THE TAMIL NADU Dr. M.G.R. MEDICAL UNIVERSITY

No. 69, ANNA SALAI, GUINDY, CHENNAI – 600 032.

M.D. / M.S.

POST GRADUATE DEGREE COURSES

SYLLABUS AND CURRICULUM

2021 - 2022

M.D. NUCLEAR MEDICINE

THE TAMIL NADU Dr. M.G.R MEDICAL UNIVERSITY, CHENNAI

M.D. NUCLEAR MEDICINE

Nuclear Medicine involves use of small quantities of open, unsealed, short lived and medical grade radioactive substances (radiopharmaceuticals) in diagnosis, treatment and research in medical sciences. This postgraduate medical course provides a comprehensive study of basic principles, practices and protocols associated with nuclear and molecular medicine.

PREAMBLE:

The purpose of PG education is to create specialists who would provide high quality health care and advance the cause of science through research & training.

Nuclear medicine is a multi-disciplinary practice and the training of medical doctors is critical to the performance of a Nuclear Medicine department. Successful post graduate students are awarded a final certificate, degree or diploma that is recognized by the government, local health authority and hospital employer as an assurance of specialist competence in Nuclear Medicine. Post graduate training programme in Nuclear Medicine consists of an integrated training course of three years duration and would enable the post graduate student to practice nuclear medicine safely.

The purpose of this document is to provide teachers and learners illustrative guidelines to achieve defined outcomes through learning and assessment. This document was prepared by various subject-content specialists. The Reconciliation Board of the Academic Committee has attempted to render uniformity without compromise to purpose and content of the document. Compromise in purity of syntax has been made in order to preserve the purpose and content. This has necessitated retention of “domains of learning” under the heading “competencies”.

SUBJECT SPECIFIC LEARNING OBJECTIVES

The objective of the programme is to enable the post graduate student s to perform Nuclear Medicine practice, teaching and research independently and fulfill the manpower needs of ever expanding new branch of diagnostic and therapeutic medicine.

GOALS:

This 3-year post graduate course is aimed at providing comprehensive and quality education for the medical professionals in the field of Nuclear and Molecular Medicine.

This enables the student to become fully competent to practice, organize, conduct research and involve in teaching activities as well as become well versed with radiation safety, quality, medical ethics and legal aspects of imaging and treatment with radioisotopes.

At the end of this training, the student shall be able to:

1. Provide the health care to the patients needing Nuclear medicine service.

2. Teach and train future undergraduate and postgraduate medical students, junior doctors and technologists in Nuclear medicine in Medical Colleges, Institutions and other Hospitals.

3. Acquire a spirit of scientific enquiry, carry out and guide research to improve the art clinical medicine and science of Nuclear medicine.

4. Have management capabilities to make cost-effective and quality healthcare.

5. Recognize the health needs of the community and carry out professional obligations ethically, while keeping with the objectives of the national health policy.

6. Be aware of the contemporary advances and developments in the field of Nuclear and molecular medicine.

2. OBJECTIVES

The postgraduate students have to acquire adequate knowledge in all the basic concepts, knowledge in instrumentation and radiochemistry and acquire optimum clinical skills relevant to the practice of Nuclear Medicine, in complains with moral and ethical values of the country and humane approach to the patient.

Primary Objectives:

The student should be able to

1 Suggest and conduct all routine diagnostic in-vitro and in-vivo nuclear medicine procedures.

2 Interpret the results of in-vitro and in-vivo non-imaging and imaging procedures and also provide a differential/provisional diagnosis, based on the results obtained.

3 Provide radioisotope therapy for endocrine, bone and joint diseases, with special emphasis on the management of thyrotoxicosis, thyroid cancer, neuro-endocrine tumours, rheumatoid arthritis and disseminated skeletal metastasis with intractable bone pain.

4 Independently conduct emergency diagnostic nuclear medicine procedures and manage disorders accordingly.

5 Independently organise and conduct seminars, teaching programmes and research projects in medicine including use of radioisotopes.

