



**King Fahd University of Petroleum & Minerals**  
**College of Sciences**



**Master's Program**  
**in**  
**Medical Physics**

## Medical Physics

Medical physics is an applied branch of physics concerned with the application of the concepts and methods of physics to the diagnosis and treatment of human disease. The main areas of medical physics are the treatment of cancer by ionizing radiation (*radiation oncology*), diagnostic imaging with x rays, ultrasound and nuclear magnetic resonance (*diagnostic radiology*), diagnostic imaging with radioisotopes (*nuclear medicine*) and the study of radiation hazards and radiation protection (*health physics*).

## Role of Medical Physicists

Medical physicists are generally involved in three areas of activities: clinical service and consultation; research and development; and teaching. Clinical medical physicists are responsible for assuring that imaging and treatment facilities meet the rules and regulations of the various Health Departments. They insure the quality of diagnostic imaging procedures and the radiation safety. They develop and improve imaging techniques (e.g., mammography, CT, MR, ultrasound). They also insure the quality and accuracy of radiation therapy for the treatment of cancer. They collaborate with radiation oncologists to design treatment plans to insure that cancer patients receive the prescribed dose of radiation to the correct location.

## Program Objectives

The primary objectives of this Master's program in medical physics are to provide education and clinical training for graduate students and to prepare them for careers in areas of diagnostic imaging, nuclear medicine, radiation therapy, and health physics.



## Admission Requirements

Motivated applicants who have a B.S. degree in science or engineering from a university of recognized standing are invited to apply for admission to the Master's degree in medical physics, provided they satisfy the general admission requirements of the Graduate School. Applicants must have a suitable scientific background to enter the medical physics program demonstrated by the completion of the following KFUPM courses or their equivalent: Methods of Applied Mathematics (MATH 301), Modern Physics (PHYS 212), Experimental Physics I (PHYS 303), and Physiology (BIOL 202). Applicants must make up any deficiencies in their prior program within two semesters of enrollment. Once accepted in the program, graduate students are required to take a full time course load.

## Academic Program

The following are the requirements for the Master's degree in medical physics.

COURSE	CREDITS
1. Completion of core courses	22
2. Completion of elective courses	11
3. Completion of clinical training	6
4. Completion of Med Phys Project	3
5. Passing the comprehensive examination	—
<b>TOTAL</b>	<b>42</b>

**Core Courses**

The following six core courses are required for the Masters degree in medical physics.

<b>COURSE</b>	<b>#</b>	<b>TITLE</b>	<b>CR</b>
MEPH	500	Human Anatomy and Physiology	3
MEPH	510	Radiobiology	2
MEPH	561	Radiological Physics and Dosimetry	3
MEPH	563	Radioisotopes in Medicine and Biology	3
MEPH	566	Radiotherapy Physics	3
MEPH	567	Diagnostic Radiology Physics	3
MEPH	569	Health Physics	4
			<b>22</b>

**Elective Courses**

A candidate for the Master's degree in medical physics will also be required to take 11 credit hours to be chosen as follows:

1. A minimum of 3 credit hours to be selected from the following list of courses.

<b>COURSE</b>	<b>#</b>	<b>TITLE</b>	<b>CR</b>
MEPH	581	Laboratory in Radiological Physics – Radiotherapy	1
MEPH	582	Laboratory in Radiological Physics – Diagnostic Radiology	1
MEPH	583	Laboratory in Radiological Physics – Nuclear Medicine	1
MEPH	584	Laboratory in Radiological Physics – Health Physics	1
MEPH	585	Laboratory in Radiological Physics – CT, MRI, and DSA	1
MEPH	586	Laboratory in Radiological Physics – Medical Ultrasound	1

2. The rest of the electives should be selected from the following list of courses.

<b>COURSE</b>	<b>#</b>	<b>TITLE</b>	<b>CR</b>
MEPH	501	Physics for Medicine and Biology	3
MEPH	511	Instrumentation for Medical Physics	3
MEPH	568	Magnetic Resonance Imaging (MRI)	2
MEPH	570	Advanced Brachytherapy Physics	2
MEPH	571	Advanced External Radiation Oncology	3
MEPH	573	Imaging in Medicine	3
MEPH	574	Applications of Digital Imaging: DSA, CT, MRI	2
MEPH	575	Diagnostic Ultrasound Physics	3
MEPH	591	Selected Topics in Medical Physics	3
MEPH	592	Independent Reading	3
EE	614	Digital Signal Processing	3
EE	617	Image Processing and Holography	3
MATH	513	Mathematical Methods for Engineers	3

**Clinical Training**

Clinical medical physics training is obtained in the Laboratory in Radiological Physics courses (MEPH 581-586). Each laboratory involves performing particular experiments and procedures in hospitals. Additional clinical medical physics training is obtained in the clinical training course (MEPH 590). The course consists of a 16-week hospital-based clinical rotation in: diagnostic imaging (x-rays, CT, DSA, fluoroscopy, diagnostic ultrasound), MRI, nuclear

medicine, radiation therapy, mammography, radiation protection, and health physics. A student in this course observes and practices clinical procedures under the direct supervision of a senior clinical medical physicist. The student will write a monthly progress report about the clinical procedures he learned and performed. The evaluation and the follow-up of each student will be done in cooperation between the supervising medical physicist from the hospital and a medical physics faculty member from KFUPM.

