C A M P E P

Commission on Accreditation of Medical Physics Educational Programs, Inc.

Standards for Accreditation of Graduate Educational Programs in Medical Physics

Revised May 2025

Preamble

Medical Physics is a branch of physics that applies the concepts and principles of physics to the diagnosis and treatment of human disease. Medical Physics encompasses four fields: Imaging Physics, Nuclear Medicine Physics, Radiation Oncology Physics and Medical Health Physics. This document focuses on the essential educational and experience requirements needed to engage in medical physics research and development, and to enter a residency program in preparation for clinical practice of one of the first three fields.

Terms such as “shall”, “must”, “require”, “should”, “may” and “recommend” are frequently used in these standards. The terms “shall”, “must”, and “require” denote items or activities that CAMPEP considers are mandatory components of an educational program. The terms “should”, “may” and “recommend” are considered desirable but not essential components of an educational program.

* Items marked with an asterisk are not required for graduate certificate programs.

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1. Program Goal and Objectives

The program objectives shall, at a minimum, include the development in the student of:

- an understanding of the role of patient safety in the clinical practice of medical physics;
- an understanding of the physics, mathematics and other physical science required for a career in medical physics;
- an understanding of how research and inquiry lead to the creation of new knowledge;
- the ability to critically evaluate research and scholarship in medical physics;
- the competent use of research to pose new questions and to solve problems in research and clinical settings;
- the communication and interpersonal skills that are necessary to function in a collaborative, multidisciplinary environment;
- the professional attributes and the ethical conduct and actions that are required of medical physicists; and
- a valuing of career-long continuing education to keep scientific knowledge and skills current.

1.1 The program shall state its mission and objectives.

2. Program Structure and Governance

2.1 Institutions in the United States that offer graduate education in medical physics must be accredited by an accreditation organization recognized by the US Department of Education or the Council for Higher Education Accreditation. Programs in other jurisdictions must have received appropriate equivalent recognition.

2.2 *Graduate programs in medical physics shall be sited in a well-defined university structure where the term "university" refers to an institute of higher learning and research, with standing in the academic community, a full-time faculty, frequently multiple schools and departments offering study in a comprehensive range of multidisciplinary areas and generally with a reputation for distinct areas of research. Although a Medical Physics Graduate Program may be newly established within the institution, it is expected that the institution be well-established with a history of stability, an infrastructure to support students through their studies, and with well-defined services for protecting students' interests, e.g., an ombudsman.

2.3 The Graduate program shall be overseen by an appropriate steering committee, which is chaired by the program director or delegate and meets at least twice a year.

2.4 The steering committee's membership shall include the program director and other faculty members who are involved in medical physics education.

2.5 The process for appointment of the members of the steering committee shall be documented.

2.6 Minutes of the steering committee meetings, including a summary of any actions that are proposed or taken, shall be recorded.

2.7 A mechanism for students to communicate with the steering committee shall be available.

2.8 The steering committee shall establish a process for evaluating the quality of the educational program and annually assess the quality of the educational program based on this process, taking appropriate action to address improvements when needed.

2.9 The steering committee shall assess and monitor the strengths, weaknesses, needs, and long-term goals of the program.

2.10 A procedure shall be in place to appropriately counsel, censure, and, after due process, dismiss students who fail to achieve acceptable grades, or who behave unethically.

2.11 All courses and clinical practica, including distance learning courses, shall use well-defined and consistently applied metrics for evaluating student progress and performance.

2.12 *A graduate program that has tracks that are not CAMPEP-accredited must clearly identify those students who are enrolled in the accredited program. The mechanism by which the program designates the graduates of the accredited track, e.g., an attestation of completion or a unique notation on the diploma, must be clearly stated on the program's website.

2.13 An accredited program must publicly describe the program and the achievements of its graduates and students, preferably through a publicly accessible web site, readily accessible from the program website home page. This information must be updated no less often than annually and must include, for each program (MS, PhD or Certificate), the numbers of applicants to the program, of students offered admission, of students matriculated, and of graduates. Where possible, information on the subsequent positions of graduates must also be provided, i.e., residencies, industrial positions, etc. This information should not identify individuals.