Secondary Objectives:

The student should be able to

1. Conduct routine quality control tests on all nuclear medicine related instruments and correlate the functional status of an isotope generator, dose calibrator, uptake probe, gamma camera, gamma camera and radiation monitor.

2. Perform all routine quality control tests on radio-immunoassay procedures and maintain an acceptable degree of sensitivity, specificity and reproducibility of the test results.

3. Conduct quality control tests to assess the radiochemical purity and sterility of the radio-pharmaceuticals used in the department, including commercially available kit preparations.

4. Advise routine radiation safety measures during handling and administration of radioactive isotopes, and also calculate (wherever necessary) the radiation dose absorbed by the patients and their relatives during the course the investigations and therapy following ALARA principles.

5. Interpret the radiographic images and specialized investigations of an allied nature (e.g. angiography, endoscopy, histopathological specimens, etc.)

Tertiary Objectives:

The nuclear medicine physician should be able to

1. Setup nuclear medicine department either as an independent unit, or in hospitals and medical colleges.

2. Carry out and help in the conduct of research in nuclear medicine, communicate the results of such research at medical meetings and report in medical journals.

3. Guide research projects of students and critically evaluate the results of other

Apart from above, the postgraduate student has to develop human values, ethical practice and communication abilities:

1. Adopt ethical principles in all aspects of his medical practice.

2. Develop communication skills, in particular, various options available for management and to obtain a true informed consent from the patient or the attendant.

3. Provide leadership and get the best out of his team in a congenial working atmosphere.

4. Apply high moral and ethical standards while carrying out human or animal research.

5. Be humble and accept the limitation in his knowledge and skills to ask for help from colleagues when needed.

6. Respect patient's rights and privileges right to information and right to seek a second opinion.

3. Components of the Postgraduate curriculum

- **Theoretical knowledge:**

Basic sciences: Basic principles, mathematics, counting statistics and statistical methods relevant to nuclear medicine. Introduction to computers, basic of computer applications related to nuclear medicine, digital image acquisition, processing, archiving and retrieval of data.

Radiation physics: Introduction to nuclear physics, Radioactivity, Decay, Interaction of radiation with matter, units of measuring radioactivity, dosimetry.

Radiochemistry and radiopharmaceuticals: Production and properties of radio isotopes, mechanism and biological behavior radiopharmaceuticals and quality control.

Radiobiology and safety: Biological effects of radiation, diagnosis and therapeutic procedures, radiation protection, ICRP recommendations, managements of radiation accident, radioactive waste disposal and misadministration.

Instrumentations: Basics of electronic instruments, radiation measuring and detecting instruments, imaging and counting systems, Cross sectional Anatomy, SPECT – CT, PET – CT, PET – MRI, other contemporary imaging technologies and other in-vitro diagnostic instruments in Nuclear medicine.

- **Practical and Clinical skills**

Diagnostics procedure: Standard operating guidelines to be followed depending on the type of investigations

Therapeutic procedure: Full clinical work up is necessary with consultant opinion on co morbidities

Quality Control Procedures: Quality control procedures for diagnostic nuclear medicine equipment, radiopharmaceuticals and imaging and therapeutic protocols.

- **Writing thesis/research articles**

Each candidate should carry out a research program and has to submit a thesis, as per the Medical Council of India Guidelines and Regulations of this University before appearing in the final examination. Students are encouraged to attend CME's publish research papers and present posters or platform presentations at the state, national and international conferences.

- **Attitudes including communication skills**

Students should develop the art of eliciting the maximum information from the patient in a given time considering the sensory deficits of the patients and caregivers.

Communication skills can be learnt through observation and from formal communication skills training and workshops. Students have to develop patience and empathy in dealing with pediatric and geriatric- therapy and imaging patients. They have to learn and develop humane approach to patients.

- Training in research methodology, medical ethics/bioethics and medico legal aspects

Students should compulsorily attend the research Methodology workshop conducted by the University within first six months of the M.D course.

Students are encouraged to attend workshops/CME's on Bioethics conducted by the University and other reputed Institutions.

