Semester Wise Lay out of Course of M.Sc Nuclear Medicine

Semester No	Course Number	Course Title	Credits
First Semester	MS- 501 Ms-502 MS- 503 MS-504 MS-505 MS-510 CMS-501	Introduction to Nuclear Physics Mathematics and Statistics Radiation Detection and Instrumentation Radiation Protection and Radiation Biology Radiochemistry and Radiopharmaceuticals Introduction to Nuclear Technology Communication Skills	3 3 3 3 3 NC+IR 1
Second semester	MS-511 MS-601 MS-602 MS-512 MS-515	Essentials of radiology and Radiotherapy Diagnostic Imaging and Function Techniques Invitro Studies and Therapeutics Quantitative Analysis and data Processing in Nuclear Medicine Nuclear Medicine Laboratory	3 3 3 3 3 3
Third Semester	MS-697	Thesis Project	15
Fourth Semester	MS-699	Intensive Clinical Training in Nuclear Medicine	15

Detailed Course Contents

MS-501 Introduction to Nuclear Physics

Compulsory	
Credits	3
Prerequisite	Nil
Course Format	Three hours of lectures per week

Atomic and nuclear structure; Artificial and natural radioactivity; Modes of radioactive decay; Exponential decay and; Half-life and mean life of radio nuclides; Radioactive decay series and equilibrium; Nuclear reactions and reaction cross-sections; Nuclear fission and fusion; Nuclear reactors and particle accelerators.

References:

MS-502 Mathematics and Statistics

Compulsory	
Credits	3
Prerequisite	Nil
Course Format	Three hours of lectures per week

Second degree algebraic equations and inequalities; Trigonometric identities; Sequences and series; Binomial expansion; Differentiation and integration; First order and second order differential equations; Fourier Transform. Significance of statistics in Nuclear Medicine; Standard deviation; Poison and Gaussian distribution; Applications of statistical analysis; Chi-square test; Elementary concepts of probability; Tests of significance; Statistical criteria for the selection and adjustment of counters

MS-503 Radiation Detection and Instrumentation

Compulsory	
Credits	3
Prerequisite	Nil
Course Format	Three hours of lectures per week

Basic principles of radiation detectors and their common properties, Gas-filled detectors and their application, Scintillation detectors and radiation spectroscopy; Nuclear electronics; Photographic emulsions; Thermo luminescent dosimeters; Chemical dosimeters; Liquid scintillators; Rectilinear scanners; Non imaging probes; Scintillation counters; Dose calibrator; Scintillation camera; Multi crystal devices; Tomographic imaging technique; PET; Collimation of radiation detectors; Image production & display; Image quality in nuclear medicine; Basic concepts of CT & Magnetic Resonance Imaging (MRI); Quality assurance procedures in Nuclear Medicine instrumentation; Use of computers in Nuclear Medicine-principles & applications to NM data acquisition, processing & display.

MS-504 Radiation Protection and Radiation Biology

Compulsory	
Credits	3
Prerequisite	Nil
Course Format	Three hours of lectures per week

Introduction; Radiation quantities and units; International organizations setting standards; Radiation protection standards; Absorbed dose estimation from external and internal exposure;

Health physics instrumentation; Principles of control of external and internal exposure hazards; Early medical treatment of radiation injury; Radioactive waste disposal; Radiation shielding and transportation of radioactive materials. Historical aspects; Radiation chemistry; Radiation biochemistry; Radiation effects on cells; Differential cell sensitivity; Physical, chemical, and biological factors effecting radiation effects; Repair of radiation injury; Cell survival curves; Target theory; Application of target theory; Single and multi hit effects; Late effects of radiation; Acute radiation syndromes; Mutagenesis; Ionizing radiation as a mutagen; Significance of genetic mutations.

MS-505 Radiochemistry and Radiopharmaceuticals

Compulsory	
Credits	3
Prerequisite	Nil
Course Format	Three hours of lectures per week

Introduction; Radiopharmaceuticals; Basic principles and licensing considerations; Production of radioisotopes; Radioisotope generators; Dosage control techniques; Formulation of radiopharmaceuticals for different organs; Quality control and quality assurance of radiopharmaceuticals; Pharmacology of radiopharmaceuticals; Good Radio pharmacy practice for special radiopharmaceutical procedures; Hot laboratory and dispensing operations; Chemical toxicity of radio nuclides.

