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

I st Year

1. Statistics (50 hrs)

Population-Sample -kinds of samples -stastical 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.

2. 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.

3. 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 Soft ware processing-Filters and their applications-Components of Image quality-image sharpness-spatial relationships-optimum image viewing options.

[Internal examinations on these three supportive subjects should be conducted by the institute by 6 months of starting the course and marks to be submitted to the University]

4. Basic Sciences-Human Anatomy, physiology, Biochemistry and Pathology and Medicine & Surgery **(50 hrs each)**

5. 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.

EXAMINATION SCHEDULES
FIRST YEAR

	THEORY	PRACTICALS & VIVA
PAPER-I	Section –A Basic Sciences Section –B Medicine & Surgery	Diseases oriented Clinics & Viva
PAPER-II	Basic Physics & Nuclear Physics	Practicals & Viva

Note: For the supportive subjects – Statistics, Mathematics & Computer applications in Nuclear Medicine internal tests to be conducted by the institute conducting the course at first 6 months during I st year and marks should be submitted to the University.

MARK SHEDULE

SCHEME OF EXAMINATION
FIRST YEAR
(270 WORKING DAYS)

Theory Subject Title	University Theory Exam		Practical Subject Title	Practical Marks		VIVA		IA	
	Max	Min		Max	Min	Max	Min	Max	Min
PAPER-I **Section-A** Basic Science **Section-B** Medicine & Surgery	100	50	Systemic Disease oriented Clinics & Viva	100	50	50	25	50	25
PAPER_II Basic Physics & Nuclear Physics	100	50	Experiments Charts, Models, & Graphs Demo	100	50	50	25	50	25

Internal Assessment	Marks
Theory	20
Practical	20
Log / Record work	10
Total	**50**

Theory 100 Marks
Practical 100 Marks
Viva 50 Marks
IA 50 Marks

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.

Books to be added for-

Statistics
Mathematics
Anatomy
Physiology
Biochemistry
Pathology
Medicine
Surgery

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Syllabus for Medical Postgraduate Degree Course – M.D. in Nuclear Medicine

II nd Year

6. Physics of Nuclear Medicine instrumentation & Nuclear Medicine Techniques (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.

Techniques of all kinds of radionuclide scan procedures including in-vitro procedures.

7. Radiochemistry & Radio pharmacy (120 hrs)

Radiopharmaceutical 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 radionuclides – Good manufacturing practices – laws related – RIA radiopharmaceuticals and kits production.

EXAMINATION SCHEDULES

SECOND YEAR

	THEORY	**PRACTICALS & VIVA**
PAPER-I	Physics of Nuclear Medicine instrumentation & Nuclear Medicine Techniques	Identification of Equipments, parts
PAPER-II	Radiochemistry & Radio pharmacy	Radiopharmaceutical preparation / Formulae.

MARK SHEDULE

SCHEME OF EXAMINATION
SECOND YEAR

(270 WORKING DAYS)

Theory Subject Title	**University Theory Exam**		**Practical Subject Title**	**Practical Marks**		**VIVA**		**IA**	
	Max	Min		Max	Min	Max	Min	Max	min
Physics of Nuclear Medicine instrumentation & Nuclear Medicine Techniques	100	50	Identification of Equipments, parts	100	50	50	25	50	25
Radiochemistry &			Radiopharmaceutical Preparation						

Radio pharmacy	100	50	formulae.	100	50	50	25	50	25

Theory 100 Marks
Practical 100 Marks
Viva 50 Marks
IA 50 Marks

Internal Assessment	**Marks**
Theory	20
Practical	20
Log / Record work	10
Total	**50**

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.

Syllabus for Medical Postgraduate Degree Course – M.D. in Nuclear Medicine.

IIIrd Year

8. 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), Reno gram

(ERPF) –Cardiac studies – In Vivo procedures – thyroid uptake and calculate data etc. – all other radionuclide scans.

