

DETAILED SYLLABUS FOR THE POST OF ASSISTANT PROFESSOR
(NUCLEAR MEDICINE) (MEDICAL EDUCATION)

(Cat.No. : 342/2023)

Part I: Radiation Physics and Instrumentation. (10 marks)

- a. Structure of atom, Natural and artificial radioactivity.
- b. Modes of Radioactive decay.
- c. Interaction of radiation with matter.
- d. Principles of radiation detection and detectors.
- e. Basic principles of production of radionuclides by reactors and cyclotrons.
- f. Nuclear Medicine Instrumentation including Gamma Cameras, Single Photon Computed Tomography (SPECT), Positron Emission Tomography (PET), Hybrid Imaging Systems like SPECT/CT, PET/CT and PET/MR
- g. Counting Systems: Well counters, liquid scintillation counters, spectrometers, Radioactive Iodine Uptake (RAIU) probe and radiation monitoring devices.
- h. Quality control of Nuclear Instruments, as in (f and g).
- i. Collimation of radiation detectors and the characteristics of various collimators, their response to point, line and plane sources.
- j. Electronic instruments, such as pulse amplifiers, pulse height analyzer, count rate meters and computer interfaces including gating devices.
- k. Software and hardware fusion technology, Digital Imaging and Communications in Medicine (DICOM) technology and Picture Archiving and Communication System (PACS).

Part 2: Mathematics, Statistics and Computer Sciences. (10 marks)

- a. Basic Mathematical concepts, counting statistics, probability distribution, Bayesian and McNemar statistics, parametric and nonparametric statistics.
- b. Compartmental analysis and mathematical models of physiologic systems.
- c. Basic aspects of computer structure, function and programming.
- d. Computer applications with emphasis on digital image acquisition, analysis, processing and enhancement, tomographic reconstruction, display and recordings of findings.
- e. Fundamental of filters, their applications and uses.

Part 3: Radio-pharmacy related to Nuclear Medicine (10 marks)

Radiopharmaceuticals

The chemical, physical and biological properties of radiopharmaceuticals used in Nuclear Medicine investigations; production, Quality Control and Regulations of hospital based-Nuclear Pharmacy.

The emphasis will be on:

- a. Physical and chemical characteristics of radionuclide used in diagnostic Nuclear Medicine
- b. Criteria for selection of radionuclide for diagnostic purposes
- c. Biological behavior of radiopharmaceuticals
- d. Quality control
- e. Mechanism of localization
- f. Positron Emitting radionuclides, target reactions and their radiopharmaceuticals chemistry, various synthetic modules.
- g. Specific topics on Radiopharmaceuticals: Bone seeking, hepatobiliary, brain and cerebrospinal fluid (CSF), renal, thyroid, parathyroid, infection imaging, Tumor Seeking, cardiac imaging etc.
- h. Good Manufacturing Practice (GMP) and Laws pertaining to in-house manufacturing of Radiopharmaceuticals.
- i. Radiopharmaceuticals for Research.

PART 4: Radiation biology and radioprotection. (10 marks)

- a. The biological effects of radiation exposure with emphasis on the effects of low level exposure.
- b. Methods of reducing unnecessary radiation exposure to patients, personnel and environment.

- c. ICRP and AERB recommendations and their amendments from time to time and other international recommendations, environmental regulations regarding limits of radiation exposure, handling of radioactive patients, transport of radioactivity material, personal radiation monitoring and disposal of radioactive wastes.
- d. The diagnosis, evaluation and treatment of radiation over exposure in any form.

PART 5: Anatomy, Physiology and Pathology (5 marks)

- a Normal Imaging anatomy on nuclear medicine, computed tomography and magnetic resonance imaging, images in the transverse axial, coronal, sagittal, and orthogonal (oblique) cross sectional imaging plane, within the a. Head b. Neck c. Thorax d. Abdomen e. Pelvis f. Body g. Extremities and large joints.
- b Distinguish common pathologies recorded on multiplanar images.
- c Physiology related to Radiopharmaceuticals.

