M.Sc. NUCLEAR MEDICINE TECHNOLOGY
SYLLABUS

First Year Subjects

Paper :1: Principles of Epidemiology, Research Methodology, Biostatistics and Medical Ethics :-

UNIT I: EPIDEMIOLOGY

Introduction: Historical aspects and evolution of epidemiology, definitions and concepts in Epidemiology.

Natural history of disease. Approaches in Epidemiology. Descriptive and Analytical Epidemiology, Disease burden and Measures of risk and death. Epidemiological Investigations.

UNIT-II – RESEARCH METHODOLOGY

Principles of Research study designs, Sampling Methods, Sample size Estimation, Protocol writing and Measures of Association.
Introduction to Operations Research.

UNIT III: BIOSTATISTICS

Fundamentals of Biostatistics: Introduction, Types of data, Tabular and graphical presentation of data. Measures of location, dispersion and correlation: Measures of central tendency. Mean, mode, median, GM, HM, quartiles Measures of dispersion— Range, Standard Deviation, Variance, Coefficient of Variation.

Probability and statistical inference: Concept and probability distribution. Normal distribution — density curves, applications and statistical tables. Concept of significance tests, parametric and nonparametric tests, standard error and confidence intervals.

Inferential statistics: Probability and distributions – Poisson, Binomial and Normal distribution – Chi-square test – Hypothesis test - Student's t-test – Correlation and Regression – ANOVA.

UNIT IV: MEDICAL ETHICS

Bioethics and Medical ethics: Historical perspectives & Introduction to Bioethics, Nuremberg Code, Declaration of Helsinki, Principle of essentiality, informed consent, confidentiality, minimisation of risk, accountability and responsibility. Ethics of clinical trials: Drug trials, vaccine trials, Clinical Trials with medical devices/surgical procedures/radioactive materials, Research in transplantation and stem cell therapy. Regulatory framework and guidelines for conduction of human research: Review processes, Institutional ethical committees, composition of committees, review procedures, WHO, UNESCO and ICMR guidelines.

References :

1. Epidemiology: An Introduction. Kenneth J. J. Rothman. Latest edition / Pub. Date: May 2002. Publisher: Oxford University Press.
2. Epidemiology. Leon Gordis. Latest edition / Pub. Date: November 2004. Publisher: Elsevier Health Sciences.
3. Diseases and Human Evolution. Ethne Barnes. Latest edition / Latest edition / Pub. Date: March 2005. Publisher: University of New Mexico Press.
4. Epidemiology: Beyond the Basics. F. Javier Nieto, Moyses Szklo. Latest edition / Pub. Date: November 2003. Publisher: Jones & Bartlett Publishers, Inc.
5. Basic and Clinical Biostatistics. Beth Dawson, Robert G. Trapp, Robert Trapp. Latest edition / Pub. Date: March 2004.
6. Discovering Statistics Using SPSS. Andy Field. Latest edition / Pub. Date: April 2005. Publisher: SAGE Publications.

7. Arora PN & Malhon PK (1996). Biostatistics Imalaya Publishing House, Mumbai.
8. Sokal & Rohif (1973). Introduction to Biostatistics, Toppan Co. Japan.
9. Stanton A & Clantz, Primer of Biostatistics — The McGraw Hill Inc., New York.
10. Government of India. Good Clinical Practices for Clinical Research in India. New Delhi: 2001
11. Indian Council of Medical Research. Ethical Guidelines for Biomedical Research on Human Subjects. New Delhi: 2000
12. United Nations Educational, Scientific and Cultural Organisation UNESCO). Universal Declaration on Bioethics and Human Rights. Paris; 2005

Paper II

1. Anatomy

Musculo-skeletal system, Cardiovascular system, Respiratory system, Genitourinary system, Cerebro-vascular system, Alimentary system, Renal system, Central nervous system, Endocrinesystems.

2. Physiology

Blood, Lymphatic channels, Digestive system, Cardiovascular system,Central Nervous system,Respiratory system, Endocrine system

3. Biochemistry

Introduction to Biochemistry – Carbohydrates, Proteins, Enzymes, Lipids, Hormones and Vitamins, Nucleic acids.

