# Syllabus for Licensing Examination of

## M.Sc. Medical Physics/Master of Medical Physics

## 2025

# Nepal Health Professional Council

Bansbari, Kathmandu

## Table of contents

## 1. Basic Sciences (15%)

- **Anatomy physiology**
  - Anatomical Nomenclature: Origin of anatomical names, Prefixes and suffixes, Anatomical position and body planes
  - Bones: Classification, Structure, Development
  - Spinal Column: Divisions of the spinal column, Vertebral structure, Radiography and CT of the spinal column
  - Thorax: Bones of the thorax, Organs in the thorax, Radiography and CT of the thoracic structures
  - Abdomen: Divisions and regions, Organs in the abdomen, Abdominal systems
  - Respiratory System: Organs, Function, Radiography , CT
  - Digestive System: Divisions, Location, extension, Function, Radiography, CT
  - Urinary System: Organs, Location, Function, Radiography, CT
  - Reproductive System: Organs, Location, Function, Radiography, CT
  - Circulatory System: Major components, Function, Radiography, Visit to catheterization laboratory, CT
  - Pathology: Identification of organs at autopsy, Organ location, Organ composition, Correlation of radiographic findings

- **Radiobiology & oncology**
  - Classification of Radiation in radiobiology
  - Cell-Cycle and cell death
  - Effect of cellular radiation, oxygen effect
  - Type of radiation damage
  - Cell survival curve
  - Dose-response curve
  - Early and late effects of radiation
  - Deterministic and stochastic effects of radiation
  - Modelling, Linear Quadratic Model,
  - Dose Rate Effect
  - Tumour Control Probability (TCP), Normal Tissue Complication Probability (NTCP), Equivalent Uniform Dose (EUD)
  - Tolerance Doses and Volumes, Quantitative Analysis of Normal Tissue Effects in the Clinic (QUANTEC) [10]
  - Normal and tumour cell therapeutic ratio
  - Radio-sensitizers, Protectors

- **Radiation Physics**
  - Basic Radiation Physics: Fundamental Physical constants, Important derived physical constants and relationships, physical quantities and units, Classifications of Forces in nature, Classification of fundamental particles, Classification of

radiation, Classification of ionizing photon radiation, Einstein's relativistic mass, energy and momentum relationships, Radiation quantities and units.

- Atomic and nuclear structure: Basic atomic structure, Rutherford's model of the atom, Bohr's model of hydrogen atom, Multi electron atoms, nuclear atoms, Radioactivity, Activation of isotopes, Modes of radioactive decay
- Electron interaction: Electron orbital electron interaction, Electron nucleus interaction, Stopping power, Mass scattering power
- Photon interactions: Types of indirectly ionizing photon radiation, Photon beam attenuation, Types of photon interaction, Photo electric effects, Coherent (Rayleigh) scattering, Compton effect (incoherent scattering), Pair production, Photo nuclear reactions, Contributions attenuation coefficients, Relative predominance of individual effect, Effects following photon interactions, Summary of photon interactions, Example Production of vacancies in atomic shells.

## 2. Physics of Radiation Oncology (40%)

- **Radiotherapy physics**
  - Overview of clinical radiotherapy
  - Radiation therapy equipment (accelerators, cobalt 60, cyclotrons, kV generators)
  - Basic photon radiation therapy (dosimetric functions, etc.)
  - MU calculation
  - Treatment planning: 2D, 3D conformal, intensity-modulated radiation therapy (IMRT), and volumetric modulated arc therapy (VMAT).
  - Dose calculation algorithms: pencil beam, Monte Carlo, and convolution/superposition.
  - Simulation, virtual simulation, DRR's, image registration and TPS
  - Image guidance and verification in radiotherapy (Cone beam CT, ultrasound, Portal imaging, in-vivo dosimetry, image registration)
  - Patient setup, including positioning and immobilization
  - ICRU Reports 50, 62 and 83
  - Basic electron radiation therapy, ICRU Report 71
  - Dose calculation algorithms and heterogeneity corrections
  - Inverse Planning, optimization, IMRT/VMAT and TPS
  - Brachytherapy, ICRU Report 38 , AAPM TG 43 formalism
    - HDR/LDR, radioactive seed implant, Source types (e.g., Ir-192, Cs-137), dose calculation Equipment, Treatment Planning
  - Introduction and applications of AI in radiation therapy
  - Radiation therapy information systems
  - Acceptance testing and commissioning
  - Health technology procurement and maintenance
  - Small field dosimetry (fundamental aspects, protocols)
  - Small-field radiotherapy equipment and techniques
  - Radiotherapy Record &Verification systems
  - Recent advances in Radiation therapy technology