2.14 A graduate program shall clearly identify the program type (MS, PhD, and/or certificate). If that is not clearly delineated in the program name, then the program must identify the program type on the home page of its website.

3. Admissions

3.1 Students entering a medical physics graduate educational program shall have a strong foundation in basic physics. This shall be demonstrated either by an undergraduate or graduate degree in physics, or by a degree in an engineering discipline or another of the physical sciences and a minor in physics. CAMPEP considers at least three upper-level undergraduate physics courses taught through a physics department to be equivalent to a minor in physics. The topics of these courses may include classical mechanics, modern physics, quantum mechanics, electromagnetism, statistical physics and thermodynamics, optics, nuclear/particle physics, and astrophysics).

3.2 If a graduate program conditionally admits applicants with deficiencies in their academic background, the remedial physics education of such students shall be well-defined and documented.

3.3 Admission standards for incoming students are clearly stated.

3.4 The method of processing an application, including evaluating the application and informing the applicant of actions taken, shall be clearly stated.

3.5 The program must engage in admissions processes that: (a) create an admissions environment that is free from discrimination, harassment, or coercion of applicants, and (b) support the recruitment of a diverse and inclusive educational program.

4. Program Director

4.1 The process for the appointment of the program director shall be documented.

4.2 A sole program director shall be responsible and accountable for ensuring that the graduate program satisfies the CAMPEP standards and shall ensure that all students receive a high-quality education in all courses and practica.

4.3 The program director must possess a PhD or other doctoral degree in medical physics or a closely-related discipline, and hold an appropriate academic appointment at the institution hosting the program.

4.4 The program director shall have at least five years of full-time post-graduate experience in medical physics.

4.5 The program director shall be responsible for coordinating the faculty, recruiting students into the program, advising the students, and evaluating and promoting the program.

4.6 The program director shall be responsible for determining and documenting that each student offered entry into the graduate program satisfies the CAMPEP admission standards for graduate education in medical physics or completes rigorous remedial education to meet the standards.

4.7 The program director shall ensure that all student statistics, annual reports, and other information that is required by CAMPEP are reported accurately and in a timely fashion.

4.8 The program director shall ensure that student progress is regularly monitored.

5. Program Faculty

5.1 The process for the appointment of the program faculty shall be documented

5.2 An adequate number of program faculty members shall be available and have sufficient time for teaching and advising graduate students.

5.3 A majority of the program faculty shall have an academic appointment at an accredited educational institution.

5.4 Some of the program faculty members shall be licensed to practice medical physics by an appropriate jurisdiction or be certified in a branch of medical physics by an appropriate certifying agency.

5.5 Program faculty members shall be engaged in scholarly activities such as participation in scientific societies and meetings, scientific presentations and publications, and continuing education.

6. Institutional Support

6.1 The institution that sponsors the graduate program shall provide administrative support, including educational resources, a budget, students' office or cubicle space and access to computing resources, conference room(s), audiovisual facilities, and office support (e.g., copiers, internet access, email accounts, and telephones).

6.2 The institution must express its intention to support the program both financially and administratively for the term of the accreditation.

6.3 Any financial support of students, including benefits, shall be described clearly to prospective applicants prior to their application to the program.

6.4 Entering students shall be provided with orientation information to ensure their efficient integration into the program.

6.5 The program shall instruct its students on the potential hazards that they might encounter and on the appropriate measures for them to take to minimize risks to themselves, others, and equipment.

6.6 The program shall instruct its students regarding the professional, ethical, and regulatory issues in the responsible conduct of research and in the protection of the confidentiality of patient information.

6.7 The program must engage in practices that a) create an educational environment that is free from discrimination, harassment, or coercion of graduate students and program staff, (b) educate students and program staff regarding unprofessional behavior and the process for reporting, investigating, and addressing such concerns, and (c) support the recruitment and retention of a diverse and inclusive workforce for its educational program.

7. Educational Environment

7.1 The program shall have mechanisms that encourage open discussion and communication, and facilitate the exchange of knowledge, experience and ideas.

7.2 *Conference, seminar, and journal club activities shall be used for students to practice their presentation and oral communication skills.