Introduction to Immunology- humoral immune response, cell-mediated immune response, antigen-antibody interaction, monoclonal antibodies. Basic molecular biology

Paper III

1. Computers

Basic aspects of computer structure and function, Applications of computer in nuclear medicine (Acquisition – static/dynamic/list mode/frame mode, processing the data and image processing), gamma camera – computer interface card and performance characteristics, uniformity correction circuits, LAN/WAN, Hub/switches, networking software, Internet browsers.

Personal computer-principals and application software for word processing, database, excel, power point and operating systems (DOS, UNIX). Introduction to computer programming in BASIC, C- Language, etc.

Internet in nuclear medicine : FTP, TCP/IP protocols, DICOM and interfile conversion
software.

2. Fundamentals of Electricity & Electronics

Circuit components – resistors, capacitors, inductors, transformers, Ohm's law, Circuit element –R, CR, LCR and LC networks

Basic Circuits- pulse amplifiers & pulse shaping oscillators, regulated power supply, SMPS power supply, RF power supplies, rectifiers, regulators, filter circuits, PM tubes, pre- amplifiers, pulse height analysers, SCA, MCA, coincidence & anti coincidence circuits, equivalent circuits.

Semiconductors: Conduction in crystals, energy band. Intrinsic and extrinsic semiconductors, n-type and p-type semiconductors, majority and minority carriers. p-n junction- properties forward and reversed bias, characteristics of p-n junction rectifiers- half wave and full wave, ripple factor, efficiency of Half wave and full wave rectifiers, filtercircuits, Zener diodes.

Digital electronics – Boolean algebra, Gates, number systems, ADC/DAC, CRT. Transistor oscillators, Transistor as a switch - multivibrator–Monostable and Bistable multivibrators.

Special devices-SCR, Diac- Triac, Unijunction transistor (UJT), Field effect transistor (FET), Metal oxide field effect transistor (Mosfet). Simple ideas on operational amplifier.

Advance topics: Euclid's equation, Fourier Transforms, Modulation Transfer Function, Laplace transform, Sievert's integral, Numerical methods of integration, Digital filters.

Paper IV

1. Mathematics

Functions and limits, Differentiation, Rules of differentiation, sum, difference, product and quotient formulae, function of a function rule, Differentiation of inverse trigonometric functions, parametric functions, Implicit functions, Logarithmic differentiation, Higher order derivatives and Partial differential integration, Methods of integration, Integration by substitution, Integration by parts, Definite integral and its properties. Differentialequations, compartment analysis.

Vectors: Definition, Product of vectors, scalar and vector products, vector differentiation, Gradient, Divergence and curl.

Matrices system and Applications

Complex numbers: Definition, Modulus, Amplitude & properties, De Moivre's theorem, Extraction of roots of a complex number.

2. Statistics

Probability – definition & laws; statistical models distribution – normal, binomial & Poisson,Measure of central tendency – mean, mode, median and standard deviation; Error of distribution – confidence limits test of significance, Z-Test, students-t test, F-

Test, chi-square, concept of correlation, regression line, curve fitting and least square fit, Analysisof variance.

Counting statistics – error propagation, limits of detectability, distribution of counting time,standard error, accuracy, figure of merit.

Specificity, sensitivity, accuracy and ROC

Paper V

1. **Radiation Physics**

Basics of Atom, Radioactivity,Radioactive decay,Basics and operation of nuclear reactorand cyclotron. Interactions of radiation with matter and their importance in nuclear medicine.

Radiation detection and measurement :-

Gas filled detectors,Scintillation detectors,. General systems for the scintillation detector. Liquid Scintillation detectors. Semi conductor detectors

2. **Radiation Chemistry**

Atomic and molecular structure- bonding (electrovalent, covalent and *dative* bonds), valency,Atomic weight, molecular weight, solutions-normality, molarity of solution, acids and bases, hydrogen ion concentration, pH value, chemical reactions, solute, solvents, solubility, crystallisation, concept of chromatography and Rf.

Paper VI

Radiation Biology

General Biology, physiology, interaction of radiation with cells, mechanism of damage, nature of damage, factors modifying the damage, deterministic and stochastic effects of radiation, cancer risk estimation, damage to individual organs, prenatal effects of radiation, radiation protection standards.