**Comprehensive Examination**

All candidates for the Masters degree in medical physics are required to take a written comprehensive examination prior to receiving the degree. The examination is offered near the end of each semester and consists of questions on the core courses. Candidates are advised to take this exam at the end of the semester in which they complete the courses. A candidate who fails the examination may repeat it at a later regularly scheduled time. Only one such repeat is permitted.



**Degree Plan**

COURSE #	TITLE	LT	LB	CR	
<b>FIRST SEMESTER</b>					
MEPH 500	Human Anatomy and Physiology	3	0	3	
MEPH 510	Radiobiology	2	0	2	
MEPH 561	Radiological Physics and Dosimetry	3	0	3	
MEPH 567	Diagnostic Radiology Physics	3	3	4	
		<b>12</b>	<b>3</b>	<b>12</b>	<b>12</b>
<b>SECOND SEMESTER</b>					
MEPH 566	Radiotherapy Physics	2	3	3	
MEPH 563	Radioisotopes in Medicine and Biology	2	3	3	
MEPH 58x	Elective Laboratory in Radiological Physics	0	3	1	
XXX xxx	Elective	3	0	3	
MEPH 599	Seminar	1	0	0	
		<b>8</b>	<b>9</b>	<b>10</b>	<b>10</b>
<b>THIRD SEMESTER</b>					
MEPH 569	Health Physics	3	3	4	
MEPH 58x	Elective Laboratory in Radiological Physics	0	3	1	
MEPH 58x	Elective Laboratory in Radiological Physics	0	3	1	
XXX xxx	Elective	3	0	3	
XXX xxx	Elective	2	0	2	
		<b>8</b>	<b>9</b>	<b>11</b>	<b>11</b>
<b>FOURTH SEMESTER</b>					
MEPH 590	Clinical Training	0	0	6	
MEPH 600	Medical Physics Project	0	0	3	
		<b>0</b>	<b>0</b>	<b>9</b>	<b>9</b>
					<b>42</b>

**Courses Description****MEPH 500 Human Anatomy and Physiology (3-0-3)**

The course will cover subjects including cells physiology, organs and systems physiology and anatomy. The student will learn to identify gross anatomical structures, define the major organ systems, and describe the physiological mechanisms for repair, maintenance, and growth. Anatomical structures and physiological function should be correlated with the imaging modalities used to view them.

Prerequisite: Instructor Consent

**MEPH 501 Physics for Medicine and Biology (3-0-3)**

Forces on bones and muscles; body fluid flow; electrodynamics of nerve impulses; electrocardiograms; magnetocardiograms and magnetoencephalograms; diffusion processes, membrane transport, kidney function; biological effects in magnetic resonance and ultra-low frequency electromagnetic radiation; laser applications.

Prerequisite: PHYS 212 or equivalent

**MEPH 510 Radiobiology (2-0-2)**

Effects of ionizing radiations on living cells and organisms, including physical, chemical, and physiological bases of radiation cytotoxicity, mutagenicity, and carcinogenesis.

Co-requisite: MEPH 561

**MEPH 511 Instrumentation for Medical Physics (2-3-3)**

Concepts of medical instrumentation, transducers, and medical electronics design. Various types of sensors and measurement apparatus used for the calibration of medical imaging and therapy systems will receive particular attention.

Prerequisite: PHYS 303 or equivalent

**MEPH 561 Radiological Physics and Dosimetry (3-0-3)**

Interactions and energy deposition by ionizing radiation in matter; concepts, quantities and units in radiological physics; principles and methods of radiation dosimetry.

Prerequisites: PHYS 212 and MATH 202 or equivalent

**MEPH 563 Radioisotopes in Medicine and Biology (2-3-3)**

Physical principles of radioisotopes used in medicine and biology and operation of related equipment; lecture and lab.

Prerequisite: PHYS 212 or equivalent

**MEPH 566 Radiotherapy Physics (2-3-3)**

Ionizing radiation use in radiation therapy to cause controlled biological effects in cancer patients. Physics of the interaction of the various radiation modalities with body-equivalent materials, and physical aspects of clinical applications; lecture and lab.

Prerequisite: MEPH 561

**MEPH 567 Diagnostic Radiology Physics (3-3-4)**

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Physics of x-ray diagnostic procedures and equipment, radiation safety, general imaging considerations; lecture and lab.

Prerequisites: PHYS 212 and MATH 202 or equivalent

**MEPH 568 Magnetic Resonance Imaging (MRI) (2-0-2)**

Physics and technology of magnetic resonance imaging (MRI), emphasizing techniques employed in medical diagnostic imaging. Major topics: physics of MR, pulse sequences, hardware, imaging techniques, artifacts, and spectroscopic localization.

