# POSTGRADUATE INSTITUTE OF SCIENCE
UNIVERSITY OF PERADENIYA

# M.Sc. in Medical Physics
**(2010/2011)**

## 1. INTRODUCTION

Medical Physics is an ever-expanding field as a separate discipline. During the past two decades medical physics has undergone a tremendous evolution, progressing from a branch of science on the fringes of physics into an important mainstream discipline that can now be placed on equal footing with other more traditional branches of physics.
Applications of physics in medicine cover a wide range. The four important sub-specialties in medical physics are related to: 1/ Diagnostic imaging with x rays (*diagnostic radiology physics*) 2/ Diagnostic imaging with radio-nuclides (*nuclear medicine physics*) 3/ Treatment of cancer with ionizing radiation (*radiation oncology physics*) 4/ Study of radiation hazards and radiation protection (*health physics*).

Although medical physics is a well-developed discipline in all developed countries it is not well established in developing countries like Sri Lanka. The two obvious areas that Medical Physicists are needed in Sri Lanka are in the fields of Radiotherapy and Nuclear Medicine. In Sri Lanka there are six government cancer treatment centers and one private center to provide all types of radiation therapy procedures. The Maharagama cancer institute, the largest in the country, needs service of about 10 Medical Physicists. The other five government centers in Kandy, Galle, Jaffna, Anuradhapura and Badulla need about two to three Medical Physicists each. In addition, each base hospital in Sri Lanka now has modern diagnostic equipment such as CT scanners and is hoping to have its own nuclear medical facilities. Therefore we need at least one Medical physicist per teaching hospital in Sri Lanka to cover up the need on diagnostic radiology side. As the health service improves, the need for Medical Physicists will further increase.

On the other hand, in Sri Lanka the research activities on topics related to medical physics has not developed due to non-availability of appropriate facilities and resource personnel.

The Postgraduate Institute of Science (PGIS) of the University of Peradeniya with the support of other Faculties of University of Peradeniya, Cancer Institute at Maharagama, Atomic Energy Authority, University of Colombo and Teaching hospitals has formulated a M.Sc. programme in Medical Physics to train physicists, to meet the above demands. PGIS is the pioneer in starting the M.Sc. degree program in Medical Physics in 1996 and is the only institution that provides a postgraduate level program that caters to the need in the whole country.

## 2. OBJECTIVES

1. To train personnel in Radiotherapy, Diagnostic Radiology and Radiation Protection, so that they will have the basic knowledge to carry out the duties in a hospital as Medical Physicist.
2. To provide opportunities for research connected with physics applied to medicine.
3. To provide supplementary courses for postgraduate training in some disciplines of medicine such as radiology, anesthesiology etc.

## 3. PROGRAMME ELIGIBILITY

Applicants for admission to this programme must have successfully completed one of the following courses at a recognized University.

1. B.Sc. special degree in physics or B.Sc. special degree in chemistry with physics as the subsidiary or B.Sc. general degree with physics as a subject.
2. A degree in engineering science.
3. Any other equivalent qualification with strong physics content acceptable to the Board of Study in Physics of the PGIS.

The number of candidates admitted to the programme in a given year will depend on the number of places available in the year. The selection will be based on merit. Candidates should be proficient in English as English will be the medium of instruction.

## 4. PROGRAMME FEE

| | M.Sc. programme fee |
|---|---|
| local candidates | Rs. 100,000/- |
| SAARC countries | US $ 3300/- |
| other countries | US $ 6600/- |

Programme fee shall be paid in two installments *(50% at registration and the balance 50% within six months from registration).* Other payments including registration fee, medical fee, library subscription, examination fee and deposits (science and library) should be paid according to the procedure stipulated by the PGIS.

## 5. THE PROGRAMME STRUCTURE AND DURATION

This is a full-time programme consisting of course work and a research project. Course work will be conducted over a period of two semesters of 15 - weeks each *(during weekends and/or weekdays)*. The entire programme duration will be about 15 - 18 months inclusive of three to six months for the research project. Satisfactory completion of a minimum of 24 credits of course work is required for the programme in addition to the six credits allocated for the full-time research project. Continuous attendance is compulsory during the period of research work. In order to proceed to the research project he/she shall obtain a GPA of not less than 3.00 from the compulsory (22 credits) and optional courses (2 credits). If the student obtains a GPA in the range 2.75 to 2.99, then he/she is eligible for the Diploma in Medical Physics but not the M.Sc. Degree. After successfully completing the research project, the student is eligible for the award of the M.Sc. Degree.