Paper VII

Nuclear Medicine Instrumentation

Gamma ray spectrometer,Probe systems ,Nuclear gamma probe system with clinical applications,Rectilinear scanner,Focussed collimators- iso-response curve, focal length, depth of focus, effect of size and number of holes on response, septa thickness, resolution and sensitivity, line source response and MTF,Whole body counters – profile scanning and clinical applications

Paper VIII

. **Radiopharmacy - Part I**

Production of radioisotopes - reactor produced, cyclotron produced, Radionuclide generators. Radionuclide generator system: ^{99}Mo-^{99m}Tc generator – solvent extraction, column generator, gel type generator; ^{188}W-^{188}Re, ^{113}Sn-^{113m}In, ^{68}Ge-^{68}Ga; Ultra short-lived radionuclide generators: ^{82}Sr-^{82}Rb, ^{81}Rb-^{81m}Kr; Parent-daughter equilibrium.

Physical and chemical characteristics of radionuclides used in nuclear medicine, Criteriafor selection of the radionuclides for diagnosis and therapy.

Chemistry of ^{99m}Tc, labelling of commonly used cold kits- DTPA, GHA, DMSA, MAG3, MDP, phytates, ECD, EC, IDA compounds and S-colloid .Formulation of radiopharmaceuticals

PET Radiopharmacy and Radiochemistry, Synthesis modules to produce ^{18}FDG, $^{11}CO_2$, $^{13}NH_3$

and $H_2{}^{15}O$

Paper XI

Clinical Nuclear Medicine Techniques – Part I

Haematology studies- red-cell mass estimation, RBC survival and sequestration studies,^{51}Cr gastrointestinal blood pool loss study, plasma volume estimation using ^{125}I-HAS and Ferrokinetic studies.

^{67}Ga imaging, Lacrimal scintigraphic imaging, gastrointestinal protein loss estimation using ^{51}Cr-chromic chloride, Lymphatic imaging, adrenal imaging using ^{131}I-MIBG, Vitamin B_{12} absorption study and Schilling Test, etc.

Diagnostic - In-vitro Techniques:

Principles of RIA, standard curve, data analysis, QC and applications. Methods ofreceptor assays, hormones, drugs, IRMA, ELISA. RIA estimation – T3, T4, TSH and thyroid antibodies, etc.

Practical / demonstrations:

1.	Counting statistics.
2.	Gamma ray spectrometry (EHT, gain, discriminator, etc.)
3.	Gamma ray spectrometry- calibration, spectrum, energy resolution, linearity.
4.	Spectrum of mixture of two isotopes and scatter fraction
5.	Identification of unknown radionuclides.
6.	Liquid scintillation counting.
7.	Autoradiography
8.	Radiation exposure: effect of distance, time &shielding
9.	Photographic development.
10.	Dispensing of low dose from bulk supply
11.	Calibration of pocket dosimeter and survey meter
12.	Study of energy dependence of a pocket dosimeter and a survey meter.
13.	Thermal neutron attenuation in graphite, concrete and iron using a BF_3 counter.
14	Characteristics of different radiation.
15	Absorption and back-scatter of radiation.
16.	Plateau of G.M. Counter.
17	Dead time and resolving time of G.M. counter.
18	Half value layer of γ emitters and range of β emitters
19	Half life of radioisotopes
20	Resolution of half-lives from a mixture of radionuclides.
21	Daughter- parent relationship of radioactive decay and radionuclides.
22	Efficiency of counting system.

* **IGCAR, Kalpakkam – 2 days field visit.**

* **Practical (One day) – Common covering all Subjects**

Second Year Subjects

Paper I

Nuclear Medicine Instrumentation- Part II

Gamma Camera: Basic principles of gamma camera, collimators - parallel hole, divergent, pinhole, fan beam, slant hole collimator. Gamma camera-computer interface- ADC/DAC. Criteria of installation of Gamma camera. Selection of gamma camera – specifications and other aspects.