MS- 510 Introduction to Nuclear Technology

Compulsory	Institutional Requirement
Credits	1
Prerequisite	Nil
Course Format	One hour of lecture per week

Developments in physics leading to the discovery of nuclear fission; Development of nuclear technology; Review of nuclear reactors and fuel cycle facilities; Present status of nuclear power in Pakistan and in the world; Current problems and future prospects of nuclear power.

CMS- 501 Communication Skills

Compulsory	C
Credits	1
Prerequisite	Nil
Course Format	1 hour of lecture per week

Writing Module: Preparation of a project proposal or technical report, Writing letters, Mission statements, Office memos etc. Speaking Module: Presentation of the project proposal or technical report. Listening Module: Simulations of interviews, lectures and question-answer sessions. Reading Module: Reading of a suitable fiction novel (approximately 30-50 pages a week) with the use of vocabulary support, completion of assigned tasks and discussions

Ms-511 Essentials of Radiology and Radiotherapy

Compulsory	
Credits	3
Prerequisite	Nil
Course Format	Three hours of lectures per week

Conventional radiology encompassing Chest x-ray, Plain Abdominal x-ray, Fluoroscopy (Barium studies, IVP, Female genital tract). , Bones x-ray and Mammography, **C.T Scan/MRI** covering the Basics of C.T, C.T Chest, Brain, Abdomen, Basics o0f MRI(T1, T2, spin echo), MRI Brain, Spine, Joints and **Ultrasound** with emphasis on its basics, Abdominal Ultrasound, Echocardiography, Pelvic Ultrasound(Gynaecology /Obstetrics, Urinary tract), Thyroid and its Hands on training.

Radiotherapy section covers the Introduction to Pathophysiology: causes, Prevention, Genesis, Spread, Basis of Therapy, Practice of radiotherapy, Sensitivity of tumour, Principles of therapy planning, Response of tumours and management of various tumours including Lymphomas, Ca Lung, Ca Larynx, Brain Tumours, Ca Breast, CA Colon, Ca Stomach, Ca Cervix and uterus, Ca prostate, Ca urinary Bladder Bone tumours, Ca Nasopharynx, Bone tumours, Ca Nasopharynx and Photo dynamic therapy of tumours.

MS-601 Diagnostic Imaging and Function Techniques

Compulsory	
Credits	3
Prerequisite	Nil
Course Format	Three hours of lectures per week

Diagnostic imaging in-vivo studies; Radiopharmaceuticals commonly used in imaging techniques, their bio distribution, elimination, and kinetics; Major indications and interpretation of imaging for different body functions and organs; Different methods and techniques of imaging and their quantitation; The use of single and multidetector systems for equilibrium and time dependent studies; Medical decision making; Differential evaluation of nuclear medical imaging in light of other imaging modalities.

MS-602 In-vitro Studies and Therapeutics

Compulsory	
Credits	3
Prerequisite	Nil
Course Format	Three hours of lectures per week

Radioimmunoassay; Principles and techniques; Basic chemical concepts; Labeling methods; Separation procedures; Data handling and quality control; In-vitro studies: indications, techniques, evaluations and analysis of results; Therapeutic uses of radio nuclides: indications, patient selection and radiopharmaceuticals used; Calculation of activity to be administered; Absorbed dose estimation; Health physics considerations and precautions in handling patients containing therapeutic quantities of radio nuclides.

MS- 512 Quantitative Analysis and Data Processing In Nuclear Medicine

Compulsory	
Credits	3
Prerequisite	Nil
Course Format	Three hours of lectures per week

Tracer techniques; Static and kinetic studies; Dilution principle; Measurement of volumes and spaces; Kinetic theory; Flow studies; Compartmental analysis; Transit times; Convolution and deconvolution; Fourier analysis; Ferro kinetic studies; Regional blood flow measurement; General principles of data processing; Scintillation camera data collection; Static image processing; Image correction, Selective enhancement; Interpretation; Thresholding; Contours; Data bounding and fitting; Dynamic data collection; Modes and methods of analysis; Quantitative functional analysis in cardiac, pulmonary and renal systems.