PROGRAMME SUMMARY

| Course Code | Course | Lecture hrs. | Practical hrs. | No. of Credits |
|---|---|---|---|---|
| | **Semester 1** | | | |
| PH 531 | Human Biology and Cell Biology | 30 | - | 2 |
| PH 532 | Physics of Diagnostic and Therapeutic Radiology | 30 | - | 2 |
| PH 533 | Nuclear Medicine I | 15 | - | 1 |
| PH 534 | Radiobiology | 15 | - | 1 |
| PH 535 | Statistics | 15 | - | 1 |
| PH 537 | Introduction to Digital Electronic and Microprocessors | 15 | - | 1 |
| PH 538 | Applications of Physics in Medicine | 15 | - | 1 |
| PH 540 | Clinical Instrumentation | 15 | - | 1 |
| PH 541 | Laboratory Course | - | 30 | 1 |
| | **Optional Courses** | | | |
| PH 536 | Computing* | 15 | - | 1 |
| PH 555 | Ultrasound in Medicine* | 15 | - | 1 |
| | **Semester II** | | | |
| PH 546 | Radiation Protection | 30 | - | 2 |
| PH 547 | Radiotherapy Physics | 30 | - | 2 |
| PH 548 | Medical Imaging Physics | 30 | - | 2 |
| PH 549 | Radiotherapy and Medical Imaging Laboratory | - | 60 | 2 |
| PH 550 | Nuclear Medicine II | 15 | 30 | 2 |
| PH 557 | Clinical Tutorials and Demonstrations | - | 30 | 1 |
| | **Optional Courses** | | | |
| PH 551 | Medical Electronics and Instrumentation* | 15 | - | 1 |
| PH 552 | Computer systems and method* | 15 | - | 1 |
| PH 553 | Biomechanics, Biomaterials and Rehabilitation Engineering* | 15 | - | 1 |
| PH 554 | Computer Architectures and Artificial Intelligence* | 15 | - | 1 |
| PH 556 | Non-ionising E.M. Radiations in Medicine* | 15 | - | 1 |
| PH 558 | Advanced techniques and special procedures in Radiotherapy* | 15 | - | 1 |
| **PH 599** | **Research Project** | **(3 - 6 months)** | | **6** |

** Optional courses. Students are required to obtain 2 credits from optional courses.*

## 6. PROGRAMME CONTENTS

**PH 531: Human Biology and Cell Biology** *(30 L)*

*Basic Physiology*

Role, function and interactions of the major organs and body systems. Physiological regulatory processes. Introduction to organ systems, Gastrointestinal system, Respiratory system, Heart, Circulation, Urinary system, Reproductive system, Blood and body fluid, Nervous system, Joints and bones. Sensory Organs: Eye, Ear, Vestibular sensations taste and smell.

*Diseases in man*

A brief overview of the various types of clinical conditions the medical physicist might encounter in practicing hospital physics.

*Cell Biochemistry*

The basic body cell, cell organelles; Fundamental biochemical building blocks; DNA structure, synthesis and replication; protein synthesis; energy metabolism.