PART 6: Diagnostic Nuclear Medicine (15 marks)

6.1 In vivo Diagnostic Imaging

- a. General clinical indications for organ imaging; normal and altered anatomy, physiology, biochemistry and metabolism of various organs. The technical aspects of performing the procedures including proper patient preparation and patient management before, during and after the procedure.
- b. In vivo imaging and/or functional studies including brain Single Photon Emission Computed Tomography (SPECT), tracing of cerebrospinal fluid pathways, thyroid imaging, salivary glands, lungs, heart, gastrointestinal, hepatobiliary system, spleen, kidney, prostate, adrenal, bone and joints, bone marrow evaluation etc.
- c. The use of physiologic gating techniques for functional studies and patient monitoring during intervention, both physical exercise and using pharmacological stress agents
- d. Cellular kinetics, absorption and excretion analysis, nuclear hematology and metabolic balance studies using radiotracers.
- e. Comparative analysis of Nuclear Medicine procedures with X-ray, Ultrasound, Echo, MRI, CT and angiography etc.
- f. Nuclear Cardiology: Stress and redistribution studies using Thallium201 and other technetium-based myocardial perfusion agents; myocardial viability, Gated SPECT studies, etc.
- g. Positron Emission Tomography (PET): All indications for use of PET imaging in oncology, cardiology, neurosciences, infection & inflammation and psychiatric disorders. PET tracers.

6.2 In vitro Studies

- a. Principles of Radioimmunoassay (RIA), quality control and data analysis for various hormones and drugs assays.
- b. Glomerular Filtration Rate (GFR) estimation, Red Cell Survival, Red Cell Mass using chromium and C14 urea Breath test.

Part 7: Therapeutic Nuclear Medicine (15 marks)

- 7.1 Principles of Internal Dosimetry: Calculation of the radiation dose from internally administered radionuclide
- 7.2 Characteristics of Radionuclides/Radiopharmaceuticals for radionuclide therapy
- 7.3 Radiation protection in therapeutic set up: Design of Isolation ward as per the norms of Atomic Energy Regulatory Board (AERB)
- 7.4 Principles of OPD and in-door therapy administration.
- 7.5 Therapy in thyroid disorders; benign thyroid diseases, aetiology of hyperthyroidism, various modalities of treatment and follow up strategy, long-term outcome and various national and international regulations pertaining to therapeutic administration of radionuclides.
Therapy in thyroid disorders; aetiopathology, classification and diagnosis of thyroid nodules and malignancies- various modalities of treatment and follow-up strategies, long-term outcome and various national and international regulations pertaining to therapeutic administration of radionuclides.
- 7.6 Bone pain palliation using various radionuclides such as P32, Sr89, Y90, Sm153, Ra223, Lu177 etc.
- 7.7 Radiosynevectomy
- 7.8 Radiopeptide therapy and Radioconjugate therapy
- 7.9 Radioimmunotherapy
- 7.10 Locoregional internal radiation therapy
- 7.11 Research agents in radionuclide therapy, targeted alpha therapy.

Part 8: Ethics & Law & Recent Advances in Nuclear Medicine (5 marks)

8.1 Recent advance in aspects of the following areas:

8.1.1 Instrumentation

8.1.2 Radiopharmaceuticals

8.1.3 Diagnostic procedures

8.1.4 Therapeutic procedures

8.2 Ethics & Law

8.2.1 Ethical Theories/Principles

8.2.2 Personal Ethics, Professional Ethics & Societal Ethics

8.2.3 Scope of Practice and Practice Standards in Nuclear Medicine

8.2.4 Medical-Legal Issues

8.2.5 Communication skills with patients and fellow staff.

Part 9: Training, administration, and teaching skills (10 marks)

- a. How to train Residents and NM technology students in Nuclear Medicine.
- b. Theory, clinical & practical modes of training
- c. Structured training: lectures, seminar, Journal club, Ward-round, Physics demonstration, Practical, Case Presentations (e.g. Long Case; short case)
- d. Participation in various procedures, techniques happening in department.
- e. Administration of I-131, Lu and alpha therapy and supervision of isolation ward and laws pertaining to it.
- f. Visiting other NM centers & Other oncology department
- g. Clinical Nuclear Medicine Physician role as an administrator
- h. How to set up a Nuclear medicine department, planning of infrastructure, equipments in a government facility.
- i. Role in National Cancer Control Programme (NCCP)
- j. Responsibilities towards safety & quality assurance

Part 10: Biomedical Research fundamentals as per NMC criteria. (10 marks)

- a. Statistical basis of clinical trials and interpretation of trials.
 - b. Planning a research study.
 - c. Ethical issues in conducting a research study.
 - d. Writing a research protocol.
 - e. Designing, the appropriate forms of documentation.
 - f. Determining the proposed duration of the trial, either in terms of a fixed closing date, or the entry of a predetermined number of patients.
 - g. Establishing conditions under which the trial may be terminated earlier than planned & procedures for detecting these conditions.
 - h. Re-assessing the proposed trial in terms of ethics, appropriateness to the short & long terms objectives, feasibility & the availability of resources.
 - i. Writing the protocol.
 - j. Running a pilot study.
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NOTE: - It may be noted that apart from the topics detailed above, questions from other topics prescribed for the educational qualification of the post may also appear in the question paper. There is no undertaking that all the topics above may be covered in the question paper.