Medical ethics, bioethics, moral and legal issues, medical audit are part and parcel of the curriculum and syllabus in geriatric medicine.

The year-wise schedule of training would be as follows:

Year 1

(a) Scientific principles:

- Basic physics and mathematics,
- Instrumentation,
- Principles of computing,
- Basic radiation biology and radiation protection,
- Basic Radiopharmacy and radiochemistry,

(b) Principles of tracer technology Clinical Nuclear Medicine:

- Diagnostic: Normal and abnormal appearances of images, mode of pharmaceutical uptake; normal variants and common artifacts in bone, heart, lung, kidney, brain, thyroid, tumour and infection images.
- Therapeutic: Basic principles of radionuclide therapy; treatment of hyperthyroidism, thyroid cancer and metastatic bone pain.
- Principles of radiation protection: ALARA (as low as reasonably achievable) ALARP (as low as reasonably practicable).

Year 2

(a) Requirements of Year 1 in greater depth:

- Tracer kinetics;
- Computing and image processing;
- Radiobiology including the biological effects of high and low level radiation;
- Linear hypothesis and the threshold hypothesis of the biological response to low level radiation;
- The effective dose equivalent and the calculation of radiation dose from radiopharmaceuticals.

(b) Radiopharmacy:

- Properties of commonly used diagnostic and therapeutic radiopharmaceuticals;
- Production of radionuclides by reactors, cyclotrons and radionuclide generators;
- Quality assurance and quality control of radiopharmaceuticals.

Year 3

(a) Requirements of Year 2 in greater depth:

- Principles of radiology including ultrasound, computerized tomography and magnetic resonance imaging.
- Co-registration of nuclear medicine images and those from other imaging techniques.
- Diagnostic: special investigations in cardiology, lung disease, gastroenterology, hepato-biliary diseases, nephro-urology, neurology and psychiatry, endocrinology, haematology, oncology and infection.

(b) **Therapeutic applications:**

- Treatment of bone metastases, neural crest tumors, prostate malignancies, solid malignancies;
- Use of radionuclide monoclonal antibodies and radionuclide labeled peptides for tumor therapy.

(c) **Further practice and experience of work accomplished in years 1 to 3:**

- Legal and regulatory requirements,
- Audit,
- Departmental management,
- Research techniques and evaluation,
- Teaching and training.

1. THEORY SYLLABUS

I. Physics in Nuclear Medicine

a) Modes of Radioactive decay, with special emphasis to radionuclides commonly used in nuclear medicine

b) Emissions accompanying radioactive decay, and their biological implications.

c) Interactions of radiation with matter.

d) Basic physics of other imaging procedures including X-ray computed tomography, Nuclear magnetic resonance and ultrasonography.

e) Probability distribution and parametric and non-parametric statistics.

f) Compartmental analysis and mathematical models of physiological systems.

g) Computer applications with emphasis on digital image acquisition, analysis, processing and enhancement, tomographic reconstruction, display and recordings of findings.

2. Instrumentation

a) Principles of radiation detection and detectors.

b) Nuclear Medicine instrumentation including Gamma scintillation cameras, scanners, dose calibrators, tomographic imaging devices, positron imaging instruments, whole body counters, Gamma well counters, liquid scintillation counters, monitoring devices and Cyclotron.

c) Quality control of Nuclear Medicine instruments.

d) Collimation of radiation detectors, the characteristics of parallel hole and other types of collimators, their response to point, line and plane sources.

e) Electronic instruments, such as pulse amplifiers, pulse height analyzers, count rate meters and computer interfaces including gating systems.

f) Image production and display technology including photographic principles, with special emphasis on sensitivity, resolution, contrast latitude and film processing.

3. Radiation Biology & Protection

a) The biological effects of radiation exposure, with emphasis on the effects of low level exposure.

b) Administrative and technical means of preventing unnecessary radiation exposure to patients, personnel and environment.

c) Calculation of the radiation dose from internally administered radionuclides.

d) The diagnosis, evaluation and treatment of radiation overexposure in any form.

e) International recommendations and governmental regulations regarding limits of radiation exposure, handling of radioactive patients, transport of radioactive material and disposal of radioactive wastes.

f) Management of radiation accidents, including monitoring, decontamination and subsequent control.

