Syllabus for PG Medical Course M.D. Nuclear Medicine.

Basics Sciences & Instrumentations of Nuclear Medicine:

Statistics (50 hrs)

Population-Sample -kinds of samples -statistical methods-types of measurements or data-frequency distribution-frequency polygon-histogram- Bar graphs- pie diagrams-centiles-Mean-Median-Mode-Standard Deviation- Coefficient of variation-percentage error-Normal or Gaussian distribution- Poisson distribution-Chisquare-standard error of mean-confidence limits- testing hypothesis-null hypothesis-variation & covariation-computer methods of analyzing medical data.-Counting Statistics-Nuclear counting statistics – Probability distribution, parametric and nonparametric statistics.

Mathematics (50 hrs)

Basic Mathematical concepts for Nuclear Medicine-Calculus- Derivatives or Differential- Differential equations- Integrals- laws of indices- limits- limit concept-continuity-evaluation using log tables- compartmental analysis- numbers- Function and Variables- index notation- Logarithms- logarithmic function-Graphs & Equations-exponential equations- Mathematic models of physiologic systems etc.

Computer Applications (50 hrs)

Computer Applications related to Nuclear Medicine- Introduction to computer-Characteristics of computers-Computer basics- Word processing- data base-analog images-digital image-image processing-picture, volume elements-gray scale & color scale-software-hardware-keyboard skills-hard ware description-software packages-Computer limitations-Storage devices. Basics on Nuclear Medicine image hard copies-Computer applications with emphasis on digital image acquisition, image analysis, processing and enhancement- tomographic reconstruction display and recording of findings-Fundamental Software processing- Applications and uses of fundamental filters. Components of Image quality-image sharpness-spatial relationships- optimum image viewing options.

2. Basic Physics & Nuclear Physics: (100 hrs)

Basics: Elementary introduction to structure of matter- elements-compounds and mixtures- molecules and atoms-Atomic & Nuclear structures-Atomic models-Periodic table-simple ideas of quantum mechanics- Mass energy equivalence-Fluorescence- Phosphorescence-luminescence-electromagnetic spectrum. Radioactivity & Interaction of Radiation: Radioactivity-Discovery-Natural & Artificial Radioactivity-Isotopes and nuclides-binding forces between nuclear particles-alpha & beta particles-gamma radiation-mechanisms of radioactive decay-half life –Interaction of electrons, X-ray & r-rays with matter- Radiation intensity & exposure- radiation dose- Radiation quality- law of exponential attenuation- half value layer- linear attenuation coefficient-Scattering- photo elective effect- Compton-scattering-pair production-particle interactions-

total attenuation coefficient-relative clinical importance. Basics on Electricity, Magnetism and Electro magnetic induction.

BOOKS FOR STUDY

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.

3. Nuclear Medicine Equipments / instrumentation & Techniques including recent advances in technology (120 hrs)

Electronic instruments – amplifiers – pulse height analyzer – count rate meters – computer interface – gating system –Principles of radiation detection – detectors – Scintillation Cameras –Scanners –Nuclear Reactors – Cyclotron – Radionuclide Generators – Isotope Calibrators – Well Counters - liquid scintillation counters – Whole body counters – Quality control of Nuclear Medicine Equipments –Collimation of detectors – Newer Computer applications in Nuclear Medicine – DICOM Technology – Medical Data Communications and Computer Networks. Physics of Nuclear Medicine Equipments and Instruments used – Collimators and collimation techniques - Techniques of all kinds of radionuclide scan procedures including in-vitro procedures.

Radiochemistry & Radiopharmacy (120 hrs)

Radiopharmaceuticals Production – Nuclear Reactors – Cyclotron – radionuclide Generators – Quality Control – chemical, physical & biological properties – criteria for selection – biological behaviour – mechanisms of localization – radiopharmaceuticals for diagnosis & treatment in humans – PET radiopharmaceuticals –Good manufacturing practices – laws related– RIA, IRMA radiopharmaceuticals and kits production.

BOOKS FOR STUDY

1. Instrumentation in Nuclear Medicine – Gerald J. Hine.
2. Hand book of Nuclear Medicine – Frederick L. Datz.
3. Essentials of Nuclear Medicine Imaging – Fred A Mettler, Milton J Guiberteau.

4. Fundamentals of Nuclear Pharmacy – Gopal. B. Saha.

5. Modern Nuclear Chemistry – Waltor D Loveland, David Morrissey and Glenn.

4. Clinical Nuclear Medicine including recent advances. (150 hrs)

Clinical indications for radionuclide procedures – limitations – patient preparation – In-vivo function studies of all organ systems Liver Scan – Hepatobiliary Study – Gallium Scan – Bone Scan (whole body and spot views) – Thyroid scan – Brain Scan – Lung Scan, Perfusion, Ventilation –Renal Studies, Renal image, Renal flow (GFR), Renogram. (ERPF) –Cardiac studies – In Vivo procedures – thyroid uptake and calculate data etc. – and all other radionuclide procedures in practice.

Recent advances in imaging techniques & image processing including fusion techniques – image guiding for radiotherapy & stereo tactic surgeries.

Recent advances in SPECT, PET including hybrid systems.

Recent advanced in radiopharmaceuticals – FDG – Sodium fluoride for bone imaging – Neuro & cardiac radiopharmaceuticals.