**PH 532: Physics of Diagnostic and Therapeutic Radiology (***30L)*

*Atomic physics*
Atomic and nuclear structure, radioactivity, production of radioactive materials; Interactions of photons and other ionizing radiations with matter.
*Basic interaction processes*
Coherence scattering, incoherence scattering (Compton), photo electric, pair production, Photonuclear reaction and their clinical importance, Range of secondary electrons, Bragg curve,. HVL/TVL, Attenuation and absorption coefficients, stopping powers, LET.
*X-ray radiology*
X-ray production, design of X-ray tubes. X-ray generators, heat rating, Beam collimation. Interaction of X-photons with patients, radiographic contrast. Film construction, role of intensifying screens. Film processing, Film contrast, scatter reduction. Characteristics curve.
*Radiation dosimetry*
Kerma, absorbed dose, charged particle equilibrium (CPE). Bagg-Gray Cavity Theory ,practical ion chambers.
*Radiation Detectors*
Gas ionisation, Scintillation, Semiconductor, film, Thermoluminescence (TLD) detectors.
Chemical and calorimetric methods of measuring radiation and their clinical applications.
*A general introduction to radiotherapy physics*
Radiation as a treatment for cancer, historical review including X-ray and gamma ray teletherapy equipment, treatment planning and brachytherapy.
*Physics of teletherapy*
Definition of PDD, TAR, BSF, TPR, TMR, SAR their properties and application. Iso-dose curves, beam modifier -Wedge filter, Clarkson segmental integration, Calculation of simple treatment techniques for clinical applications.

**PH 533: Nuclear Medicine I** (*15 L)*
Nuclear Physics, Planar and tomographic imaging, Data processing, Mode of action of radiopharmaceuticals and the interpretation of clinical studies, In vitro studies, Positron emission tomography.
The gamma camera, Specification of camera performance.

**PH 534: Radiobiology** *(15 L)*
*Basic radiobiology*
Free radical formation; damage to biological molecules; effects at cellular and whole body levels.
*Radiobiology and human oncology*
Cell survival curve - RBE therapeutic ratio, cell cycle and radio sensitivity; Sensitivity of different types of tissues; Tissue tolerance dose LD 50/5, LD 5/5, paediatric dosimetry; Fractionation NSD concept; Prescribing, recording, and reporting photon beam therapy ICRU report 50; Design and conduct of clinical trial - study objective, patient eligibility end points, treatment allocation, size and duration of study, data management, ethics, Surface marking of organs,

**PH 535: Statistics (***15 L)*
Definitions, Descriptive statistics, Binomial, Poisson and Gaussian distributions, Central limit theorem, Inferential statistics, population mean, standard error and deviation, difference between statistics, Curve fitting, regression analysis.

**PH 536: Computing** *(15 L)*
Technology evolution, Structure of algorithms, Representation and models of arithmetic manipulation, Operating system and language review, Principles of project and system design, Future trends, Tutorials on use of packages, Overview of biomedical applications of computing, including Artificial Intelligence and parallel processing approaches, Introductory signal and image processing, Data reduction, Principles of software design, Software development techniques and good programming practices, Introduction to C with worked examples and opportunities for supervised programming.
**PH 537: Introduction to Digital Electronics and Microprocessors** *(15 L)*

*Digital Electronics*
Boolean logic, Digital circuit elements, Truth tables and state tables, Common logic circuits.
*Microprocessors*
Microprocessor hardware, Interfacing devices.

**PH 538: Applications of Physics in Medicine** *(15 L)*
*UV, Lasers and Fiber Optics, uses in Medicine*
EM radiation in medicine, The role of lasers and Fiber optics in medicine, UV radiation in medicine. Hazards of lasers and UV radiation, Audiological physics, Physics applied to ophthalmology.
*Nuclear Magnetic Resonance in Medicine*
Energy levels; effects of magnetic fields; the spin system; precession; field gradients; spatial information; relaxation phenomena; basic pulse sequences, inversion recovery and spin echo; basic hardware.
*Ultrasonics in Medicine*
Generation, properties of acoustic waves; reflection, transmission at interfaces; intensity and other parameters; imaging; artifacts; measurements of acoustic power and intensity: hyperthermia and tissue destruction by ultrasound: bio-effects.