7.3 Students shall have access to a variety of journals, books, and appropriate resource materials.

7.4 Students shall have access to appropriate clinical and research facilities and the program shall demonstrate that clinical facilities and equipment are used in the teaching of practical aspects of core topics in imaging physics and radiation oncology physics.

7.5 Students shall be provided with a mechanism for regular feedback concerning the quality of their instruction and the diligence of their teachers and mentors. The students shall be protected from unwarranted retribution.

7.6 Feedback on the overall effectiveness of the program and recommendations for improvement should be sought from graduates.

7.7 Issues and concerns that are identified through feedback shall be evaluated by the steering committee and remedial action shall be taken where appropriate.

7.8 *Graduate students shall engage in research projects to develop a systematic approach to solving problems and to gain a familiarity with scientific method.

8. Core Graduate Curriculum

The structure of course work in a graduate education program in medical physics may be defined by the program but shall, as a minimum, include the topics listed below. These core topic courses will, for example, typically require about 18 semester credit hours or more. A typical university requires in excess of 30 credit hours of didactic courses to fulfill graduate degree (M.S., Ph.D.) requirements. Additional courses provided by the graduate program to fulfill these requirements may vary widely from program to program. For example some programs may require graduate level physics courses, while others may offer advanced courses in medical physics, statistics, or other allied topics. These additional courses may be required or elective at the discretion of the program.

Typically, completion of a master's program will take two academic years. Significant deviations from this period should be justified.

8.1 Radiological physics and dosimetry

8.1.1 Atomic and nuclear structure
8.1.2 Classification of radiation
8.1.3 Quantities and units to describe radiation fields
8.1.4 Quantities and units to describe radiation interactions
8.1.5 Indirectly ionizing radiation: photons
  8.1.5.1 Exponential attenuation
  8.1.5.2 Photon interactions
8.1.6 Indirectly ionizing radiation: neutrons
  8.1.6.1 Neutron interactions
8.1.7 Directly ionizing radiation (electrons, protons, others)
  8.1.7.1 Interactions of directly ionizing radiation
8.1.8 Radioactive decay
8.1.9 Charged particle equilibrium
8.1.10 Radiation dosimetry – general
8.1.11 Radiation dosimetry – calorimetry
8.1.12 Radiation dosimetry – chemical
8.1.13 Cavity theory
8.1.14 Ionization chambers
  8.1.14.1 Calibration of photon and electron beams with ionization chambers
8.1.15 Dosimetry and phantoms for special beams
8.1.16 *In vivo* dosimetry (TLD, OSL)
8.1.17 Relative dosimetry methods
8.1.18 Neutron dosimetry
8.1.19 Pulse mode detectors

8.2 Radiation protection and safety

8.2.1 Introduction and historical perspective
8.2.2 Interaction physics applied to radiation protection
8.2.3 Protection principles (time, distance, shielding)

8.2.4 Handling radiation and radioactive sources
8.2.5 Radiation survey/contamination equipment
8.2.6 Personnel monitoring
8.2.7 Radiation dose limits
8.2.8 Protection regulations
8.2.9 Shielding Principles: beams and sources
8.2.10 Application of statistics
8.2.11 External exposure
8.2.12 Internal exposure
8.2.13 Environmental dispersion
8.2.14 Radioactive waste

8.3 Fundamentals of medical imaging

8.3.1 History of medical imaging
8.3.2 Mathematical Models
8.3.3 Reconstruction mathematics
8.3.4 Radiography
- 8.3.4.1 X-ray tube construction and X-Ray beam production; kV, mA, pulse width
- 8.3.4.2 X-ray beam properties and interactions in matter
- 8.3.4.3 Sources of image contrast and noise; detector efficiency and dose, noise power spectrum analysis
- 8.3.4.4 Spatial and temporal resolution
- 8.3.4.5 Detector technologies and anti-scatter grids
- 8.3.4.6 Digital radiography and computed radiography
- 8.3.4.7 Mammography
- 8.3.4.8 Performance testing and equipment QA