SPECT: image reconstruction techniques, filters, artefacts in SPECT (attenuation correction, non-uniformity corrections, correction with combined SPECT-CT system), effect of scatter & scatter correction, partial volume effects, multi detector SPECT, coincidence, SPECT acquisition – step & shoot/continuous. SPECT v/s planar camera, SPECT v/s other modalities (CT, MRI, Ultrasonography}

PET: Historical developmental of Functional In Vivo Studies Using Positron, Physics and instrumentation in PET, Data acquisition and Performance Characterization in PET, Image reconstruction Algorithm in PET, Quantitative techniques in PET, Tracer Kinetic Modeling in PET, Co-registration of Structural and Functional images, Radiation Dosimetry and Protection in PET

Medical Cyclotron: Working principles of Cyclotron-Types of Cyclotron-Cyclotron generated radionuclides-Cyclotron layout & Approval-Shielding-Quality Control Procedures- production of 18F,11C,13N,$_{15}$O.

Paper II

Clinical Nuclear Medicine Techniques - Part II

Renal imaging studies-diuretic renogram, Captopril renogram, standard renogram, uretic reflux study, renal transplant studies, static renal study.

Bone imaging: Routine bone (whole body and spot) imaging, bone flow study, quantitative bone scan-sacroiliac quantitative study, 3-phase bone scans.

Liver-spleen study, bone marrow imaging, spleen imaging with denatured RBC’s

Gastrointestinal study- Hepatobiliary imaging, pancreas imaging, gastric oesophageal reflux, gastric emptying time, biliary reflux, Meckel's diverticulum imaging, GI bleeding with ^{99m}Tc- RBC, Salivary gland imaging (static/dynamic), Gall bladder dynamic, dynamic studies using IDA compounds.

Lung imaging studies – ventilation lung imaging studies using gases (^{133}Xe, ^{81m}Kr),Inhalation imaging using aerosols, aerosols generators, mucociliary clearance, COPD, Pulmonary permeability using DTPA, perfusion imaging (MAA, Microsphere) –pulmonaryembolism.

Cardiac studies- static blood pool imaging, Rest/stress myocardial imaging, infarct imaging, MUGA, gated blood pool study, first pass study (shunt detection), placental imaging

Central nervous study- cerebral blood flow dynamic studies, static brain imaging, cisternography and ventriculoatrial and ventriculoperitoneal shunts. Use of ^{201}Tl, ^{18}FDG and NH_3 for cardiac studies.

Endocrine studies- thyroid imaging and uptake (^{99m}Tc and ^{131}I), Perchlorate dischargetest, T_3/T_4 suppression test, TSH stimulation test. ^{131}I whole-body imaging, parathyroid imaging, adrenal cortex imaging, ^{131}I-MIBG imaging, testicular imaging.

Paper III

Therapeutic Nuclear Medicine Procedures

Choice of radionuclide- ^{131}I, ^{32}P, ^{90}Sr, ^{153}Sm, ^{186}Re, ^{90}Y etc.

Choice of radiopharmaceuticals, therapy procedures, hyperthyroidism, thyroid carcinoma, neural crest tumours, painful bone metastasis, polycythemia Vera, rheumatoid arthritis, osteoarthritis.

Pre and post therapy imaging and patient preparation

Paper IV

Quality Control (QC) of Nuclear Medicine equipment

QC of Dose calibrator, gamma ray spectrometer, rectilinear scanner, planar gamma camera SPECT, coincidence Camera and PET. Phantoms for QC, software phantoms, Internet based QC.

Film processing and film characteristics – ASA, fog density, lattices, slope, etc. Dark room quality control.

Paper V

Radiopharmacy-Part II

QC of kits – radiochemical purity, sterility checks, chromatography, pyrogen test, bio- distribution studies, ^{99}Mo break through test.

Quality control of PET radiopharmaceuticals by TLC scanner,HPLC and Gas Chromatography.

QC in hospital radiopharmacy practices - includes aseptic practices & pharmaceutical safety aspects. Good manufacturing practice (GMP), ISO and ISI standards in radiopharmaceuticals.

Mechanism of localisation of radiopharmaceutical in different organs, recent trends in radiopharmaceuticals, iodination and technique of iodination. Various receptor imaging, ligands and labelling of molecules. Regulations, ethics and registration of radiopharmaceuticals.