**PH 540: Clinical Instrumentation** *(15 L)*
Bio-electric potentials; causes and nature; suitability of different electrodes for their measurement: the electrocardiogram. Transducers to measure physiological parameters such as pressure, temperature. Amplifiers for measurement of physiological signals, the reduction of electrical interference. ECG and EEG equipment;. Blood pressure measurements; Pacemakers; Defibrillation; Surgical diathermy; Infusion pumps. Safety of equipment, Management of equipment;

**PH 541: Laboratory Course** *(30 Hrs)*
Each student MUST complete TEN of the following experiments. Each experiment is 3hr.
1. Scintillation techniques for radionuclide counting
2. Pulse height spectroscopy, Analysis of spectrum from radioactive sources with the use of a single-channel spectrum analyser
3. Measurement of HVL for diagnostic X-ray beams
4. Electrocardiograph performance
5. Performance of a gamma camera
6. Stray -Radiation detection and dose measurement
7. Clinical thermoluminescent dosimetry
8. Personnel dosimetry
9. Counting statistics
10. Digital electronics hardware
11. Ultrasound scanner
12. Optical analogue for X-ray CT and Emission Tomography
13. The failure mechanism of ligaments
14. Central axis depth dose and dose profiles measurement for Co-60 Teletherapy beam
15. Measurement of TAR and PDD for C0-60 teletherapy beam
16. Construction and calibration of a GM-Monitor
17. Study of voltage current characteristics of an ion-chamber
18. Calibration of gamma-ray spectrometer and identification unknown sources
19. Calibration of TLD with TLD –reader and dose evaluation

**PH 546: Radiation Protection** *(30 L)*
*Radiation protection*
Unit and quantities used in radiation protection including Calculation of Effective dose, Radiation Protection principles including current dose limits, and ICRP regulations, Calculations of shielding form X and gamma ray, neutrons and beta particles with practical exercise. Calculations of does from ingestion and diagnostic investigations.

External and Internal Radiation hazards and methods of control; Design of radioactive laboratories and their safety. Epidemiological data and maximum permissible dose. . Personnel dosimetry. Practical use of health physics instruments. Emergency procedures and risks, role of police, fire brigade, decontamination procedures, waste disposal. Calculation of shielding for Medical linear Accelerators

*Practice of Radiological safety*

Sri Lankan regulations on Radiation Protection; with emphasis on Radiation Protection Adviser, regulation of working practices, local rules, controlled and supervised areas.

Safety in use of x-rays in Diagnostic Radiology and proper use of imaging systems. Preparation of a QA programme and its practical implementation

*Practice of Radiation Protection*

Optimisation of occupational exposure in radiotherapy and radiology practices. Safety features in controlled areas ,protective gears and application of time /distance /shielding related to radiotherapy and Nuclear medicine with typical examples. Selection of proper monitoring devices for RP. Preparation of contingency plans for radiotherapy and Nuclear medicine.

**PH 547: Radiotherapy Physics** *(30 L)*

*Dosimetry and calibration of photon and electron beams with cavity ion chambers*

Determination of absorbed dose in free space and in water for photons and electron beams, IAEA code of practice: TRS 277and 398 protocols.

*Radiation Detectors*

Diode, films, TLD, chemical and calorimetric methods of measuring radiation and their clinical applications.

*Radiotherapy Treatment Planning-EBT*

Tumour localization and cross sectional information. Acquisition of patients' specific data from simulators, CT scanners and from other procedures. General principles in treatment planning. Dose specifications planning techniques - fixed, moving, irregular fields. Use of wedge filters, tissue compensation filters, bolus, patient immobilization devices.2-D planning. 3D-conformal radiation therapy (3D-CRT). Treatment verification methods and treatment optimisation methods. Quality control of treatment planning systems.

*Radiotherapy Equipment*

SXRT, DXRT machines, Isotope machines, LINACS, particle generators, Equipment specifications, tests and Quality Control..

*Brachytherapy*

Introduction - Radium and its radio active series. Other brachytherapy sources and their properties. Construction and care of brachytherapy source. Source strength specifications. Dose specifications. ICRU practice. Dosimetric systems . Brachytherapy techniques - Intra cavitory, interstitial, moulds, and intra lumenal.

*Modern HDR-Brachytherapy*

Source reconstruction and dose calculations manual and computer methods. Dose optimization. Quality assurance of brachytherapy systems. RBE+ comparison of HDR, MDR, PDR, LDR systems.

*Unsealed Source Therapy*

Choice of radio nuclides - physical and biological considerations, dosimetry. MERD theory and practice. Preparations for therapy, dispensing monitering and discharge of patients.

