Development Programmes in India and Telangana.
3. Natural Resources in India and Telangana: their distribution, exploitation, conservation and related issues.
4. Basic concepts of Ecology and Environment and their impact on health and economy; Disasters and Disaster management.
5. Impact of changing demographic trends on health, environment and society.
6. Agriculture, Industry, Trade, Transportation and Service sectors in India and Telangana.
7. Food adulteration, Food processing, food distribution, food storage and their relevance to public health.
8. Recent trends in Science and Technology.
9. Telangana Statehood movement and formation of Telangana State.
10. Moral values and Professional ethics.
11. Logical Reasoning: Analytical Ability and Data Interpretation.

Paper.II: Radiological Physics / Medical Physics (Post M.Sc Diploma Level)

Unit-1: Radioactivity
Natural and artificial radioactivity, Modes of radioactive decay, Exponential decay, Physical, biological and effective half-lives, mean life, decay constant, Types of nuclear reactions and Principles of radionuclide production.
Interaction of Radiation with matter: Interaction of Photons with matter- types, properties and their relative importance, mass, electronic and atomic attenuation coefficient – Total attenuation coefficient, Total transfer and absorption coefficient. Interaction of heavy

charged particle with matter – Electron interaction with matter - Energy loss mechanisms: Collisional losses, Radiation losses, Stopping power - Mass collisional and radiative stopping power, LET, Ionization, Excitation, and Scattering. Interaction of Neutrons with matter-Neutron induced nuclear reactions.

Unit-2: Radiobiology

Structure of the cell- types of cells and tissue, their structures and functions. Biological modifiers and Cell Kinetics, Cell cycle control mechanisms. Anatomy and Physiology of human body as applied to Radio diagnosis and Radiotherapy.

Radiobiological Effects: Radiation effect at cellular level, Radiation effect on human tissue, Radiation effect on organs, Radiation effect on malignant cells and tissues, Radiation effect on the fetus, Five R's of Radiobiology. Fractionation and its effect, Nominal Standard Dose concepts, TCP / NTCP. Radiobiological Concepts: Sensitizers, Protectors, Reduction of side effects, Linear energy transfer, (LET) Radiobiological effectiveness (RBE), Oxygen effect, Oxygen enhancement ratio (OER), Radiobiological models, TDF factors, Gap correction, LQ model, Alpha - Beta concepts.

Unit-3: Radiation Quantities, Units and Detection

Concept, definition, units of kerma, absorbed dose, dose equivalent, equivalent dose, effective dose, air kerma rate constant, reference air kerma rate, activity and apparent activity – Energy Transfer – Electronic Equilibrium – Bragg Gray Cavity theory – measurement of absorbed dose.

Basic principles of Radiation detection. Ionization chambers, Semi-conductor detectors, Optical and thermo luminescence Dosimeters. Calorimetric, MOSFET, Diamond detectors, Scintillation Detectors, Detector arrays, Radiation Field Analyser, Radioisotope calibrator. Film Dosimetry, Chemical dosimetry, Gel dosimetry. Brachytherapy dosimeters, Neutron dosimeters and Radiation Protection dosimeters.

Unit-4: Diagnostic Radiology

Production and properties of X-rays, breamstraulung and characteristic X-rays. Radiography techniques: Prime factors (kVp, mAs and SID/SFD), influence of prime factors on image quality, selection criteria of prime factors for different types of imaging. Filters: inherent and added filters. Scatter reduction and scatter reduction methods; beam restrictors and different types of grids. Intensifying screens: Function of intensifying screens, screen function evaluation parameters, emission spectra and screen film matching, conventional screens Vs rare earth screens, Construction and working principles of image intensifiers. Flouroscopic X-ray units, C-arms and Mobile X-ray units. Digital Radiography(DR), Computed Radiography(CR), Zero Radiography(XR) and Film Radiography(FR). QA of conventional diagnostic X-ray equipment: Purpose of QA, QA protocols, QA test methods for performance evaluation of X-ray diagnostic equipment. Layout designs.