Paper VI

Health Physics and Radiation Protection

Radiation Protection Instruments,Radiation dosimetry,Radiation protection in nuclear medicine,Radiation quantities and units, Radiation hazards– evaluation and control; basic principles and operational limits; , Basic safety standards, Planning of nuclear medicinelaboratories; radiation monitoring, decontamination procedures; radiation protection in diagnostic and therapeutic nuclear medicine- protection of the patient. Guidance level fordiagnostic administration, misadministration and preventive measures.

Protection of staff, public and environment, radiation surveillance procedures.
Radioactive waste management:,Transport of radioactive material:
Radiation emergencies, preparedness and record keeping:

Large-scale spillage, leakage of radioactivity substance in environment, accidentalinhalation, death of a patient with radioactivity , Regulatory aspects & licensing

The Atomic Energy Act, Surveillance procedures issued under the Rules, Notifications issued under RPR, 1971, AERB Safety Directive, Safety code for NM facility, Duties of Medical physicist/ technologists/ radiopharmacists, RSO, Regulatory clearance-Approvalof NM Lab, Ethics, registration of radiopharmaceuticals and their use

Patient Care and Hospital practice

Behavioural science (Care of the patient): Management of ambulatory and non-ambulatory patients and aids for this, elementary hygiene and cleanliness, nursing care, first aid, principles of asepsis- handling of contaminated swabs, used syringes and needles, handling of secretions, sterilization methods, preparation of patients for general nuclear medicine procedures, precautions-administration of radiopharmaceutical to children, nursing and care taking mothers and pregnant women.

Practical / demonstrations

1. Isoresponse curve of different collimators.
2. Line spread function of collimators
3. Phantom studies for scintigraphy
4. In-vitro radiospirometry.
5. Radiation survey of nuclear medicine lab
6. Contamination levels and methods of decontamination
7. Radiopharmacy procedure, elution of generators, preparation

   of different radiopharmaceuticals.

8. Grey scale calibration (calibration of a photo scanner).

9. Organ Imaging

10. Profile scanning (whole body counter)

11. Analog studies with single or multiple probes.

12. Dilution principle (blood volume).

13 In-vitro sample measurement of various types.

14 Flow measurements

15 Renogram

16 Thyroid uptake unit and collimator response

17 Radioimmunoassays of various types

18 Formulation ^{99m}Tc compounds from kits

19 Determination of ^{99}Mo breakthrough in ^{99m}Tc

20 Q.C of Dose Calibrator

21 Q.C of Gamma Camera

22 Q.C of SPECT

23 QC of radiopharmaceuticals by paper chromatography.

24. QC of PET radiopharmaceuticals by TLC scanner, HPLC & Gas chromatography

25 Rapid determination of radiochemical purity of radiopharmaceuticals.

26 Animal biodistribution –unknown radiopharmaceutical.

27 Pre and post ^{131}I-therapy imaging and patient preparation

*** Practical (One day) – Whole Body PET Scan & Question related to all system.**

*** Two weeks in house participation Training in Medical Cyclotron.**

*** Inclusion of MRI posting for to 4 weeks.**

Project :

At the beginning of the 2nd year, the candidates will be allotted a Project by the Guide, which has to be submitted to the University by the candidate two months before the Final Examination for approval.

Log book has to be maintained by each candidate, which includes, investigations performed, Journal club, Seminars conducted, conferences if attended, etc.

SCHEME OF EXAMINATION:

First year

S.NO	SUBJECT TITLE	IA		THEORY	
		Max.	Min.	Max.	Min.
1	Principles of Epidemiology, Research Methodology, Biostatistic and Medical Ethics	50	25	100	50
2.	Anatomy, Physiology and Biochemistry	50	25	100	50
3	Computers, Fundamentals of Electricity and Electronics	50	25	100	50
4	Mathematics & Statistics	50	25	100	50
5	Radiation Physics & Radiation Chemistry	50	25	100	50
6	Radiation Biology	50	25	100	50
7	Nuclear Medicine Instrumentation – I	50	25	100	50
8	Radiopharmacy – I	50	25	100	50
9	Clinical Nuclear Medicine Techniques I	50	25	100	50