Therapeutic uses of Radionuclide (Patient selection, including the diagnostic procedures necessary to establish the need for radionuclide therapy- indications and contra-indications for the use of Radionuclide therapeutic procedures - their efficiency in relation to other Therapeutic approaches. Dose administration in patient management including dose to the target areas, to the surrounding tissues and or other organ systems and total-body exposure - the range of doses in each specific application - special problems of patient care caused by radionuclide therapeutic procedures - potential early and late adverse reactions, the timing and parameters of anticipated clinical response - followup care and evaluation as needed) – Thyrotoxicosis – Differentiated thyroid cancers – Receptor targeted therapy – 1311 MIBG Therapy – Palliation of painful osseous metastases: ^{32}p, ^{89}Sr & ^{153} Sm – Radiosynovectomy using Yttrium, Holmium – Targeted internal radiation in HCC:^{90} Y – Sirsphers;^{131} I – Lipidol.

Recent therapeutic radio-pharmaceuticals and procedures like Lutetium, Rhenium and Alpha emitters etc.

Special Posting in Clinical Nuclear Medicine

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

Radio Biology, Radiation safety Quality Assurance in Nuclear Medicine

(150 hrs)

Biological effects of Radiation – induction of Radiation injury – somatic and hereditary effects of radiation – effects of radiation on embryo - normal and abnormal human exposure to radiation – maximum permissible levels – Choice of Radiopharmaceutical for the clinical situation and the equipments in hand – Dosimetry – absorbed dose – calculation of absorbed dose – Dosimetry of individuals – absorbed dose from diagnostic

& therapeutic nuclear survey & monitoring – Quality assurance in Nuclear Medicine – Administrative and technical means of procuring radionuclides – Diagnosis, evaluation and treatment of radiation overexposure –ICRP recommendations – Management of radiation accidents – Radiation protection in different Nuclear isotope therapy procedures – protection of workers, patient relatives – Radiation effect on pregnancy and fertility – Role of National & International bodies.

Plan & Designing a Nuclear Medicine dept. of varying capacities.

Recommended Books :

1. Diagnostic Nuclear Medicine Martin P Sandler, Edward Colmann. Recent advances in

   Nuclear Medicine John. H. Lawrence.
2. Radiation Biology and Physics Paul F Wilson and Joel S Bedford Radiation safety in Nuclear Medicine – Max. H.Lombardi.
3. An introduction to Radiobiology – A.H.W.Nias.
4. Biological assessment of Radiation Damage – Thomas. L, Walden.Jr and Nushin K
5. Radiobiology for the Radiologist –Eric J Hall, and Amato J Giaccia. PET: Physics, Instrumentation, and Scanners – Michael Phelps.
6. PET and PET-CT A clinical Guide –Eugence Lin and Abbas Alavi
7. Text Book of Nuclear Medicine - Henkins
8. Nuclear Medicine and PET/CT Technology and Techniques –Paul Christian and Kristin Waterstram.

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.

Thesis

Every candidate shall carry out work on an assigned research project under the guidance of a recognised Post Graduate Teacher, the result of which shall be written up and submitted in the form of a Thesis. Work for writing the Thesis is aimed at contributing to the development of a spirit of enquiry, besides exposing the candidate to the techniques of research, critical analysis, acquaintance with the latest advances in medical science and the manner of identifying and consulting available literature. Thesis shall be submitted at least six months before the Theory and Clinical / Practical examination

EXAMINATION SCHEDULE THIRD YEAR

	THEORY
PAPER-I	Basics Sciences & Instrumentations of Nuclear
PAPER-II	Clinical Nuclear Medicine including Radiopharmaceuticals and their Applications.
PAPER-III	Recent advances in Nuclear Medicine - Instrumentation, Radiopharmacy and Clinical Applications
PAPER-IV	Radiation Biology, Radiation safety & Quality Assurance in Nuclear Medicine.

MD NUCLEAR MEDICINE:

CLINICALS	
Long Case -1 **(1 X 80 MARKS)**	**80 MARKS**
Short Cases -2 **(2 X 35 MARKS EACH)**	**70 MARKS**
OSPE / SPOTTERS	50 marks
Total	200 marks (A)
VIVA - VOCE	60 marks (B)
LOG Book	40 marks (C)
Total (Clinical + Viva)	300 MARKS (A+B+C)
Minimum marks required for Pass (50%)	150 marks

Dissertation	Approved / Not Approved

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.
3. Cases worked up for radionuclide therapy.
4. Schedule of interdepartmental rotations.
5. Details of apprenticeship.
6. Conferences attended – National / International.
    a. Papers presented of conference with title name of the conference, date of presentation.
7. Paper published with title, name & issue of the journal.

Mid Term Evaluation

Each candidate shall have mid term evaluation in terms of Case presentation session.

1. Scan Interpretation session.
2. Oral Viva.
3. Evaluation of the Log book.
4. Presentation of work completed in Thesis.

Pre examination Evaluation

Examination appearing students shall be evaluated by the faculty and observe for following:

1. Case presentation
2. Scan Interpretation
3. Oral Viva
4. Summary of results of thesis experiments

Training Programme

1. Didactic Lecture in Physics related in Nuclear Medicine, Radiopharmacty, 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.