Prerequisite: MEPH 567

**MEPH 569 Health Physics (3-3-4)**

Physical and biological aspects of the use of ionizing radiation in industrial and academic institutions; physical principles underlying shielding instrumentation, waste disposal; biological effects of low levels of ionizing radiation; lecture and lab.

Prerequisite: MEPH 561

**MEPH 570 Advanced Brachytherapy Physics (2-0-2)**

The use of radioactive sources for radiotherapy including: materials used, source construction dosimetry theory and practical application, dosimetric systems, localization and reconstruction. The course covers low dose rate, high dose rate and permanently placed applications.

Prerequisite: MEPH 566

**MEPH 571 Advanced External Radiation Oncology (3-0-3)**

Physics of ionizing radiation therapy with emphasis on external beam dosimetry and treatment planning.

Prerequisite: MEPH 566

**MEPH 573 Imaging in Medicine (3-0-3)**

The conceptual, mathematical and statistical aspects of imaging science, and a survey from this formal viewpoint of various medical imaging modalities, including film-screen radiography, positron and x-ray computed tomography, and magnetic resonance imaging.

Prerequisites: PHYS 212 and MATH 301 or equivalent

**MEPH 574 Applications of Digital Imaging: DSA, CT, MRI (2-0-2)**

This course will focus on practical aspects of digital diagnostic imaging. The course will cover digital subtraction angiography (DSA), x-ray transmission computed tomography (CT), and nuclear magnetic resonance imaging (MRI).

Prerequisites: MEPH 561 and MEPH 567

**MEPH 575 Diagnostic Ultrasound Physics (2-3-3)**

Propagation of ultrasonic waves in biological tissues; principles of ultrasonic measuring and imaging instrumentation; design and use of currently available tools for performance evaluation of diagnostic instrumentation; biological effects of ultrasound; lecture and lab.

Prerequisites: PHYS 212 and MATH 202 or equivalent

**MEPH 581 Laboratory in Radiological Physics – Radiotherapy (0-3-1)**

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Practicing the protocol for the determination of absorbed dose from high-energy photon and electron beams. Performing dosimetry and quality assurance for radiation therapy machines. Participating in treatment plans of cancer patients.

Prerequisite: MEPH 566

**MEPH 582 Laboratory in Radiological Physics – Diagnostic Radiology (0-3-1)**

Measuring the performance of clinical x-ray, mammography, fluoroscopy and angiography machines. Performing dosimetry tests and quality assurance.

Prerequisite: MEPH 567

**MEPH 583 Laboratory in Radiological Physics – Nuclear Medicine (0-3-1)**

Practicing the acceptance and quality assurance procedures for Nuclear Medicine imaging and non-imaging hardware. Practicing regulations and record keeping associated with the acquisition and dispensing of radio-pharmaceuticals. Radiation safety of patients, personnel, and area monitoring.

Prerequisite: MEPH 563

**MEPH 584 Laboratory in Radiological Physics – Health Physics (0-3-1)**

Performing dosimetry procedure to monitor ionizing radiation in hospital and radiation areas. Performing shielding tests and shielding design. Practicing regulations and record keeping associated with radiation monitoring and radiation safety.

Prerequisite: MEPH 569

**MEPH 585 Laboratory in Radiological Physics – CT, MRI, and DSA (0-3-1)**

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

Prerequisite: MEPH 567

**MEPH 586 Laboratory in Radiological Physics – Medical Ultrasound (0-3-1)**

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

Prerequisites: PHYS 212 and MATH 201 or equivalent

**MEPH 590 Clinical Training (0-0-6)**

The course consists of a 16-week hospital-based clinical rotation in: diagnostic imaging (x-rays, CT, DSA, fluoroscopy, diagnostic ultrasound), MRI, nuclear medicine, radiation therapy, mammography, radiation protection, and health physics. The student will write a monthly progress report about the clinical procedures he learned and performed.

Prerequisite: Department Approval

**MEPH 591 Selected Topics in Medical Physics (3-0-3)**

Various subjects of interest to medical physics faculty and students.

Prerequisite: Consent of the Instructor

**MEPH 592 Independent Reading (3-0-3)**

The course can be taken under the supervision of a faculty member to conduct an in-depth study of a subject.

Prerequisite: Consent of the Instructor

**MEPH 599 Seminar (1-0-0)**

Graduate students are required to attend the regular departmental seminars. This course carries no credit and is graded on a Pass or Fail basis.

Prerequisite: Graduate Standing

**MEPH 600 Medical Physics Project (0-0-3)**

The project is an independent study performed under the supervision of a medical physics faculty advisor. The report should include an introduction to the topic, literature review, research methodology, analysis of data, conclusions and recommendations, appendices and references. The report will be presented and evaluated by a faculty committee.

Prerequisite: Graduate Standing.