4. Radiopharmaceuticals

a) The safe handling of radioactive material.

b) Production of radio-nuclides by reactors, cyclotrons, other particles accelerators and the use of radionuclide generators and labelled compounds.

c) Formulation of radiopharmaceuticals considering chemical properties and quality control with special emphasis on Tc-99m Chemistry.

d) Biochemistry, physiology and pharmacokinetics of radio-pharmaceuticals.

5. **In vivo diagnostic use of radio-nuclides**

a) General clinical indications and limitations in the appropriate usage of radionuclide procedures; normal and altered anatomy, biochemistry and metabolism of the various organs or processes to be examined; technical performance of the procedure, including proper patient preparation and patient management before, during and after the procedure.

b) The use of imaging devices, external detectors and computers for body organ imaging, and for time dependent and differential function studies.

c) The use of physiologic gating techniques for functional studies.

d) Patient monitoring during interventional tests such as exercise and pharmacological administrations and necessary management of any emergency situation.

e) Cellular kinetics, absorption and excretion analysis, nuclear haematology and metabolic balance studies using radiotracers.

f) Body composition tests, including compartmental analysis.

g) Whole body counting and total body scanning.

h) Relationship between Nuclear Medicine imaging modalities including available, established (gamma camera, SPECT.CT, PET.CT and PET.MRI) and newer emerging nuclear medicine functional imaging methods with other pertinent imaging modalities.

i) Quantification analysis methods using SPECT and PET imaging in in neurology, cardiology, oncology, hepatobilary and genitourinary systems

j) In vivo imaging and/or function studies in following organ systems

1. **Clinical Applications of Cardiovascular Nuclear Medicine**.

a) Radio-Pharmaceutical agents for cardiac imaging,

b) Computer aspects of myocardial imaging,

c) Functional Cardiac imaging,

d) Clinical application of myocardial perfusion imaging,

e) Radiopharmaceuticals for myocardial infract imaging,

f) MIBG imaging,

g) Positron emission Tomography of the Cardio-vascular system,

h) Peripheral Vascular Disease: Arterial &Venous.

2. **Clinical applications of endocrine nuclear medicine,**

a) The thyroid gland,

b) Scintigraphy Imaging of the Adrenals & neuro-ectodermal tumours,

c) Parathyroid scintigraphy,

d) Correlative endocrine Imaging.

3. Clinical Application of Gastrointestinal Nuclear Medicine.

a) Radio pharmacy aspects of gastrointestinal imaging salivary gland,

b) Oesophageal transit and reflux,

c) Gastric emptying scintigraphy,

d) Radio pharmacy for Liver & Spleen imaging,

e) Liver & Spleen Imaging,

f) Radiopharmaceuticals for hepatobilary imaging,

g) Evaluation of Gastrointestinal bleeding by nuclear medicine techniques,

h) Scintigraphy assessment of Peritoneo venous shunt function

4. Clinical Application of Genitourinary Nuclear Medicine

a) Radiopharmaceuticals for renal imaging,

b) Glomerulus Filtration,

c) The role of ACE inhibitor,

d) Renography in the diagnosis of Reno vascular hypertension,

e) Evaluation of renal transplants,

f) Paediatric Urology.

4. Clinical Application of Musculoskeletal Nuclear Medicine

a) Bone imaging – Radiopharmaceutical,
b) Skeletal scintigraphy in non-neoplastic osseous disorders.
c) Malignant bone disease,
d) Bone marrow scintigraphy,
e) Bone mineral analysis

5. Clinical Application of neurosurgical and neurologic Nuclear Medicine,

1. Radiopharmaceuticals for cerebral imaging cerebral perfusion imaging, Cerebrospinal fluid imaging,

2. The role of positron emission, Tomography in the investigation of neurologic disorders,

3. The role of positron emission, Tomography in the investigation of psychiatric disorders,

4. Correlative imaging in neurology and neurosurgery.

6. Clinical Application of Pulmonary Nuclear Medicine

a. Radiopharmaceuticals for pulmonary Imaging ventilation- perfusion scintigraphy

b. Pulmonary imaging for non-thromboembolic disease.

c. Clinical application of Oncologic Nuclear Medicine,

d. Non-FDG Tumor imaging lymphoscintigraphy in Oncology,

e. Positron Emission Tomography: Application in Oncology.