Unit-5: Special Imaging devices in Radiology

Mammography, Cathlab X-ray units used in Interventional radiology, Conventional tomography (principle only), Orthopantomography (OPG) and other Dental X-ray units, Bone Mineral Density (BMD) measuring X-ray unit. Computed Tomography (CT)- CT system components, Layout and QA of CT equipment. Magnetic Resonance Imaging (MRI):MRI system components - proton density, relaxation time T1 & T2 images - Image characteristics - Magnets, Magnetic fields, Gradients, Magnetic field shielding, Radio Frequency systems, computer functions - Imaging process – Image artifacts – MRI safety. Ultrasound Imaging: Interaction of sound waves with body tissues, production of ultrasound - transducers – acoustic coupling - image formation - modes of image display - colour Doppler.

Unit-6 : Nuclear Medicine

Introduction to Nuclear Medicine, Properties and uses of various radioisotopes used in Nuclear Medicine. Radionuclide Generators and their operation principles. Radionuclide Imaging: The Rectilinear Scanner, Anger Camera / Scintillation Camera; Different types of Collimators, Digital Image Processing Systems and principles of 2D and 3D Imaging Techniques - Basic Principles of Focal Plane Tomography, Emission Computed

Tomography, Single Photon Emission Computed Tomography, Positron Emission Tomography. Various Image Reconstruction Techniques, Image Quality Parameters and Methods of Evaluation of Spatial Resolution, Contrast, Noise. NEMA Protocols followed for Quality Assurance / Quality Control of Imaging Instruments. In-vitro Technique: RIA/IRMA techniques and its principles. Principles of PET, Detector and Scanner Design and uses of PET scanner. Working of Medical Cyclotron, Radioisotopes Produced and their characteristics. Treatment of Thyrotoxicosis, Thyroid cancer with I-131, concept of Delay Tank and various Waste Disposal Methods used in Nuclear Medicine. Planning and Shielding Calculations during the installation of SPECT, PET/CT and Medical Cyclotron.

Unit-7: External Beam Radiation Sources

kV X-ray units-Design and operation of Orthovoltage and Superficial therapy units, Tele-isotope units: Cesium teletherapy unit, Cobalt-60 teletherapy unit, Vaults design, Specification and acceptance testing, commissioning, quality control. Medical Accelerators: Linear accelerator, Medical Microtron, Betatron, - Facility design, Photon & Electron beam properties, Specification for Linear accelerator, Installation and acceptance testing, commissioning, Quality assurance, Safety considerations. Beam Shaping- Alloy Blocks, Physical and dynamic wedges, compensating filters, Multileaf collimators (MLCs). Different methods of Intensity modulation. Electron Portal Imaging devices, On Board Imaging devices, RPM-gating devices and other IGRT-devices.

Unit-8: Brachytherapy

Basic principles of brachytherapy. Surface, interstitial, intracavitary, intravascular and intraluminal techniques. Low, medium, high and pulsed dose rate brachytherapy. manual afterloading and remote after loading machines. Layout design, installation and acceptance testing. Brachytherapy dosage systems – Manchester system, Paris system, Methods of reconstruction – optimization in Brachytherapy and dosage calculation using radiography, CT and MRI. ICRU dose specification system. Radioactive Sources for Brachytherapy: Gamma sources - Caesium-137, Iridium-192, Gold-198, Cobalt-60, Iodine-125, and Palladium 103. Beta sources - Strontium-90, Yttrium-90 and Ruthenium-106. Production of these radioactive sources, Source construction including filtration. Physical Properties - Spectra of radiation emitted, half-life and specific activity. Comparative advantages of these radio nuclides. Handling, calibration, inspection, storage and transport of brachytherapy sources.

Unit-9: Dosimetry and Networking

Phantoms, Commercially available 2D and 3D dose measuring Instruments. Measurement of radiation quality - Output and dose distribution for photon and electron beams. Dosimetry protocols – IAEA TRS 398 and AAPM TG 51. Periodic QA of Telecobalt unit - Linear accelerator – MLC – EPID – OBI – TPS(Treatment planning system) – Daily, weekly and monthly QA of Radiotherapy machines. Patient specific QA of IMRT, VMAT, SRS/SRT and other treatments.

Dosimetry in brachytherapy – AAPM TG 43 - Measurement of reference air kerma rate (RAKR)/ air kerma strength (AKS) for sealed brachytherapy sources. Activity and dose rates for unsealed radionuclides.

Networking in Radiotherapy – DICOM Format – DICOM RT – Radiation Oncology information management system.