8.3.5 Fluoroscopy
- 8.3.5.1 Detector technologies; Flat panel imager, image intensifier/TV
- 8.3.5.2 Radiographic contrast agents
- 8.3.5.3 Automatic exposure control and basic imaging modes
- 8.3.5.4 Digital angiography and digital subtraction angiography
- 8.3.5.5 Operating technique and dose to patient and staff
- 8.3.5.6 Performance testing and equipment QA

8.3.6 Computed tomography
- 8.3.6.1 Basic data acquisition principles and scanning modes
- 8.3.6.2 Basic reconstruction modes
- 8.3.6.3 In-plane spatial resolution, slice thickness, image noise, dose
- 8.3.6.4 Artifacts
- 8.3.6.5 Cone-beam computed tomography
- 8.3.6.6 Performance testing and equipment QA
- 8.3.6.7 CT scanning technique and patient dose

8.3.7 Nuclear medicine imaging
- 8.3.7.1 Modes and processes of radioactive decay
- 8.3.7.2 Basics of nuclear reactions and radioactivity
- 8.3.7.3 Nuclear counting statistics
- 8.3.7.4 Counting systems and gamma cameras
- 8.3.7.5 Image quality and reconstruction

8.3.7.6 Physics of SPECT and PET systems
8.3.7.7 Radiotracer techniques
8.3.7.8 Radiopharmaceutical design and mechanisms of localization
8.3.7.9 Performance testing and equipment QA

8.3.8 Magnetic resonance imaging
8.3.8.1 Magnetization, precession, Larmor equation, rotating frame of reference, spin tipping
8.3.8.2 T1 and T2 relaxation
8.3.8.3 Pulse sequences and image formation (slice selection, phase encoding, frequency encoding)
8.3.8.4 Spin echo image formation
8.3.8.5 Image contrast (proton density, T1, T2 and T2*)
8.3.8.6 Definition of common acquisition parameters (TE, TR, field of view, spatial resolution) and signal-to-noise ratio
8.3.8.7 Rapid imaging techniques (gradient echo, fast spin echo)
8.3.8.8 Magnetization preparation techniques (inversion recovery, saturation)
8.3.8.9 Artifacts
8.3.8.10 Performance testing and equipment QA
8.3.8.11 MR contrast agents
8.3.8.12 Safety and biological effects

8.3.9 Ultrasound
8.3.9.1 Propagation of ultrasound through tissue; sources of contrast
8.3.9.2 Diagnostic transducers, including materials and probe types
8.3.9.3 2-D, 3-D ultrasound imaging
8.3.9.4 Spatial and temporal resolution
8.3.9.5 Doppler and color flow imaging
8.3.9.6 Performance testing and equipment QA
8.3.9.7 Elasticity imaging methods
8.3.9.8 Artifacts
8.3.9.9 US contrast agents
8.3.9.10 Safety and biological effects

8.4 Radiobiology

8.4.1 History of radiation injuries in humans
8.4.2 Radiation interactions in cells/tissues
8.4.3 Radiation injury to DNA
8.4.4 Repair of DNA damage
8.4.5 Indirect effects of radiation
8.4.6 Chromosomal damage and repair
8.4.7 Target theory and cell survival curves
8.4.8 Free radical formation
8.4.9 Apoptosis, reproductive cell death
8.4.10 Cell kinetics
8.4.10.1 Cell recovery processes
8.4.10.2 Cell cycle sensitivity
8.4.11 Radioprotectors, radiosensitizers
8.4.12 RBE, OER, LET

- 8.4.13 Tissue injuries
  - 8.4.13.1 Acute effects of radiation
  - 8.4.13.2 Delayed effects of radiation
  - 8.4.13.3 Radiation carcinogenesis
  - 8.4.13.4 Radiation mutagenesis
  - 8.4.13.5 Radiation teratogenesis
  - 8.4.13.6 Other embryo/fetal effects
- 8.4.14 Risk estimates of radiation
- 8.4.15 History of linear no-threshold theory
- 8.4.16 Predictions of cancers in populations
- 8.4.17 Radiation epidemiology
- 8.4.18 Evidence of cancers in populations
- 8.4.19 Concept of radiation hormesis
- 8.4.20 Tumor radiobiology
- 8.4.21 Time, dose, fractionation
- 8.4.22 Molecular mechanisms
- 8.4.23 Drug/radiation interactions