7. Immunologic and Oncologic Aspects of Nuclear Medicine.

a. New approaches to radio labelling monoclonal antibodies,

b. Tumour necrosis therapy for Cancer: New methods of Antibody Targeting,

c. Radiation Dosimetry of Radio Labelled monoclonal Antibodies: Practical considerations,

d. Over view of Imaging Procedures with Radio labelled monoclonal antibodies in cancer patients.

8. In vitro Studies

a) Principles of radio-isotopic micro analytical techniques, including Quality control and data analysis.

b) Radioimmunoassay (RIA) and Immuno radiometric assay (IRMA) – specific assays of thyroid hormones (T3, T4, TSH)- - principles, Procedures, data analysis and quality control methods

c) Binding capacity studies such as receptor assays and T-3 Resin uptake etc.

d) Principles of activation analysis and autoradiography.

e) Chromium-51 RBC studies - estimation of RBC mass and splenic Sequestration

f) Calculation of Glomerular Filtration Rate (GFR) by Tc-99m DTPA - one sample, two sample and multiple sample techniques, data analysis and quality control

g) Carbon-14 urea breath test for diagnosis of Helicobacter pylori infection and prognosis after treatment

h) Miscellaneous studies – RAIU, Denatured RBC studies for accessory spleen

10. Therapeutic Uses of Radionuclide

(a) Patient selection, including the diagnostic procedures necessary to establish the need for radionuclide therapy, indications and contraindications for the use of radionuclide therapeutic procedures and their efficiency in relation to other therapeutic approaches.

(b) Dose administration in patient management including dose to the target areas, to the surroundings tissues and/or other organ systems, and total body exposures; the range of doses in each specific application, the special problems of patient care caused by radionuclide therapeutic procedure, potential early and late adverse reactions, the timing and parameters of anticipated clinical response, and the follow up care and evaluation as needed.

(c) Specific applications: radio-iodine in hyperthyroidism and thyroid carcinoma; radio phosphorus (soluble) in polycythaemia Vera and other myelo proliferative disorders, colloidal radio phosphorus and radio-colloids for intra cavitary therapy of malignant effusions and treatment of chronic inflammatory joints (Radiosynovectomy); radiolabelled antibodies, radioisotope bone pain palliation, radionuclide therapy for neuroendocrine tumors.

(d) Radionuclide therapy using both established and newer radioisotopes in various conditions, their advantages and limitations in comparison to other available conventional modes of therapy.

11. Recent Advances in SPECT-CT, PET-CT & PET-MRI and their clinical applications

12. Recent Therapeutic Radiopharmaceuticals and Procedures.

13. Organizational Considerations

(a) Design of laboratories.

(b) Economic aspects of Nuclear Medicine and cost-effectiveness of Nuclear Medicine procedure.

(c) Public relations.

(d) Role of national and International Organizations.

PAPER-I Basic Sciences related to Nuclear Medicine

Radiation Physics and Instrumentation, (Structure of atom, Natural and artificial radioactivity.

Modes of Radioactive decay.

Interaction of radiation with matter.

Principles of radiation detection and detectors.

Basic principles of production of radionuclides by reactors and cyclotrons.

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. Counting Systems: Well counters, liquid scintillation counters, spectrometers, Radioactive Iodine Uptake (RAIU) probe and radiation Monitoring devices.

Quality control of Nuclear Instruments, Collimation of radiation detectors, Electronic instruments, such as pulse amplifiers, pulse height analyzer, count rate meters and computer interfaces including gating devices, Software and hardware fusion technology, Digital Imaging and

Communications in Medicine (DICOM) technology and Picture

Archiving and Communication System (PACS).)

