

**Master of Science Programme
in Medical Physics
Adjusted in 2018**

1. Programme Title

Master of Science Programme in Medical Physics

2. Name of Degree

Full name : Master of Science (Medical Physics)

Abbreviation : M.Sc. (Medical Physics)

3. Responsible Unit

3.1 Department of Radiology, Faculty of Medicine, Ramathibodi Hospital, Mahidol University

3.2 Faculty of Graduate Studies, Mahidol University

4. Philosophy and Objectives of the Programme

4.1 Philosophy of the Programme

Master of Science Programme in Medical Physics is a programme which involves the application of radiation physics in medicine. The programme emphasizes on producing graduates who are capable of developing and applying sciences of diagnostic imaging physics, radiotherapeutic physics and nuclear medicine physics in diagnosis and treatment of diseases; employs a student – center approach in curriculum development as such courses are designed to help students acquiring the capability in orientation of self learning from research and practice to become a knowledgeable scholar and a medical physicist with high professional skill and high moral and ethical standards.

4.2 Objectives of the Programme

To educate and train scientist to be

- 4.2.1 Demonstrate moral and code of ethics for providing services to the patients and multidisciplinary health-professions in medical physics research and practice.
- 4.2.2 Evaluate the qualitative and quantitative management of radiation source, radiological instruments, and clinical dosimetry process according to international standards as well as risk management, prevention of radiation hazards and safety. In addition, be able to attribute techniques in medical image processing and information systems.
- 4.2.3 Conduct a research to solve the problems of medical physics.
- 4.2.4 Develop multidisciplinary health professions, and possess leadership and teamwork skills.
- 4.2.5 Demonstrate effective communication and interactive presentation skills in English and lifelong learning on medical physics practices.
- 4.2.6 Develop specialized skills through clinical training for safe use of radiation in medicine in one of the three majors i.e., radiation therapy, diagnostic imaging, and nuclear medicine.

5. Reasons for Adjustment

To adjust the course curriculum to match the modern practices in Radiology.

6. Programme Starts

The programme was approved by the Office of the Commission for Higher Education on 13 August 1999, the first adjustment was approved by the Office of the Commission for Higher Education on 28 April 2000 and the second adjustment was approved by the Office of the Commission for Higher Education on 9 August 2001. The third adjustment was approved by the Office of the Commission for Higher Education on 20 July 2007. The fourth adjustment was approved by the Office of the Commission for Higher Education on 17 October 2012.

The current one is going to submit for AUN-QA model for internal assessment within 2017.

7. Admission Requirements

- 7.1. Students must hold a Bachelor's degree in Science.
- 7.2. Receive a cumulative GPA of at least 2.5.
- 7.3. Exceptions to the items 7.2 may be made by the Administrative Programme Committee and the Dean of Faculty of Graduate Studies.

8. Selection Method

Written examination and interview. Final judgement will be under the consideration of the Administrative Programme Committee and the Dean of Faculty of Graduate Studies, Mahidol University.

9. Academic System

9.1 Semester system

9.2 Credits

The number of credits assigned to each subject is determined as follows:

- 9.2.1 **The lecture or discussion** consuming at least 15 hours per semester is equal to 1 credit hour.
- 9.2.2 **The laboratory or practice** consuming at least 30 hours per semester is equal to 1 credit hour.
- 9.2.3 **The thesis** consuming at least 45 hours per semester is equal to 1 credit hour.

10. Duration of Study

The duration of must take at least 2 or not more than 3 academic years.

11. Registration

- 11.1 Students must register as a full time students.
- 11.2 Students must register no less than 9 credits but no more than 15 credits per regular semester, or up to the recommendation of the advisors.

12. Evaluation and Graduation Requirements

12.1 Evaluation

Student evaluation is in accordance with the rules and regulations of Mahidol University.