Unit-10 : Photon beam therapy

Characteristics of Photon beams, Variation of percentage depth dose and output with field size and SSD. Methods of compensation for patient contour variation and/or tissue inhomogeneity and shielding of dose-limiting tissues. Static and dynamic Wedges, bolus, build-up material, compensating filters, multileaf collimators (MLC).

Treatment Planning and Advances in Radiotherapy Delivery: Patient positioning and Immobilization methods – lasers – SSD and SAD treatment deliveries. Treatment verification Methods: Electronic portal imaging devices (EPID), kV cone beam CT, MV Cone beam CT, RPM-gating and other IGRT techniques. Adaptive radiotherapy and on-line treatment verification. Treatment delivery protocols of 3DCRT, IMRT, SRS/SRT, VMAT and SBRT treatments.

Unit-11: Electron Beam Therapy

Energy spectra, Energy specification, Variation of mean energy with depth, Suitability of measuring instruments for electron beam dosimetry, Characteristics of electron beams, 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, Treatment planning - energy and field size choice, air gaps and obliquity. Tissue inhomogeneity - lung, bone, and air filled cavities. Bolus, Field junctions (with either electron or photon beams), Internal shielding and Arc therapy.

Unit-12: Treatment Planning systems and dose distribution

Computerized Treatment Planning Systems – Patient data acquisition techniques - Determination of body contour and location of internal structures, target volume and critical tissues. Imaging for radiotherapy planning- Plain film, CT, MRI, Ultrasonography, PET, Hybrid imaging. Specification of Tumor dose – ICRU 50 & 62 Reports.

Dose calculation algorithms – Model-Based Algorithms - Dose Calculation in Homogeneous Media - Superposition and Convolution Algorithms -Pencil Beam and Path Length Scaling - Collapsed Cone and Kernel Tilting – Monte Carlo calculations. 2D and 3D conformal treatment planning techniques, methods and combination of beams - Calculation methods – inhomogeneity corrections. IMRT, VMAT and SRS/SRT optimization techniques – Plan Evaluation techniques – Isodose charts and Dose Volume Histograms – Measurements of dosimetry parameters.

Unit-13: Special Procedures of Radiotherapy

Total Body Irradiation-Guidelines and delivery techniques. Patient positioning, dosimetry for commissioning, in-vivo dosimetry protocol. Total Skin Electron Irradiation- Guidelines and delivery techniques. Patient positioning and dosimetry. Intraoperative Radiotherapy. Stereotactic Radiosurgery – Methods, dosimetry, treatment planning and quality assurance. Gamma knife and CyberKnife Radiosurgery, Tomotherapy, Proton therapy - rationale, techniques, Boron Neutron Capture therapy, Photodynamic therapy – Monoclonal antibodies therapy.

Unit-14: Fundamentals of Radiation Protection

Radiation protection - Historical development, Principles of radiation protection and units, Radiation weighting factors, Tissue weighting factors, Annual dose limits. Radiation effects –Somatic and genetic effects, Classification of radiation effects on dose - Stochastic and deterministic effects, justification, optimization, ALARA principle. Radiation protection rules (RPR) and tools. Prescribed regulatory requirements, Applicable Safety Codes, Standards, Guides and Manuals of Atomic Energy Regulatory Board (AERB) for Radio diagnosis, Nuclear Medicine and Radiotherapy departments. Basic safety standards (BSS) and ICRP 60 and 103.

Radiation Protection Instruments: Ionization chamber, large volume chambers, Survey meters, Proportional counters, GM counters, Area zone monitors, Contamination monitors. Personal monitoring devices – Film badge, TLD and pocket dosimeters.

Unit-15: Safe handling of Radioactive Materials and Responsibilities

Methods of transport, Classification of radioactive packages for transport, Procedures for preparing the radioactive package for transport, Regulatory requirements for transport of radioactive materials – National and international. IAEA safety standards, Emergency preparedness. Safety and security of sources during storage, Use, Transport and disposal. Radio toxicity of different radionuclides and the classification of laboratories. Radiation injuries, their treatment and medical management

Licensing, Inspection and Enforcement. Responsibilities of Employers, Licensees, Radiological safety officers and Radiation Workers. Professional aspects and role of Medical Physicists. National inventories of radiation sources, Import and Export procedures.