Statistics and Computer Sciences, Radiation Biology (The biological effects of radiation exposure with emphasis on the effects of low level exposure. Methods of reducing unnecessary radiation exposure to patients, personnel and environment.

ICRP 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 and disposal of radioactive wastes.

The diagnosis, evaluation and treatment of radiation over exposure, any form.

PAPER-II Diagnostic Nuclear Medicine

Radiopharmaceuticals, (The chemical, physical and biological properties of radiopharmaceuticals used in

Nuclear Medicine investigations; production, Quality Control and Regulations of

hospital based-Nuclear Pharmacy) In vivo Diagnostic Imaging (Principles of Radioimmunoassay (RIA), quality control and data

analysis for various hormones and drugs assays.

Glomerular Filtration Rate (GFR) estimation, Red Cell Survival, Red

Cell Mass using chromium and C14 urea Breath test.)

PAPER –III Therapeutic Nuclear Medicine

Principles of Internal Dosimetry, Characteristics of Radionuclides/Radiopharmaceuticals for

radionuclide therapy, Radiation protection in therapeutic set up, Principles of OPD and in-door therapy administration, Therapy in thyroid disorders; benign thyroid diseases, etiology 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, various

national and international regulations pertaining to therapeutic

administration of radionuclides.

Bone pain palliation using various radionuclides, Radiosynovectomy,

Radio peptide therapy and Radio conjugate therapy,

Radio immunotherapy,

Loco regional internal radiation therapy,

Research agents in radionuclide therapy,

PAPER –IV Recent advances in Nuclear Medicine

Covering all aspects of the following areas:

4.1 Instrumentation

4.2 Radiopharmaceuticals

4.3 Diagnostic procedures

4.4 Therapeutic procedures

5. Teaching Learning methods

1. Didactic Lectures in Physics related in Nuclear Medicine, Radiopharmacy, Radioisotope, Techniques, instrumentation data processing and quality control.

2. Participation in the daily routine work of the department including work rounds of patient admitted for radionuclide therapy.

3. Presentation of cases in the reporting sessions of the department.

4. Active participation in the combined clinical meeting with other departments for case discussions.

6. Special Posting in Clinical Nuclear Medicine

Students will be in Parent department during first year and third year

Second Year :

a. Radio diagnosis	2 months
b. Cardiology	1 months
c. Neuro-Science	2 months
d. Nephrology & Urology	1 month
e. Endocrine Surgery	1month

f. Medical & Radiation Oncology - 2 months

h. General Medicine - 2 months

i. Paediatric Surgery - 1 month

During IInd year, the Students are encouraged to undergo special postings for learning new advanced techniques / procedure / skills in institutions of higher repute where the requisite facilities are available without affecting the duties of the parent department.

7. Evaluation of the candidates in both theory and practical aspects will help the candidate in improvement of his/her knowledge, skills and attitude.

8. COMPETENCY ASSESSMENT:

- **OVERALL:**

a) Communication / commitment / Contribution / () Compassion towards patients and Innovation () - 5 Marks
b) Implementation of newly learnt techniques/Skills ()

- Number of cases presented in Clinical Meetings/ Journal clubs/seminars - 5 marks
- Number of Posters/Papers presented in Conferences/ Publications and Research Projects - 5 marks
- No. of Medals / Certificates won in the conference / Quiz competitions and other academic meetings with details. - 5 marks

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Total 20 Marks

PG CLINICAL COURSES

VIVA including Competency Assessment - 80 Marks (60 + 20)

Log Book - 20 marks

ASSESSMENT SCHEDULE IS AS FOLLOWS

Year of study	**Period**				**Total Max.20 marks**
I year	Upto Dec	10 marks	Upto June	10 marks	20 Marks
II year	Upto Dec	10 marks	Upto June	10 marks	20 Marks
III year	Upto Oct	10 marks	Upto Feb	10 marks	20 Marks
	AVERAGE				**20 Marks**