12.2 Graduation Requirements

Student must

- (1) Take at least 25 credits of course work and 12 credits of thesis, total credit or the programme not less than 37 credits, with GPA not less than 3.00.
- (2) Pass the English Proficiency Examination offered by the Faculty of Graduate Studies, Mahidol University or other qualified institutions, or have a TOEFL score more than 500.
- (3) Complete the thesis research and pass oral thesis examination required for graduation according to regulations of Faculty of Graduate Studies, Mahidol University.
- (4) Have at least one publication or the manuscript has been accepted for publication in standard journal or a conference's proceedings in accordance with the standard criteria for Graduate Studies.

13. Faculty

No	Name – Surname	Degree (Field of Study)	Office
13.1	<i>Assoc.Prof.Dr.Vipa Boonkitticharoen</i>	Ph.D. (Radiation Biology)	Consultantation Email vipaboona@hotmail.com
13.2	<i>*Asst. Prof. Dr. Sawanee Asavaphatiboon</i>	D.Eng.(Nuclear Engineering)	Department of Radiology, Faculty of Medicine , Ramathibodi Hospital Mahidol University
13.3	<i>Assoc.Prof.Thiti Swangsilpa</i>	M.D. Board of Radiation Oncology	Department of Radiology, Faculty of Medicine , Ramathibodi Hospital Mahidol University
13.4	<i>Assoc. Prof. Dr. Puthipan Puataveepong</i>	M.D. American Board of Radiation Oncology	Department of Radiology, Faculty of Medicine , Ramathibodi Hospital Mahidol University
13.5	<i>Assoc. Prof. Dr. Jirawat Utamakul</i>	M.D. Board of Nuclear Medicine	Department of Radiology, Faculty of Medicine , Ramathibodi Hospital Mahidol University
13.6	<i>Lect.Dr.Witaya Sungkarat</i>	M.D., Ph.D. (Biomedical Engineering)	Advanced Diagnostic Imaging Center (AIMC)
13.7	<i>*Lect.Dr.Putthiporn Charoenphun</i>	Ph.D. (Imaging Science and Radiation	Department of Radiology, Faculty of Medicine ,

		Biology)	Ramathibodi Hospital Mahidol University
13.8	<i>*Lect.Dr.Krisanat Chuamsaamarkkee</i>	Ph.D. (Imaging Science and Radiation Biology)	Department of Radiology, Faculty of Medicine , Ramathibodi Hospital Mahidol University
13.9	<i>*Lect.Dr.Puangpen Tangboonduangjit</i>	Ph.D. (Medical Radiation Physics)	Department of Radiology, Faculty of Medicine , Ramathibodi Hospital Mahidol University

**Responsible Faculty of the Programme.*

14. Guest Faculties

14.1 Staffs of the Department of Radiology, Faculty of Medicine, Ramathibodi Hospital, Mahidol University.

14.2 Guest lecturers from other institutes.

No.	Name – Surname	Degree (Field of Study)	Office
14.2.1	Assoc. Prof. Dr. Chiraporn Tocharoenchai	Ph.D. (Biomedical Engineering)	Department of Radiological Technology, Faculty of Medical Technology Mahidol University
14.2.2	Assoc. Prof. Dr. Krongtong Yoovathaworn	Ph.D. (Pharmacology)	Department of Pharmacology Faculty of Science, Mahidol University
14.2.3	Assoc. Prof. Dr. Rujaporn Chanachai	Ph.D. (Medical Physics)	Department of Radiology, Faculty of Medicine, Siriraj Hospital, Mahidol University
No.	Name – Surname	Degree (Field of Study)	Office
14.2.4	Asst. Prof. Dr. Napapong Pongnapang	Ph.D. (Medical Physics)	Department of Radiological Technology, Faculty of Medical Technology, Mahidol University
14.2.5	Asst. Prof. Suvit Punnachaiya	M.Eng. (Nuclear Technology)	Department of Nuclear Technology, Faculty of Engineering, Chulalongkorn

