Medical Physics Master's Programme
Full-time study mode
Language of instruction: English

PROGRAMME DESCRIPTION

Approved by Senate Resolution No. .../2025/2026. (2026. I. 26.)
Effective from: 9 February 2026

Applicable to students commencing their studies in the second semester of the 2025/2026 academic year.

Unofficial English Translation

This English translation has been prepared for the convenience of international students and applicants. In the event of any discrepancy between the English and Hungarian versions, the Hungarian version shall prevail.

Table of Contents

1. Basic Programme Information

1.1. Programme and Qualification

Programme title

Hungarian: Orvosi fizika mesterképzési szak

English: Medical Physics Master's Programme

Qualification awarded

Hungarian: okleveles orvosi fizikus

English: Medical Physicist

Degree level

Hungarian: mesterfokozat

English: Master of Science (MSc)

1.2. Programme Profile

Degree level: Master's programme

Classification

European Qualifications Framework (EQF): Level 7

Hungarian Qualifications Framework (HQF): Level 7

ISCED 2011: Level 7

ISCED-F 2013: 0533

Field of study: Physics

Orientation: Theory-oriented (60–70%)

1.3. Dual or Cooperative Education

Not relevant and not applicable to this programme.

1.4. Duration and Credit Requirements

Duration: 4 semesters

Number of credits required for graduation: 120 ECTS credits

1.5. Study Mode and Programme Organisation

Study Mode: Full-time

Detailed Description of Programme Organisation:

The full-time programme is delivered entirely through in-person instruction. Lectures are held at the University, while a substantial proportion of practical classes and laboratory sessions take place at external clinical and training sites. Students' learning and independent study activities are supported through a closed learning management system (Moodle).

1.6. Language of Instruction

Language of Instruction: English

Specific Features of the English-Language Programme:

All compulsory courses must be completed in English. Compulsory elective and free elective courses may be taken in either Hungarian or English. The thesis must be prepared and submitted in English.

The Study and Examination Regulations specify the number of foreign-language professional language credits that students are required to complete during their studies. In addition, the programme learning outcomes and qualification requirements prescribe that: *For programmes delivered in a foreign language, the required level of language proficiency is equivalent to an upper-intermediate (B2) complex language examination in English.*

Since the programme is delivered entirely in English, students are expected to attain the prescribed language proficiency level by the completion of their studies.

1.7. Persons Responsible for the Programme

Faculty Responsible for the Programme: Faculty of Natural Sciences

Programme Director: Dr. Czifrus Szabolcs

1.8. Admission Requirements

Admission requirements are determined by applicable legislation, the University Admission Regulations, and the Higher Education Admission Guide, as follows:

Applicants may be admitted to the Master's programme only if they have obtained a degree and qualification at least at the bachelor's level (or, under the previous educational system, a college-level degree), or possess an equivalent qualification acquired abroad, and satisfy the requirements laid down in the applicable legislation and in the Admission Regulations of the Budapest University of Technology and Economics (BME).

2. Programme Content, Characteristics and Requirements

2.1. *Objectives of the Programme and Its Quality Assurance System*

Objectives of the Programme:

The aim of the programme is to educate medical physicists possessing interdisciplinary theoretical and practical knowledge as well as application-oriented skills, enabling them, as scientific professionals, to perform clinical duties, participate in academic and industrial research, develop and operate advanced technologies, equipment and measurement systems, and supervise the medical use of ionising and non-ionising radiation and radioactive materials to a high professional standard. Drawing on their expertise in diagnostic imaging, nuclear medicine (both diagnostics and therapy), radiation therapy, radiation protection and radiobiology, graduates will be capable of meeting the specific professional requirements of medical physics with a strong sense of professional responsibility and in accordance with ethical standards. Graduates of the programme will also be prepared to continue their studies at the doctoral level.

Compliance with the ESG Quality Assurance Standards

The objectives and structure of the programme are aligned with the **Standards and Guidelines for Quality Assurance in the European Higher Education Area (ESG 2015)**, particularly in the following areas:

ESG 1.1 – Policy for Quality Assurance: The programme objectives are aligned with the University's quality assurance policy and contribute to the continuous enhancement of the educational portfolio in accordance with institutional strategic priorities.

ESG 1.2 – Design and Approval of Programmes: The programme was designed through a consultative process that took into consideration relevant professional and societal needs. The English-language Master's programme was launched in 2024 in response to growing national and international demand. The need for the programme was identified on the basis of institutional, industrial and international feedback, recommendations from professional organisations, and labour market data.