9. DISSERTATION AND UNIVERSITY JOURNAL OF MEDICAL SCIENCES

As per the 49th SAB Resolution under Point No. 2 and in the 52nd SAB it was reiterated regarding the topic for dissertation

The topic for the dissertation should be registered and sent to the University after Ethics Committee approval before 31st of December of the first Post Graduate Year. Only one change of topic with proper justification from the Head of the Department is permitted before 31st March of the first Post Graduate Year. The change of dissertation title will not be permitted after 31st March of the First Post Graduate Year. This modification in regulation will be scrupulously followed from the academic year 2015-16 admission onwards.

As per MCI Clause 14 (4)(a), thesis shall be submitted at least 6 Months before the Theory and Clinical/Practical Examination.

A candidate shall be allowed to appear for the Theory and Practical/Clinical Examination only after the acceptance of the Thesis by the Examiners.

The periodical evaluation of dissertation/log book should be done by the guide / HOD once in every six months. The HOD should ensure about the submission of dissertation within the stipulated time.

Regarding submission of articles to the University Journal of Medical Sciences for all the PG Degree/Diploma courses, it is mandatory that the students have to submit at-least one research paper. Case Reports are not considered as Research Paper

10 THEORY EXAMINATION

PAPER-I Basic Sciences related to Nuclear Medicine

PAPER-II Diagnostic Nuclear Medicine

PAPER –III Therapeutic Nuclear Medicine

PAPER –IV Recent advances in Nuclear Medicine

Question Paper Pattern:

Paper I : Write notes on

1. Anatomy 4 x 5 = 20
2. Physiology 4 x 5 = 20
3. Biochemistry 3 x 5 = 15
4. Pharmacology 3 x 5 = 15
5. Pathology 3 x 5 = 15
6. Microbiology 3 x 5 = 15

Total = 100 marks

Paper II, III & IV

1. Elaborate on 2 x 15 = 30
2. Write Notes on 10 x 7 = 70

Total = 100 marks

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11. PRACTICAL EXAMINATION:

CLINICALS	
Long Case -1 (1 X 80 MARKS)	80 MARKS
Short Cases -2 (2 X 35 MARKS EACH)	70 MARKS
PRACTICAL (Physics / Radiopharmaceuticals Quality Control)	30 Marks
OSCE / SPOTTERS (10 x 2 marks)	20 Marks
Total	200 marks (A)
VIVA including Competency Assessment	80 marks (B)
LOG Book	20 marks (C)
Total (Clinical + Viva)	300 MARKS (A+B+C)
Minimum marks required for Pass (50%)	150 marks
Dissertation	Approved / Not Approved

12. LOG BOOK

Each candidate should be required to maintain a log book in which following details will be entered.

1. Investigations Performed

2. Cases Presented in

   a. Clinical meetings with other departments.
   b. Departmental seminars.
   c. Journal clubs along with Title & Journal Issue with title.
   d. Cases worked up for radionuclide therapy.
   e. Schedule of interdepartmental rotations.
   f. Details of hands – on trainings.

3. Conferences attended – National / International.
   Papers presented of conference with title name of the conference, date of presentation.

4. Paper published with title, name & issue of the journal.

The Post Graduates students shall maintain a record (Log) book of the work carried out by them and the training Programme undergone during the period of training.

Periodic review of Log book and Dissertation have to be done in the Department by guide/HOD once in every 6 months.

13. VIVA (including Competency Assessment) – 80 Marks (60 + 20)

An unstructured viva will be carried out by the examiners. VIVA including Competency Assessment for Clinical courses

14. OSCE Stations

OSCE /SPOTTERS stations include topics on radiopharmaceuticals, radiation safety aspects, nuclear medicine physics and the clinical/practical relevance of these aspects in nuclear medicine.