			University
14.2.6	Dr. Kanokrat Tiyanpan	Ph.D. (Health Physics)	Office of Atoms for Peace, Ministry of Science and Technology
14.2.7	Mr. Siri Srimanorom	M.Sc. (Computer)	Department of Medical Sciences, Ministry of Public Health

15. Number of Students

Academic Year	2018	2019	2020	2021	2022
The number of students enrolled	8	8	8	8	8
Cumulative number	-	16	16	16	16
The number of graduate students	-	8	8	8	8

16. Location of Study

The programme will be conducted at

- 16.1 Department of Radiology, Ramathibodi Hospital, Mahidol University
- 16.2 The 8th floor, Medical Learning Resource Center and Ramathibodi School of Nursing Building
- 16.2 Office of Atoms for Peace (OAP), Ministry of Science and Technology
- 16.3 Thailand Institute of Nuclear Technology (TINT)
- 16.4 Division of Radiation and Medical Devices, Department of Medical Science, Ministry of Public Health

17. Library

- 17.1 There are textbooks and journals relevant to medical physics of Diagnostic Radiology, Radiotherapy and Nuclear Medicine in
 - 17.1.1 the library of the Department of Radiology, Ramathibodi Hospital.
 - 17.1.2 the library of Faculty of Medicine, Ramathibodi Hospital.
 - 17.1.3 the library of Faculty of Graduate studies, Salaya campus.
- 17.2 Textbooks and journals relevant to basic radiation and nuclear physics, radiation protection other basic subjects in and cell biology, physiology, pharmacology, etc. at
 - 17.2.1 the library of Faculty of Science and the library of Mahidol University at Salaya campus.
 - 17.2.2 the library of the Office of Atoms for Peace, Ministry of Science and Technology.
- 17.3 Facilities for internet search provided by the programme and by the library of Faculty of Medicine, Ramathibodi Hospital.

18. Budget

The total cost per graduate student is about **200,000** baht

19. Programme Curriculum

19.1 The number of credits required for the programme

At least 37 credits

19.2 Curriculum Structure

The programme is set according to the Ministry of Education Announcement titled “Standard criteria for Graduate Studies 2005”, with specified plan A(2) curriculum.

19.2.1 Core course	16	credits
19.2.2 Required Courses	5	credits
19.2.3 Elective Courses at least	4	credits
19.2.4 Thesis	12	credits

19.3 Course Requirements

19.3.1 Pre-requisites	Credit(Lecture-Lab-Self study)
RARD 511 Radiation and Nuclear Physics	No credit
RARD 528 Basic and Radiological Imaging of Anatomy and Physiology	No credit

19.3.2 Core subjects 16 credits

RARD 627 Medical Image Processing	2(2-0-4)
RARD 513 Physics of Diagnostic Imaging	2(2-0-4)
RARD 516 Radiation Protection and Safety	2(1-2-3)
RARD 520 Radiation Biology	2(2-0-4)
RARD 524 Physics of Radiation Therapy	2(2-0-4)
RARD 525 Clinical Practice of Medical Physics	3(0-9-3)
RARD 526 Physics of Nuclear Medicine	2(2-0-4)
RARD 688 Research Methodology	1(1-0-2)

19.3.3 Required courses 5 credits

RARD 587 Seminar	1(1-0-2)
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Selecting major field of study

A. Radiation Oncology

RARD 628 Advanced Techniques for Radiotherapy	1(1-0-2)
RARD 629 Introduction to Radiotherapy Oncology	1(1-0-2)
RARD 630 Commissioning and Quality Assurance for Radiotherapy Instrumentation	1(0-3-1)
RARD XXX Radiobiology in Radiotherapy	1(1-0-2)

B. Diagnostic Imaging

RARD 626 Magnetic Resonance Imaging	2(1-3-3)
RARD 627 Physics Measurement in Diagnostic Imaging	2(1-3-3)

C. Nuclear Medicine

RARD 632 Advanced Physics in Nuclear Medicine	2(1-1-3)
RARD 633 Clinical Nuclear Medicine	2(1-2-3)