**PH 548: Medical imaging Physics** *(30 L)*

*Radiography Physics, Basic imaging concepts and their relationships, imaging system capabilities*

Physics of plain radiography, mammography, fluoroscopy, dental x-ray and Image processing; emphasizing relevant design features, main physical features and functions, optimisation of image quality/noise/patient dose, controlling scatter radiation and their limitations. (typical exposure levels and dose levels associated with each imaging modality); Types of x-ray films and intensifying screens used;Importance of routine Quality Control (QC) for equipments and procedures; Contrast, noise, signal-to-noise ratio, detective quantum efficiency, resolution, point-spread function, modulation-transfer function. Rose model.

*Magnetic Resonance Imaging (MRI)*

Brief introduction of relaxation processes, excitation, magnetic field gradients. k-space interpretation of selective excitation and data acquisition; Medical applications of magnetic resonance imaging; Behaviour of magnetisation after excitation; Image contrast and measurement of MR related phenomena: s/n, c/n, proton density - gradient echo MRI (FLASH), T2* - gradient echo MRI, T2 - spin echo MRI, T1 - progressive saturation, saturation recovery, inversion recovery - selective suppression of T1 components (STIR, FLAIR), diffusion coefficient - diffusion weighted pulse gradient spin echo-navigator echo, phase contrast flow sensitive pulse gradient spin echo, magnetisation contrast - off resonance saturation of bound (high linewidth) species, gadolinium contrast enhancement via T1 - flow sensitive via bolus tracking, spin tagging assessment of slow flow. Examples of contrast changes with changes of instrumental parameters

*Applications of Digital Imaging*

Physics of photostimulable plates. Physics of direct conversion detectors, Basic principles of Digital Subtraction Angiography (DSA) and Digital Fluroscopy.

*Image reconstruction techniques*

Fourier, ART, convolution and filtered back projection, algebraic reconstruction. CT equipment designs, and current trends.

Problems in use: partial volume effects, beam hardening, artifact generation.

Applications and evaluation diagnosis and radiotherapy. methods of performance evaluation QA procedure of CT scanner.

**PH 549: Radiotherapy and Medical Imaging Laboratory** *(60 Hrs)*

*Radiotherapy*

1. Measurement of HVL of KV radiation beams;
2. Absorbed dose determination in free space and to water for KV and MV radiations;
3. Calibration of brachytherapy source;
4. Quality Assurance tests for teletherapy machine .
5. Quality Assurance tests for HDR brachytherapy systems
6. Quality Assurance of computer treatment planning systems (TPS)
7. Quality Assurance tests for Simulator and CT;
8. Treatment planning and dose calculations, fixed fields, moving fields, irregular fields, wedge fields, conformation therapy; optimisation treatment verification , and delivery.
9. Source reconstruction and dose calculation for brachytherapy (manual and computer methods); LDR + HDR
10. Calibration of radiation survey meters
11. Preparation of sealed sources for treatment;
12. Preparation and dispensing unsealed sources;
13. Mould room procedures;
14. Treatment verification, clinical applications.

*Medical Imaging (Radiology)*

15. kVp, effective keV and half-value layer of x-ray beams.
16. QA of film processing
17. Measurement of x-ray tube focal spot size. Pinhole, Siemens Star and "line-pair" techniques for measurement of focal spot size.
18. Measurements of various film parameters (H & D curves, speed and film gamma).
19. Phototimer systems.
20. Exposure timer and mAs reciprocity.
21. Measurement of fluoroscopic resolution. Low and high contrast resolution tools.
22. Beam restriction and beam alignment.
23. Evaluation of image performance of a CT scanner.
    CT test phantoms: low and high contrast resolution, slice width, CT linearity, impulse response. Effects of various reconstruction filters on image quality.
24. Basic QA of an ultrasound scanner. Evaluation of: penetration, accuracy with respect to depth; image uniformity; resolution (axial, lateral and near-field).
25. Uses of QA phantoms in MRI. Evaluation of system performance and image quality using standardized phantoms in a routine quality control program.

*Radiotherapy*

Clinical Treatment planning session will be done with the supervision of an Oncologist. Dose calculation, dose optimisation, treatment verification etc. will be supervised by a physicist. This would involve in each case.