1. TLD badge: Questions: a) Identify b) the content of the material c) Principle of its function
2. Lead pot: Questions: a) Identify b) It usage in Nuclear Medicine c) HVT of lead for I-131
3. Transport index Symbol: Questions: a) Identify b) What is transport index c) Essential Details on tremcard (Transport Emergency Card)
4. MIBI cold kit: Questions: a) Its imaging uses b) Indications for myocardial perfusion imaging c) Other imaging uses of MIBI
5. Millipore filter: Questions: a) Identify b) its uses in Nuclear medicine c) Principle of its function
6. Survey meter: Questions: a) Identify b) its uses in Nuclear medicine c) Principle of its function
7. Interesting clinical image 1: Identify and interpretation
8. Lead Apron: a) Identify b) its uses in Nuclear medicine c) Principle of its function
9. Interesting clinical image 2: Identify and interpretation

Interesting clinical image 3: Identify and interpretation

ASSESSMENT

FORMATIVE ASSESSMENT, during the training programme

Formative assessment should be continual and should assess medical knowledge, patient care, procedural & academic skills, interpersonal skills, professionalism, self directed learning and ability to practice in the system.

General Principles

Internal Assessment should be frequent, cover all domains of learning and used to provide feedback to improve learning; it should also cover professionalism and communication skills. The Internal Assessment should be conducted in theory and practical/clinical examination.

15. REFERENCE BOOKS

1. Physics in Nuclear Medicine – Simon Cherry, James Sorenson & Michael Phelps.
2. Basic Medical Radiation Physics: Stanton.
3. Medical Radiation Physics – William R. Hendee.
4. Basics of Computers and Image hard copy production in Nuclear Medicine.
5. Computers in Nuclear Medicine- A Practical Approach -Kai. H.LEE.
6. Computer Fundamentals- concepts, systems & Applications – D.P.Nagpal.
7. Effective use of computers in Nuclear Medicine: Medical J.Gelf and Stephen R. Thomas.
8. Book for basic in Statistics by Sundar Rao and Richard
9. Practical Mathematics in Nuclear Medicine technology by Patricia Wells.
10. Text Book of Nuclear Medicine by John C. Harbert, Antonio Fernando Gonçalves Rocha, Vol. 1 & 2
11. Instrumentation in Nuclear Medicine – Gerald J. Hine.
12. Hand book of Nuclear Medicine – Frederick L. Datz.
13. Essentials of Nuclear Medicine Imaging – Fred A Mettler, Milton J Guiberteau.
14. Fundamentals of Nuclear Pharmacy – Gopal. B. Saha.
15. Modern Nuclear Chemistry – Waltor D Loveland, Davi Morrissey and Glenn.
16. Diagnostic Nuclear Medicine Martin P Sandler, Edward Colmann.
17. Recent advances in Nuclear Medicine John. H. Lawrence.
18. Radiation Biology and Physics Paul F Wilson and Joel S Bedford
19. Radiation safety in Nuclear Medicine – Max. H.Lombardi.
20. An introduction to Radiobiology – A.H.W.Nias

21. Biological assessment of Radiation Damage – Thomas. L, Walden.Jr and Nushin K
22. Radiobiology for the Radiologist –Eric J Hall, and Amato J Giaccia. PET: Physics,Instrumentation, and Scanners – Michael Phelps.
23. PET and PET-CT A clinical Guide –Eugence Lin and Abbas Alavi
24. Text Book of Nuclear Medicine – Henkins 22
25. Nuclear Medicine and PET/CT Technology and Techniques –Paul Christian and Kristin Waterstram.

**** Note : The editions are as applicable and the latest editions shall be the part of the syllabi.**

16. Journals:

1. Clinical Nuclear Medicine.
2. Seminars in Nuclear Medicine.
3. Journal of Nuclear Medicine.
4. Annals of Nuclear Medicine.
5. European journal of Nuclear Medicine and Molecular Imaging
6. Nuclear Medicine Communication.
7. Indian Journal of Nuclear Medicine.
8. International Journal of Nuclear Medicine and Biology
9. World Journal of Nuclear Medicine
10. PET Clinics
11. Nuclear Medicine
12. International Journal of Radiation Biology
13. Journal of Labeled Compounds and radiopharmaceuticals

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