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 and 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; the special problems of patient care caused by radionuclide therapeutic procedures, potential early and late adverse reactions, the timing and parameters of anticipated clinical response, and the follow-up 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 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.

9. 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.

EXAMINATION SCHEDULES

THIRD YEAR

	THEORY
PAPER-I	Clinical Nuclear Medicine including recent advances.
PAPER-II	Radiation Biology, Radiation safety & Quality Assurance in Nuclear Medicine.

PRACTICALS & VIVA
Clinics with NM Procedures Demo- Short & Long Cases presentation- Scan reading sessions.
Planning & Radiation Survey- Demo

MARK SHEDULE

SCHEME OF EXAMINATION
THIRD YEAR
(270 WORKING DAYS)

Theory Subject Title	**University Theory Exam**		**Practical Subject Title**	**Practical Marks**		**VIVA**		**IA**	
	Max	Min		Max	Min	Max	Min	Max	Min
Clinical Nuclear Medicine including recent advances in Nuclear Medicine.	100	50	NM Procedures – Demo & Scan reading Session	100	50	50	25	50	25

Radiobiology, Radiation safety & Quality Assurance in Nuclear Medicine	100	50	Planning & Radiation Survey - Demo	100	50	50	25	50	25

Thesis: Thesis should be started in 6 months of joining the course, completed & approved before appearing for 3rd Year examination like in all other M.D degree courses.

Theory 100 Marks
Practical 100 Marks
Viva 50 Marks
IA 50 Marks

Internal Assessment	Marks
Theory	20
Practical	20
Log / Record work	10
Total	**50**

BOOKS FOR STUDY

Text Books:

Diagnostic Nuclear Medicine Martin P Sandler, Edward Colmann.
Recent advances in Nuclear Medicine John. H. Lawrence.
Radiation Biology and Physics Paul F Wilson and Joel S Bedford
Radiation safety in Nuclear Medicine – Max. H.Lombardi.
An introduction to Radiobiology – A.H.W.Nias.
Biological assessment of Radiation Damage – Thomas. L, Walden.Jr and Nushin K
Radiobiology for the Radiologist –Eric J Hall, and Amato J Giaccia.
PET: Physics, Instrumentation, and Scanners – Michael Phelps.
PET and PET-CT A clinical Guide –Eugence Lin and Abbas Alavi

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.

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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 candidates shall have mid term evaluation in terms of

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

Pre examination Evaluation

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

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

Thesis

Each candidate has to submit a thesis with one Chief guide & Co-guide. Which should be accepted by the board of Examiners before appearing in the final examination. The protocol should be submitted 6 months of admission & presented to entire faculty.

Thesis Evaluation

The thesis should reflect substantial work for the advancement of scientific knowledge, design or development or applied work. It should show competence in critical analysis of scientific data as well as through familiarity with back ground literature.

1. The evaluation of the thesis will consist of;
   a. Evaluation by 2 external examiners.
   b. Oral examination of the candidate on the thesis during the viva for final examination.

2. In his / her report, each examiner should highlight the salient features of the thesis and make a clear recommendation regarding its acceptance Or rejection for MD Degree. It one of the examiners gives a definite recommendation against the award of the degree, reference to a third examiner will be made. If the report from the third examiner is positive, the oral examination will be held. If his / her report is negative, the thesis will be rejected.

3. If two examiners recommend against the award of the degree, the thesis will be rejected.

Report of Examiners

1. Each examiner will be requested to send his report within 2 months of the receipt of the thesis to the registrar. The reports must contain a critical evaluation of the thesis and a clear recommendation as to whether it has attained the standard of MD or not.
2. In case the examiners are unable to make a definite recommendation they should indicate one of the following alternatives;
    a. Minor revision, which does not involve retyping or binding of the thesis.
    b. Major revision involving rewriting of one or more sections but not involving additional research.
    c. Rewriting the thesis; If the candidate's work justifies another opportunity being given to him to do further research & rewriting the thesis (this will be treated as a new examination).

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.

Apprenticeship

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

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