I. SCHEME OF PRATICAL EXAMINATIONS FOR FIRST YEAR M.Sc.,NUCLEAR MEDICINE TECHNOLOGY

Major experiments	- 1 x 30 marks	= 30 marks
Minor experiments	- 2 x 20 marks	= 40 marks
Spotters	- 5 x 2 marks	= 10 marks
Viva		= 20marks

	Total	= 100 Marks

Passing minimum = 50 Marks

List of Major Experiments

1) Dead time and resolving time of G.M Counter
2) Half value layer of y emitters and range of b emitters
3) Resolution of half-lives from a mixture of radionuclides
4) Efficiency of counting system
5) Gamma ray spectrometry -calibration, spectrum, energy resolution, linearity
6) Study and calibration of energy dependence of a pocket dosimeter and survey meter.

List of Minor Experiments:

1. Spectrum of mixture of two isotopes and scatter fraction.
2. Radiation exposure: effect of distance, time & shielding.
3. Identification of unknown radionuclides.
4. Characteristics of different radiation.
5. Absorption of back-scatter of radiation.
6. Half life of radioisotopes.
7. Daughter-parent relationship of radioactive decay and radionuclides.
8. Plateau of G.M Counter.

This will come into effect from Academic Year 2020-2021 admission onwards.

Second year

S.NO	SUBJECT TITLE	IA		THEORY	
		Max.	Min.	Max.	Min.
1	Nuclear Medicine Instrumentation – II MRI, PET & SPECT	50	25	100	50
2	Clinical Nuclear Medicine Techniques - II	50	25	100	50
3	Therapeutic Nuclear Medicine Techniques	50	25	100	50
4	Quality Control of Nuclear Medicine Equipment	50	25	100	50
5	Radiopharmacy – II	50	25	100	50
6	Health Physics and Radiation Protection	50	25	100	50

II. SCHEME OF PRATICAL EXAMINATIONS FOR SECOND YEAR

M.Sc., NUCLEAR MEDICINE TECHNOLOGY

Major experiments - 1 x30 marks = 30 marks
Minor experiments - 2 x20 marks = 40 marks
Spotters - 5 x2 marks = 10 marks
Viva = 20 marks

Total = 100 Marks

Passing minimum = 50 Marks

LIST OF MAJOR EXPERIMENTS:

1) Line spread function of collimators
2) Phantom studies for scintigraphy
3) Radiopharmacy procedure, elution of generators, preparation of different radiopharmaceuticals
4) Organ imaging
5) Renogram
6) Thyroid uptake unit and collimator response

7) Formulation Tc compounds from kits
8) Determination of Mo breakthrough in 99mTc
9) Q.C of Dose Calibrator
10) Q.C of Gamma Camera
11) Q.C of SPECT
12) Q.C of radio pharmaceuticals Anatomy, Physiby paper chromatography
13) Q.C of PET radio pharmaceuticals by TLC scanner,
HPLC & Gas chromatography
14) Rapid determination of Radiochemical purity of radiopharmaceuticals.
15) Pre and Post I-therapy imaging and patient preparation.

LIST OF MINOR EXPERIMENTS:

1) Isoresponse curve of different collimators
2) Radiation survey of nuclear medicine lab
3) Contamination levels and methods of decontamination
4) In-vitro sample measurement of various types
5) Jaszczak Phantom
6) Line spread function of collimators
7) Phantom studies for scintigraphy
8) Radiopharmacy procedure, elution of generators, preparation of different radiopharmaceuticals
9) Organ imaging
10) Renogram
11) Thyroid uptake unit and collimator response
12) Formulation Tc compounds from kits
13) Determination of Mo breakthrough in 99mTc
14) Q.C of Dose Calibrator
15) Q.C of Gamma Camera
16) Q.C of SPECT
17) Q.C of radiopharmaceuticals by paper chromatography
18) Q.C of PET radiopharmaceuticals by TLC scanner, HPLC & Gas chromatography
19) Rapid determination of Radiochemical purity of radiophamaceuticals.
20) Pre and Post I- therapy imaging and patient preparation.

This will come into effect from Academic Year 2019-2020 admission onwards.