A. Discussion

Tumour volumes – GTV, CTV, ITV, PTV, TV, IV, OR, PRV; Outline and delineation of GTV; Simulation and verification of PTV; Field arrangement and techniques of treatment; Dose identification for critical organs; Computer planning and verification of plans, weightage of doses - rechecking of critical organ doses; Checking of treatment set up with Oncologist and checking of the 1st. treatment.

B. Candidates Should Personally Plan Tumours of the Following Sites.

CNS tumour - Spinal cord, pituitary, brain stem glioma; Head and neck - PNS, tonsil/base of tongue. Supra glotic larynx, larynx. Maxillary antrum; Thorax - Lung, esophagus; Abdoman - Pancreas, bladder; Cervix - external beam + brachytherapy; Soft tissue sarcoma of limbs, brachytherapy + external beam.

*Medical Imaging (Radiology)*

Diagnostic Radiology – Participating with relevant staff professionals in the performance of clinical x-ray, mammography, fluoroscopy and angiography machines. Performing dosimetry tests and quality assurance.

CT, MRI, and DSA – Performing acceptance and quality assurance tests on CT, DSA, and MR scanners and machines. Performing dosimetry measurements to insure radiation safety.

Medical Ultrasound - Performing acceptance and quality assurance tests for clinical diagnostic ultrasound scanners. Operating clinical ultrasound equipment independently.

**PH 550: Nuclear Medicine II** *(15 L + 30 practicals)*

Covers the whole field of Nuclear Medicine, Starts with the physics of instrumentation from radiation detectors to gamma cameras, beta and gamma sample counters, etc. Considers the use of this equipment in clinical practice and the measurement of performance for quality control. The interpretation of nuclear medicine images and their role in clinical practice is considered together with the application of data processing techniques.

*Image analysis*

Use of computers in nuclear medicine, acquisition of data, data processing, algorithms for analysis.

*Single Photon Emission Tomography (SPECT)*

Reconstruction algorithms, detectors, sensitivity, scatter, attenuation and count rate problems, statistical limitations, instrumentation, calibration and quality control, artifacts.

*Positron Emission Tomography (PET)*

Detection process, reconstruction algorithms, Ring/multi-ring systems, occurrence of random counts, attenuation correction.

**PH 551: Medical Electronics and Instrumentation** * *(15 L)*

Topics will include: Active filters, amplifiers for physiological signals, transducers, instrumentation amplifiers, signal processing and recording, automated signal analysis, renal dialysis equipment, electrical stimulation, anaesthetic gas analyzers, pulse oximetry, management of equipment.

**PH 552: Computer Systems and Methods*** *(15 L)*

This unit is intended to give an insight into the concepts and techniques of applying computer systems and includes the following topics: Data and file structure, sorting and searching: numerical methods including random numbers and optimisation. Information theory and data compression; computer communications and networking. Real-time control systems. Image registration, multimodal image matching, 3D surface and volume rendering.

**PH 553: Biomechanics, Biomaterials and Rehabilitation Engineering*** *(15 L)*

Biomechanics of the musculo-skeletal system, locomotion and gait analysis. Biomechanical instrumentation. Orthopaedic biomechanics. Rehabilitation engineering. Structure and function of

biological materials, properties of bioengineering materials. Implant materials and biocompatiibility. Audiology, communication aids. Respiratory and cardiovascular mechanics.

**PH 554: Computer Architectures and Artificial Intelligence*** *(15 L)*
Modern serial and parallel computer architectures and their use in imaging and real time applications. Technology and programming of parallel systems. Artificial intelligence; introductory concepts and applications, including and outline of networks, expert systems and Prolog.