19.3.4 Elective subjects at least 4 credits

MTRD 611 Image Reconstruction and Processing in Nuclear Medicine	3(2-2-5)
MTRD 607 Computer for Radiological Technology	2(2-0-4)
GRID 603 Biostatistics	3(3-0-6)
RARD 512 Electronics and Nuclear Instrumentation	2(1-3-3)
RARD 634 Particle Beam Therapy	1(1-0-2)

19.3.5 Thesis

RARD 698 Thesis	12(0-36-0)
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19.3.6 Research Projects of the Programme

- a. Research in Diagnostic Radiology
 - Physics measurement in diagnostic imaging.
 - Optimization of diagnostic imaging.
- b. Research in Nuclear Medicine

- Dosimetric assessment in nuclear medicine investigation and treatment.
 - Optimization of radionuclide imaging.
- c. Research in Radiotherapy
- Dosimetry and optimization of treatment planning in stereotactic radiosurgery (SRS) and radiotherapy (SRT), intensity modulated radiotherapy (IMRT), VMAT, IGRT, Cyberknife, Tomotherapy, Small field dosimetry, etc.

19.4 Course Code Explanation

Two first letters represent the abbreviated name of Faculty/Institute/College.

RA = Faculty of Medicine, Ramathibodi Hospital

The third and fourth letters represent the abbreviated name of responsible units.

RD = Department of Radiology

The first numbers (5XX and 6XX) represent postgraduate programme

level.

19.5 Study Plan

Year	Semester 1	Semester 2
1	Prerequisites RARD 528 Basic and Radiological Imaging of Anatomy and Physiology RARD 511 Radiation and Nuclear Physics Core subjects RARD 513 Physics of Diagnostic Imaging RARD 520 Radiation Biology RARD 527 Medical Image Processing *RARD 587 Seminar Total 7 credits	RARD 516 Radiation Protection and Safety RARD 524 Physics of Radiation Therapy RARD 526 Physics of Nuclear Medicine *RARD 588 Research Methodology Total 7 credits
2	Major courses 4 credits <ul style="list-style-type: none"> - Radiation Oncology - Diagnostic Imaging - Nuclear Medicine RARD 525 Clinical Practice of Medical Physics RARD 698 Thesis Total 13 credits	RARD 698 Thesis Elective course at least 4 credits Total 10 credits

***Remark :** RARD 528 Seminar : The student is required to give 2 seminars for the 1st year study then the course will be graded at the end of the first semester in the second year.

19.6 Course Description

(1) Pre-requisites

RARD 511 Radiation and Nuclear Physics

Atomic structure; nuclear structure, nuclear models, nuclear disintegrations, nuclear reaction; interaction of photon with matter: interaction of charged particle with matter, interaction of neutron with matter; properties and production of X-rays; principle of shielding for photon, charged particle, and neutron

RARD 528 Basic and Radiological Imaging of Anatomy and Physiology

Major principles in anatomy and physiology, structures and functions of different systems of the human body, anatomy and physiology as delineated in radiological images, normal medical imaging appearance of anatomical structures, their functions and their relationships as demonstrated in radiological imaging.

(2) Core subjects

RARD 527 Medical Image Processing

This course will cover the fundamental components of medical image analysis and visualization. It will start with an introduction to the underlying concepts and mathematics of biomedical image processing including data storage types and co-ordinate systems. This will be followed by the image processing techniques, Intensity Correction, Registration and Segmentation. The remainder of the course will focus on specific examples of high-level image processing and their application in medical imaging. The examples covered will be Non-linear registration, image fusion or cross modality data. In addition to this theoretical background, students will be expected to work through real data examples using common image analysis software.

RARD 513 Physics of Diagnostic Imaging

Principle of physics; application and quality control of diagnostic imaging systems including conventional radiography, mammography, fluoroscopy, computed tomography (CT), ultrasound, electronic imaging, magnetic resonance imaging (MRI) systems including Technical report series 457 (TRS 457): dosimetry in diagnostic radiology an international code of practice.