Theory Examination Pattern Max. Marks: 100

Part – A (2 x 20) = 40 Marks
Part – B (10 X 6) = 60 Marks

----
100 marks

Duration : 3hours

	Max	Min
Project*	100	50
Viva / Practical	100	50
I. A	50	25

- The Final project should include a work component

Submission of Project:

Project should be in a bound volume of a minimum of 30 - 50 pages of typed in Double line spacing and on one side only.

The Project should be submitted to the Institution 3 months before the Second Year Examination.

Log Book:

Based on the curriculum Log Book to be maintained and the same are periodically, assessed by the HOD and presented at the time of discussion of project in Practical Examination.

Suggested Books and Journals:

Name of Book	Editor's Name
First Year MSc (NMT)	-
Paper I : Anatomy, Physiology & Biochemistry	
Text Books	
1 Human Anatomy	B D Chaurasia
2 Essentials of Medical Physiology	A B Singha Mahapatra et al
3 A Text Book of Biochemistry	S.S Randhawn /Sarath C Bose
Reference Books	
1 Anatomy & Physiology	Ross & Wilson
2 Concise textbook of Biochemistry	Pattabiraman
3 Human Physiology, Biochemistry & Basic Medicine	Lawrence A Cole et al

Paper II : Computers, Fundamentals of Electricity & Electronics	-
Text Books	
1 Computers in Nuclear Medicine Part I Distance Education Series	IAEA
1 Computers in Nuclear Medicine Part II Distance Education Series	IAEA
3 All New Electronics – Self Teaching guide	Henry Kybett, Earl Baysen
Reference Books	
1 Fundamentals and Electronics for Engineering	--
2 Physics in Nuclear Medicine	Sorenson
3 Getting started in Electronics	Forest M MIMS II
Paper III : Mathematics & Statistics	-
Text Books	
1 Statistical & Mathematical techniques in Nuclear Medicine	G S Pant
2 Elements of Statistical Learning	Jerome H Friedman
3 Principles of Statistics	M G Bulmer
Reference Books	
1. Research Methodology – Methods and Techniques	C R Kothari
2 Physics in Nuclear Medicine	Sorenson

3 Text book of Nuclear Medicine Technology &Techniques	Bernier
Paper IV Radiation Physics & Radiation Chemistry	
Text Books	
1 Physics in Nuclear Medicine	Sorenson
2 Nuclear Medicine Physics (A HandBook)	D L Bailey et al
3 Fundamentals of Radiation Chemistry	A Mazumder

Reference Books	
1 Essentials of Nuclear Medicine Physics & Instrumentation	Pawnsor
2 NuclearMedicine & PET CT Technology & Techniques	Paul E Christian Kristen M Waterstramrich
3 Radioactivity 2nd Edition	Michael L Annuziata

Paper V Radiation Biology	
Text Books	
1 Radiation Biology : A Handbook for Students	IAEA
2 Essentials of Radiation Biology & Protection	-
3 Radiation Biology	G B Saha
Reference Books	
1 Radiation Biology of Medical Imaging	Charles A Kelsey
2 Biophysics	–
3 Biological Effects of Dosimetry on Ionizing Radiation	–
Paper VI Nuclear Medicine Instrumentation-I	
Text Books	
1 Essentials of Nuclear Medicine Physics : A Handbook	D L Bailey et al
2 Physics in Nuclear Medicine	Sorenson
3 Essentials of Nuclear Medicine Physics & Instrumentation	Pawsner
Reference Books	
1 Molecular Imaging – Principles & Practice	
2 Nuclear Medicine Physics – A Handbook	D L Bailey et al
3 Nuclear Medicine & PET CT Technology & Techniques	Paul E Kristen M Waterstramrich
Paper VII Radiopharmacy -I	
Text Books	
1Fundamentals of Nuclear Pharmacy	Gopal B Saha
2 Nuclear Medicine & PET CT Technology &	Paul E Kristen M