- **Radiation dosimetry**
  - Interactions of charged and uncharged particles and related quantities
  - Stochastic, non-stochastic quantities
  - Radiation fields and dosimetry quantities
  - Radiation and charged particle equilibrium
  - Cavity theories and Fano theorem
  - Radiation dosimeters and instrumentation
  - Radiation primary standards
  - Calibration Chain
  - Code of practice for dosimetry in diagnostic, interventional radiology and radiation therapy

## 3. Physics of diagnostic and interventional radiology (25%)

- Production of X-rays and their interaction with human body
- X-ray tubes
- X-ray generators (rectifiers, capacitors and transformers)
- Control of scattered radiation
- Exposure timers
- Digital radiography: Digital imaging principles, Computed Radiography, Direct digital radiography
- Digital fluoroscopy: Principles of fluoroscopy, Image intensifiers, digital subtraction angiography
- Mammography: Conventional mammography, digital mammography, digital breast tomosynthesis (DBT)
- CT Scan: Basic principles of CT scanning, helical CT, multislice CT, artifacts in CT images, CT hardware, recent advances in CT technology, QC of CT
- MRI: Basic principle of MRI, Nuclear magnetic resonance, T1 and T2 relaxation processes, Image formation and contrast weighting in MRI, Spin echo pulse sequence, Gradient echo pulse sequence, MR Angiography, Diffusion weighted Imaging, artifacts in MRI, MR spectroscopy and advances in MRI technology, MR Safety
- USG: Basic principle of ultrasonography, generation of ultrasound, ultrasound beam, interaction of ultrasound beam with human tissue, ultrasound transducer and transducer arrays, Doppler ultrasonography, artifact in ultrasonography

## 4. Physics of Nuclear medicine (10%)

- Radioactivity
- Radiopharmaceuticals used in Nuclear medicine
- Production of radioisotopes: Radioisotope generator, Nuclear reactors and Cyclotron

- Construction of Gamma camera and working principle of scintigraphy, collimators, hot lab, dose calibrators, well counters
- Radionuclide Therapy
- Internal Dosimetry (MIRD)
- Acceptance testing and commissioning
- QA and QC of Nuclear medicine equipment
- SPECT, SPECT-CT
- PET, PET-CT, PET MRI

## 5. Radiation safety and protection (10%)

- Regulatory framework (NRC, ICRP, and NCRP guidelines)
- Background radiation
- Principles of radiation protection
- Radiation measurement and units
- ICRP guidelines on dose limits
- Radiation protection in pregnancy
- Personal dose monitoring systems (Film badge, TLD, OSLD, Pocket dosimeter)
- Radioactive Substances (Uses and Regulation) Nepal Act 2020
- Radioactive Substances (Uses and Regulation) Nepal Regulation 2022
- Radiation Safety Directives , Nepal 2023
- Designing and shielding calculation of
  - Radiotherapy facilities
  - X-ray room, Fluoroscopy rooms
  - CT rooms
  - Nuclear medicine facilities
- Radiation protection of patient and personnel in radiography, mammography, CT, Fluoroscopy, Nuclear medicine and Radiotherapy
- Radioactive waste disposal nuclear medicine