RARD 516 Radiation Protection and Safety

Radiation weighting factors; equivalent dose; tissue weighting factors; risk assessment; types of exposure :occupation , medicine and publicity ; international organizations in radiation protection, assessment of radiation exposure from external and internal sources; monitoring programme; biokinetic models; MIRD calculation; radiation protection against: occupational, medical, and public ; safe transport of radioactive materials; radioactive waste management; management of chronic and emergency exposure situations; ethics of radiation protection

RARD 520 Radiation Biology

Review of basic concepts; molecular aspect of radiobiology; clinical radiobiology; health effects of radiation exposure

RARD 524 Physics of Radiation Therapy

Radiotherapy equipment and detectors, commissioning and quality assurance of linear accelerator, basic concept of radiation dosimetry, clinical beams for photon and electron beams, absolute dose measurement following TRS398 protocol, relative dose measurements using various detectors, monitor unit calculation, tissue inhomogeneity corrections, Monte Carlo simulation, model base dose calculation algorithms, overview treatment planning system, advanced techniques in radiation therapy, brachytherapy concept and dose measurement.

RARD 525 Clinical Practice of Medical Physics

Major in Radiation Oncology: Performing in quality assurance of linear accelerator, CT-simulator, treatment planning system; absolute dose measurement following TRS398 protocol; monitor unit calculation; brachytherapy; shielding calculation.

Major in Nuclear Medicine: Student will receive extensive clinical and theoretical knowledge, which will equip you with the specialist skills required for the clinical medical physicist. Student will develop skills in performing and management of quality assurance of nuclear medicine equipment, internal dosimetry, radioactivity measurement and radiation protection from real clinical setting. In addition, student will gain the understanding of the workflow, clinical process and roles of medical physicist in nuclear medicine.

Major in Diagnostic Imaging: Perform dosimetry in diagnostic radiology using standard protocol 457, quality assurance of diagnostic instrument, shielding calculation including optimization of diagnostic image quality and radiation dose.

RARD 526 Physics of Nuclear Medicine

This course offers the introduction of various types of nuclear medicine counting equipment such as gas-filled detector, scintillation detector and semiconductor detector as well as using appropriated nuclear counting statistic method. Students will develop a beginning understanding of nuclear medicine equipment, imaging quality and image noise analysis in nuclear medicine. Explored in this course are the basic principles of non-imaging equipment in nuclear medicine, gamma camera, SPECT, PET, hybrid imaging (e.g. SPECT/CT and PET/CT) and BMD. This course examines radionuclide production, mechanisms of radionuclide localization the use and preparation of radiopharmaceuticals for both diagnostic and therapeutic applications and quality control of radiopharmaceuticals. This course also emphasizes on the dose calculation from internalized radionuclide with standard dosimetry method such as MIRD (Medical Internal Radiation Dose).

RARD 588 Research methodology

Introduction to research and research ethics, literature survey, presenting a scientific issue, oral presentation, management and presentation skills, poster presentation, writing research proposal, present designed project

(3) Required subjects

RARD 587 Seminar

The principles and theories; analysis the major issue; identifying the problem; analysis the reliability; suggesting the problem solving; research question, design, and tools ; ethics for conducting and publishing research

Selecting Major field of study

Major in Radiation Oncology

RARD 628 Advanced Techniques for Radiotherapy

The concept of intensity modulated radiotherapy (IMRT), volumetric modulated arch therapy (VMAT), and Tomotherapy; treatment planning system for tumor of brain, head and neck, lung, prostate, and pelvis; quality assurance for IMRT, multileaf collimator (MLC), and patient specific; stereotactic body radiotherapy (SBRT) and motion management; small field dosimetry; image registration and image guided radiotherapy (IGRT); professional conduct; treatment planning techniques for brachytherapy; total body irradiation (TBI) and total skin electron irradiation (TSEI); microdosimetry; particle therapy.