Techniques	Waterstramrich
3 Technetium 99mRadiopharmaceuticals	IAEA
Reference Books	
1 The Mayo Clinic Manual of Nuclear Medicine	Michael K O Connor
2 Molecular Imaging – Principles and Practice	Ralph Weishlader Brian Ross
3 The Requisites – Nuclear Medicine Ch 1-10	Harvey A Zeissmann et al
Paper VIII Clinical Nuclear Medicine Techniques -1	
Text Books	
1. Nuclear Medicine in Clinical Diagnosis & Treatment (Part 1) Vol 1	I D C Murray, P J Ell
2. Nuclear Medicine in Clinical Diagnosis & Treatment (Part 2) Vol 2	I D C Murray, P J Ell
3. Nuclear Medicine in Clinical Diagnosis & Treatment (Part 3) Vol 2	I D C Murray, P J Ell
Reference Books	
1.Atlas of PET CT : A quick guide to Image Interpretation	Stefano Fanti
2 Nuclear Cardiac Imaging : Principles and Applications	Ami E Iskandrian , P J Ell
3 Thyroid : A fundamental and Clinical Text Vol 1 Section 1-3	Lewis E Braverman David S Cooper
Second Year M.Sc (NMT)	
Paper I Nuclear Medicine Instrumentation -II	
Text Books	
1Physics in Nuclear Medicine Sorenson	
2 Nuclear Medicine & PET CT Technology & Techniques	Paul E Christian Kristen M Waterstramrich
3 Essentials of Nuclear Medicine Physics & Instrumentation	Pawsner
Reference Books	
1 Quality control of Nuclear Medicine Instruments	IAEA
2 Quality Control of Nuclear Medicine Instrumentation	G S Pant
3 Nuclear Medicine Physics (A HandBook)	D L Bailey et al

Paper II Clinical Nuclear Medicine Techniques II	
Text Books	
1 Essentials of Nuclear Medicine Imaging	Fried A Mettler J R Miltopn J Guilberteau
2 Clinical Nuclear Medicine	Gary J R Cook, Michael N Maisey
3 Diagnostic Nuclear Medicine	Christian Schiepers
Reference Books	
1 Atlas of PET CT : A Quick guide to Image Interpretation	Stefano Fanti
2 A Personal History of Nuclear Medicine	Henry N Wagner
3 Nuclear Medicine Clinical Diagnosis & Treatment	IDC Murray P J Ell
Paper III : Therapeutic Nuclear Medicine Procedures	
Text Books	
1 Nuclear Medicine Therapy	Janet F Eary /Winfried Brenner
2 Targeted Radionuclide therapy	Tod W Speer
3 Nuclear Medicine Clinical Diagnosis & Treatment	IDC Murray P J Ell
Reference Books	
1 Thyroid : A Fundamental & Ckinical Text Vol 1 Section 1- 3	Lewis E Braverman David S Cooper
2 Thyroid : A Fundamental & Ckinical Text Vol 1 Section 4-8	Lewis E Braverman David S Cooper
3 The Mayo Clinic Manual of Nuclear Medicine	Michael K O“Connor
Paper IV : Quality Control of Nuclear Medicine Equipment	
Text Books	
1 Quality control of Nuclear Medicine Instruments TECDOC	IAEA, TECDOC 601
2 Quality Control in Nuclear Medicine Instrumentation	G S Pant
3 Nuclear Medicine & PET CT Technology & Techniques	Paul E Christian Kristen M Waterstramrich
Reference Books	
1 Quality Assurance of SPECT System	IAEA

2 Quality Assurance of PET & PET CT	IAEA
3 PET CT Atlas on QC and Image artifacts	IAEA
Paper V : Radiopharmacy -II	
Text Books	
1 Fundamentals of Nuclear Pharmacy	Gopal B Saha
2 Nuclear Medicine & PET CT Technology & Techniques	Paul E Christian Kristen M Waterstramrich
3 Radiopharmaceuticals	M H Patel
Reference Books	
1 Essentials of Nuclear Medicine Imaging	Fried A Mettler
2 Molecular Imaging – Principles & Practice	Ralph Weishlader Brian Ross
3 Basics of PET Imaging	Gopal B Saha
Paper VI Health Physics & Radiation Protection	
Text Books	
1 Fundamentals of Nuclear Medicine Dosimetry	Michael G Stabin
2 Radiation Safety Officer Workshop Book	AERB
3 AERB Safety Guidelines & Codes for Nuclear Medicine	AERB
Reference Books	
1 Basics of PET Imaging	Gopal B Saha
2 Physics of Nuclear Medicine	Sorenson
3 AERB Safety Guidelines	AERB