**PH 555: Ultrasound in Medicine*** *(15 L)*
*Propagation of Ultrasound (US) and interaction with human tissues*
Specific acoustic impedance, pressure and intensity reflection and transmission at plane interfaces, transmission through layers, attenuation, scattering and absorption, frequency dependence of absorption coefficients, tissue absorption and image resolution, beam plotting and power measurements.
*Use of pulse- echo method in diagnostic US*
Design and construction of single element transducers, Piezoelectric effect, Transducer construction, Transducer circuit models Characteristics of single element type.
Demodulation, time gain compensation (TGC), dynamic range, registration, pre-processing, post-processing , Mechanical scanners, multi-element linear array scanners, multi-element phased array scanners, signal processing, pulse repetition frequencies, frame rates multi-element arrays, beam steering; beam focusing, dynamic focusing
*Basic Imaging Techniques*
A-scan, B-scan, TM mode; Imaging of moving structures and flow measurement with US: (Doppler Techniques) Principles of continuous wave blood velocity measurements, transducers, signal processing, bi-directional detection, pulsed Doppler, duplex scanners, colour coded Doppler images.
Artifacts in Ultrasound Images: Reverberation artifact, Refraction and beam deflection, Side lobes and grating lobes , Speed of sound artifacts ,Attenuation artifacts ,Gray scale texture and lesion detectability.
*Therapuetic Ultrasound*
Ultrasound in Hyperthermia, High Intensity Focused Ultrasound.
*Clinical applications*
Examples of applications, dosimetry , use of phantoms , safety.

**PH 556: Non-ionising E. M. Radiations in Medicine*** *(30 L)*
Therapeutic and diagnostic applications of electromagnetic radiations in medicine. Laser surgery and therapy, diathermy using RF and microwave radiations, PUVA and other ultraviolet treatments and thermographic imaging of temperature distribution. Non -ionising radiation interactions with tissue, techniques employed in medicine, biological effects dosimetric considerations and safety requirements will be covered.

**PH 557: Clinical Interactions and Demonstrations** *(30 Hrs)*
*(Assessment of this course will be based on routing clinical interaction and viva)*
Whenever possible during Phases II and III, arrangements will be made for students to receive illustrated tutorial from clinical staff or to visit clinics or operating theatres and intensive care units. The object of these tutorials and demonstrations is to enable students to appreciate the viewpoint of clinicians whose specialties involve physics, imaging computing or engineering. As dates, time and places for such events are governed by Consultant's commitments and the availability of clinical material, students will be notified when arrangements are made. The consultants in the following specialties would co-operate in providing this tuition although all may not be available each year: Anaesthesia; Diagnostic and theraputic radiology; Cardiology; Endoscopy; Pulmonary Function; Audiometry; Renal Dialysis; ICU.

**PH 558: Advanced Techniques and Special procedures in Radiotherapy** (15L)
Radiotherapy with heavy particle beams: pions, neutrons, heavy charged particles.
Isodose distributions and percentage depth dose. Advantages and disadvantages of particle

beams.
Electron therapy; Total and half-body irradiation with photon beams (TBI); Total skin electron irradiation (TSEI); 3D-Conformal Radiation Therapy (3D-CRT); Stereotactic radiosurgery and therapy (SRS),(SRT); Intensity Modulated Radiation Therapy IMRT; Image Guided Radiation Therapy (IGRT); HDR Brachytherapy/Prostate Implant / Intra-vascular Brachytherapy

**PH 599: Research Project *(6 Cr)***
Minimum duration of the project is 3 months. M.Sc. students should start thinking about their choice of project very early in Phase II, reading carefully through the full list of projects on offer, which will be issued to them at that time. It is possible for students to propose topics of their own choice or to ask for a topic in an area not covered by those on the standard list. This, however, can only be done provided a suitable supervisor can be found and provided that the Supervisor and Head of Department agree that the new topic is feasible and appropriate facilities are available.

Each project will be supervised by a specific staff member. Student should plan his/her overall programme fully with his/her supervisor before he or she starts the project. The exchange of ideas with his/her supervisor(s) should continue throughout his/her report preparation as well as his/her project work. The project will be examined by an external examiner.

## 7. PROGRAMME EVALUATION

Programme evaluation will be as stipulated in the PGIS Hand Book.