RARD 629 Introduction to Radiotherapy Oncology

Imaging used and applied in radiotherapy; neoplasia; carcinogenesis: epidemiology, mechanism of carcinogenesis, cancer prevention and screening; cancer biology: oncogene and tumor suppressor gene; molecular basis of cancer: angiogenesis, invasion and metastasis; overview of normal tissue tolerance, complication and management in radiotherapy; Radiation therapy management, techniques, and modalities according to common cancers: GI, Head & Neck, Lung, Breast, GU, Brain; cancer cell death and tumor response to radiotherapy; host defense against tumor: tumor immunity.

RARD 631 Radiobiology in Radiotherapy

Overview application of radiobiological principles in radiotherapy, BED and EQD2, TCP and NTCP, the volume effect, oxygen effect, hypoxia, LET and RBE, combined radiotherapy and chemotherapy, retreatment tolerance of normal tissues, tumor growth and response to irradiation, the dose-rate effect, particle in radiotherapy Radiation-induced malignancies

Major in Nuclear Medicine

RARD 632 Advanced Physics in Nuclear Medicine

This subject introduces the student to the advance physics of nuclear medicine. This will cover the establishing policy and Term of Reference (TOR) for purchase the nuclear medicine including the acceptance and other advanced quality assurance procedures for nuclear medicine equipment. This course covers the quantitative methods, tracer kinetic model, radiation biology, internal dosimetry and computation methods in

nuclear medicine. This subject also includes relevant nuclear medicine techniques that used in other biomedical research.

RARD 633 Clinical Nuclear Medicine

Basic concepts and the knowledge of clinical nuclear medicine, nuclear cardiology, pulmonary system, central nervous system, gastrointestinal system, genitourinary system, skeletal system, lymphatic, vascular system, endocrine system, tumour imaging, inflammation, radionuclide therapy in NM, Non-imaging procedures in NM, role of Nuclear Medicine physicist in clinical NM service diagnostic, therapeutic, non-imaging and dosimetry.

Major in Diagnostic Imaging

RARD 626 Magnetic Resonance Imaging

Physics of MRI, data acquisition and image reconstruction; image quality and artifact; advanced techniques of MRI; ethics of magnetic resonance imaging

RARD 627 Physics Measurement in Diagnostic Imaging

Physics measurement of diagnostic imaging, image quality, quality control and quality assurance, radiation dosimetry as following Technical Reports Series no. 457: Dosimetry in Diagnostic Radiology: An international code of practice, IAEA

(4) Elective subjects

GRID 603 Biostatistics

Methods of statistical data collection, analysis and interpretation of biomedical and public health data. Probability distributions, sampling distributions, estimation of parameters, significance tests by using parametric and nonparametric methods, analysis of variance, correlation and regression analyses

MTRD 607 Computer for Radiological Technology

Computer hardware and software, microprocessor architecture, Computer operating system, windows, UNIX and Linux, basic software engineering, logical operators, C-language statements and programming, software tools, MATLAB

MTRD 611 Image Reconstruction and Processing in Nuclear Medicine

Image theory, advances in image reconstruction techniques in nuclear medicine; analytical and iterative methods; image noise and filtering

RARD 512 Electronics and Nuclear Instrumentation

Introduction to electronics, circuit analysis, electronic passive devices, electronic active devices, amplifying and switching principle, electronic circuits, time and frequency domain, analog signal system, amplitude and time measurement, digital signal system, nuclear radiation detection process, nuclear instrumentation, radiation machine principle.

RARD 634 Particle Beams Therapy

Indications and clinical results for particle beam therapy; physics in particle beam therapy; detectors for absorbed dose and dosimetry under reference conditions; dosimetry under non-reference condition; motion management and treatment planning system; QA in particle beam therapy

(5) Thesis

RARD 698 Thesis

Research of medical physics in diagnostic radiology, radiotherapy, and nuclear medicine; ethics of conducting, presenting, and publishing research