8.5 Medical Anatomy & Physiologic Processes

- 8.5.1 General Terminology
  - 8.5.1.1 Anatomical reference terminology
  - 8.5.1.2 Imaging planes and orientations
  - 8.5.1.3 Diagnostic Radiology terminology and conventions
  - 8.5.1.4 Radiation Therapy terminology and conventions
- 8.5.2 Sectional and Radiographic Anatomy
  - 8.5.2.1 Breast
  - 8.5.2.2 Cardiovascular
  - 8.5.2.3 Digestive System
  - 8.5.2.4 Musculoskeletal
  - 8.5.2.5 Neurological System
  - 8.5.2.6 Reproductive/Endocrine
  - 8.5.2.7 Thoracic Cavity
  - 8.5.2.8 Urinary System
  - 8.5.2.9 Lymphatic System
- 8.5.3 Human Physiology
  - 8.5.3.1 Nervous system
  - 8.5.3.2 Musculoskeletal system
  - 8.5.3.3 Cardiovascular system
  - 8.5.3.4 Respiratory system
  - 8.5.3.5 Digestive system
  - 8.5.3.6 Integumentary system
  - 8.5.3.7 Urinary system
  - 8.5.3.8 Reproductive system
  - 8.5.3.9 Immune system
  - 8.5.3.10 Endocrine system
- 8.5.4 Pathology
  - 8.5.4.1 Neoplastic Diseases

8.5.4.2 Benign Disease
8.5.4.3 Trauma
8.5.4.4 Cardiovascular Diseases
8.5.4.5 Neurological

8.6 Radiation therapy physics

8.6.1 History of radiation oncology
8.6.2 Principles of radiation oncology
8.6.3 External beam treatments
- 8.6.3.1 Sources of external beams
- 8.6.3.2 Calibration of external beams
- 8.6.3.3 Acquisition of external beam data
- 8.6.3.4 Treatment planning principles
- 8.6.3.5 Multifield radiation therapy
- 8.6.3.6 IMRT, VMAT
- 8.6.3.7 Image fusion, registration, segmentation, quantitation
- 8.6.3.8 Motion management
- 8.6.3.9 Performance testing and equipment QA

8.6.4 Brachytherapy
- 8.6.4.1 Brachytherapy sources
- 8.6.4.2 Storing and shielding brachytherapy sources
- 8.6.4.3 Brachytherapy delivery devices
- 8.6.4.4 Brachytherapy treatment planning principles
- 8.6.4.5 Performance testing and equipment QA

8.6.5 Special techniques in radiotherapy
8.6.6 Radiation therapy with neutrons, protons, light ions
8.6.7 Radiation protection in radiation therapy

***8.7 Professionalism and Ethics**

These topics should be introduced in graduate educational programs and taught in greater detail in resident educational programs. For persons entering a residency program through the alternate pathway, all aspects of the CAMPEP standards in professionalism and ethics must be taught during the residency program.

Professionalism

8.7.1 Definition of a profession and professionalism
8.7.2 Elements of a profession
8.7.3 Definition of a professional
8.7.4 Elements of professionalism (altruism, honesty, integrity, excellence, duty, accountability, respect for others)
8.7.5 How is professionalism judged?
8.7.6 Do's and don'ts of professionalism
8.7.7 Physician's charter and applicability to physicists

Leadership

8.7.8 Qualities of leaders
8.7.9 Rules of leadership
8.7.10 Causes of leadership failure

Ethics

8.7.11 Ethics of a profession
8.7.12 Ethics of an individual
8.7.13 Interactions with colleagues and co-workers

8.7.14 Interactions with patients and the public
8.7.15 Confidentiality
8.7.16 Peer review
8.7.17 Negotiation skills
8.7.18 Relationships with employers
8.7.19 Conflicts of interest (recognition and management)
8.7.20 Ethics in research (fabrication, fraudulence, plagiarism)
8.7.21 Use of animals in research
8.7.22 Use of humans in research
8.7.23 Relationships with vendors
8.7.24 Publication ethics