## 8. TEACHING PANEL

Mr. J. Arun, Consultant Medical Physicist, National Cancer Hospital, Maharagama.
*B.Sc., M.Sc.*
Dr. L.R.A.K. Bandara, Department of Physics, University of Peradeniya
*B.Sc. (Perad.), Ph.D. (Perad.)*
Prof. M.A. Careem, Department of Physics, University of Peradeniya
*B.Sc. (Cey.), M.S., Ph.D. (Lond.)*
Prof. M.A.K.L. Dissanayake, Department of Physics, University of Peradeniya
*B.Sc. (Cey.), M.S., Ph.D. (Indiana)*
Dr. P. Ekanayake, Department of Physics, University of Peradeniya
*B.Sc. (Perad.), M.Sc. (Perad.), Ph.D. (Halle)*
Prof. R. Hewamanna, Department of Nuclear Science. University of Colombo
*B.Sc., Ph.D.*
Dr. B. Hewawitharana, Department of Medicine, University of Peradeniya
*MBBS (Colombo), MD (Radiology)*
Mr. J.M.A.C. Jayasinghe, Atomic Energy Authority, Orugodawatta, Wellampitiya, Colombo
*B.Sc. (Colombo), M.Sc. (Colombo)*
Dr. (Mrs). A. Kariyawasam, Department of Physiology, University of Peradeniya,
*BDS (Sri Lanka), Ph.D. (Toronto)*
Prof. B.S.B. Karunaratne, Department of Physics, University of Peradeniya
*B. Sc. (Cey.), Ph.D. (Warwick.)*
Mr. C. Kasige, Atomic Energy Authority, Orugodawatta, Wellampitiya, Colombo
*B.Sc. (Perad.), M.Sc. (Colombo)*
Dr. S. Kulatunge, Department of Nuclear Science, University of Colombo
*B.Sc. (Perad.), M.Sc, Ph.D.*
Mr. Dilip Kumara, Senior Medical Physicist, Teaching Hospital, Karapitiya.
*B.Sc. (Colombo), M.Sc. (Perad.)*
Dr. D. Nanayakkara, Nuclear Medicine Unit, University of Peradeniya

*MBBS (Sri Lanka), M.Phil. (N'Castle)*

Mr. Pradush Narayanan, Consultant Medical Physicist, National Cancer Hospital, Maharagama
*B.Sc., M.Sc.*

Prof. K. Premaratene, Department of Physics, University of Peradeniya
*B.Sc. (Cey.), M.S., Ph.D. (Hawaii)*

Dr. K.A. Perera, Oncologist, National Cancer Hospital, Maharagama.
*MBBS, MD*

Dr. M.G.V. Pinto, Department of Anaesthesiology, University of Peradeniya.
*MBBS, FCARCSI (Dublin), FRCA (Lond.)*

Mr. A. Ranjith, Atomic Energy Authority, Orugodawatta, Wellampitiya, Colombo
*B.Sc. (Colombo), M.Sc. (Colombo)*

Dr. (Mrs). S. Rosairo, Department of Surgery, University of Peradeniya
*MBBS (Cey.), MD (Radiology)*

Dr. V.A. Seneviratne Department of Physics, University of Peradeniya
*B.Sc.(Perad.), Ph.D.(Oklahoma)*

Dr. R. Sivakanesan, Department of Biochemistry, University of Peradeniya
*BVSc (Cey.), Ph.D. (Hull)*

Dr. V. Sivakumar, Department of Physics, University of Peradeniya
*B.Sc. (Cey), M.S., Ph.D. (Georgia)*

Mr. S. Thenuwara, Atomic Energy Authority, Orugodawatta, Wellampitiya, Colombo
*B.Sc., M.Sc.*

Dr. S. Varathan, Department of Anaesthesiology, University of Peradeniya
*MD (Col.), Ph.D. (Osaka)*

Dr. L. Watawana, Nuclear Medicine Unit, University of Peradeniya
*MBBS, MSc, Ph.D.*

Dr. R.L. Wijayawardana, Department of Physics, University of Peradeniya
*B.Sc. (Cey), M.S., Ph.D. (Albany)*

Prof. P. Wijekoon, Department of Statistics and Computer Science, University of Peradeniya
*B. Sc. (Kel.), Ph.D. (Dortmund)*

**PROGRAMME COORDINATORS**

Dr. V. Sivakumar
Department of Physics,
University of Peradeniya,
Peradeniya
Tel.: 081 2394585
E-mail: vsivakumar53@yahoo.com

Mr. A. Dilip Kumara
Cancer Unit
Teaching Hospital
Karapitiya