MS- 513 Nuclear Medicine Laboratory

Compulsory	
Credits	3
Prerequisite	Nil
Course Format	Nine hours of laboratory work per week

Out of the experiments listed below, a minimum of fifteen experiments are to be performed.

Radiation Detection and Measurement:

1. Characteristics of a G.M. tube, dead time measurement, and beta attenuation.
2. Verification of counting statistics.
3. Characteristics of scintillation detectors and determination of pulse height spectra of gamma sources.
4. Characteristics of Ge (Li), HPGe or Si (Li) detector and its use in gamma ray spectroscopy.
5. Measurement of half-lives of a single and a mixture of radio nuclides.
6. Determination of attenuation coefficient and build-up factor of gamma rays for different shielding materials.
7. Measurement of Co-60 source strength using gamma-gamma or beta-gamma coincidence method.

Health Physics

1. Calibration and use of survey meters.
2. Calibration of TLD system and measurement of unknown dose.
3. Contamination survey and decontamination procedures.
4. Verification of inverse square law and source strength measurement.
5. Study of the characteristics of liquid scintillators detector.

Clinical Laboratory

1. Elution of Mo-Tc generator system, calculation of dose and preparation of radiopharmaceuticals.
2. Quality control of radiopharmaceuticals: estimation of bound and free fraction.
3. Thyroid uptake studies.
4. Determination of RBC volume using Cr-51.
5. Radioimmunoassay of T3, T4 and TSH.
6. Quality control tests for gamma camera.
7. Routine operational tests for SPECT.
8. Dynamic renal study with patient.
9. Static and SPECT studies with liver phantom.
10. E.C.G. gated studies with phantom.
11. SPECT total performance studies with phantom.

MS-697 Thesis Project

Compulsory	
Credits	15
Prerequisite	Nil
Course Format	Twenty-seven hours of laboratory work

	per week (Duration 6 months)

In collaboration with a project supervisor, each Fellow\ student arranges a clinical project for the M.S. thesis. The purpose of the project is to acquaint the Fellow\ student with the techniques of research in nuclear medicine, particularly as it relates to developing or evaluating instrumentation and radiopharmaceuticals, and the utility of new radio nuclides or radiopharmaceuticals. This project does not necessarily have to be a completely original study but should exhibit a thorough knowledge of the subject and should be an exhaustive review of the literature on that particular topic. The area covered by the project should include nuclear physics, instrumentation, nuclear medicine statistics, dosimetry, etc. The aim of the project is to train the Fellows in planning and conducting research projects and writing scientific papers.

MS-699 Intensive Clinical Training in Nuclear Medicine

Compulsory	
Credits	15
Prerequisite	Nil
Course Format	Twenty-seven hours of laboratory work per week (Duration 6 months)

For clinical training, each Fellow\ student is attached to a specialist at a nuclear medical centre, who is responsible for providing guidance and supervision in clinical procedures. During this phase major aspects of general clinical nuclear medicine are covered. The training program includes the diagnostic, therapeutic and investigational uses of radio nuclides. It is of sufficient breadth to ensure that student is thoroughly acquainted with the techniques and methods of major nuclear medicine diagnostic and therapeutic applications.

The training program is designed to give Fellows\ students ample opportunity to attain competence in correlating the patients' problems with optimum selection of nuclear medicine studies, performing these studies, interpreting the information obtained, correlating this information with other diagnostic studies and following up patients receiving radionuclide therapy. Fellows are encouraged to perform a wide variety of studies so that the methods of investigation are fully assimilated. During the training Fellows have to take histories, do physical examination, handle the gamma camera, work on computers and they are also encouraged to interpret the scans and to write provisional reports.

At the end of the training period, a comprehensive examination is conducted in which the acquired level of competence of the Fellows is evaluated. If the examiners feel that more work is