The programme was developed by the Institute of Nuclear Techniques, Faculty of Natural Sciences, Budapest University of Technology and Economics (BME). The curriculum was finalised after taking into account the recommendations of the Medical Physics Programme Committee. The proposal was subsequently reviewed and approved by both the Faculty Education Committee and the Faculty Council before being submitted to the University Senate. As a result of this process, the programme objectives have been defined through clearly formulated learning outcomes.

ESG 1.3 – Student-Centred Learning, Teaching and Assessment: The programme objectives support active learning, student autonomy, professional responsibility and competence-based development.

ESG 1.4 – Student Admission, Progression, Recognition and Certification: The programme objectives and curriculum structure ensure transparent progression rules, recognition of prior learning, and fair and consistent certification procedures. Particular attention has been paid to the clear definition of the prior studies required for admission to the programme, as these constitute important entry requirements. Furthermore, the curriculum has been designed to provide students with genuinely new knowledge and competencies beyond those acquired during their previous studies.

ESG 1.9 – On-going Monitoring and Periodic Review of Programmes: The programme objectives and disciplinary orientation are subject to regular review based on student feedback, graduate tracking activities, and consultations with employers.

ESG 1.10 – Cyclical External Quality Assurance: The definition and periodic review of programme objectives form an integral part of the University's institutional accreditation and external quality assurance processes.

2.2. General Competencies

The courses ensuring the acquisition of the general competencies defined by Act CCIV of 2011 on National Higher Education [Section 11(2) and Section 114/P(2)(b)] and by the Programme and Outcome Requirements (KKK) are listed below:

General Competency	Courses [code and name]
Digital Competencies (*digital competencies and profession-specific digital skills; media literacy; safe internet use; and knowledge of digital solutions supporting the effective application of digital technologies for achieving learning objectives*)	BMETE80MFA6 Neutron and Gamma Transport Methods BMETE80MFAD Monte Carlo Methods BMETE80MFA9 Monte Carlo Particle Transport Methods BMETE15MF74 Computer Simulation in Physics BMETE15MF75 Artificial Intelligence in Data Science BMETE15AP61 Introduction to Machine Learning BMETEFTBsPATTM-00 Data-Science-Aided Measurements
Artificial Intelligence (*knowledge and application of AI-based tools and methods relevant to the programme*)	BMETE15MF75 Artificial Intelligence in Data Science BMETE15AP61 Introduction to Machine Learning BMETEFTBsPATTM-00 Data-Science-Aided Measurements
Financial and Entrepreneurial Knowledge Related to the Knowledge-Based Economy	BMEGT35M004 Investments

General Competency	Courses [code and name]
Health Promotion and Physical Education *(in accordance with Act CCIV of 2011 on National Higher Education, Section 11(2), higher education institutions shall provide opportunities for physical and mental health promotion, including the organisation of regular physical exercise and sports activities)*	Physical Education is available as a free elective course within the Master's programme. The range of courses and sporting opportunities is provided by the University Sports Centre.
Basic Knowledge of Sustainable Development (*knowledge and skills supporting the implementation of the Sustainable Development Goals (SDG*[1]*)*)	BMETE80AF06 Sustainable Development and Energetics (optional course)
Environmental Protection, Occupational Safety, Workplace Safety and Consumer Protection	BMETENTMsOFLAB-00 Medical Physics Laboratory BMETE80MFAL Radiation Protection in Medical Physics BMEGT35M004 Investments BMETE80MF32 Migration of Radioactive Species in Environmental and Biological Matter BMETE80MF31 Safety of Radioactive Wastes
Basic Knowledge of Corruption Prevention	BMEVIEUM300 Ethical Aspects of Medical Research BMETENTMsOMBJS-00 Quality Assurance and Legislation
Industry 4.0, Cyber-Physical Systems, Digitalisation and Automation (k*nowledge of Industry 4.0-based operations and technologies, cyber-physical systems, self-organising mechanisms, and the labour-market impacts of digitalisation and automation)*	BMETE80MFA6 Neutron and Gamma Transport Methods BMETE80MFAD Monte Carlo Methods BMETE80MFA9 Monte Carlo Particle Transport Methods BMETE15MF74 Computer Simulation in Physics BMETE15MF75 Artificial Intelligence in Data Science BMETE15AP61 Introduction to Machine Learning BMETEFTBsPATTM-00 Data-Science-Aided Measurements BMETE80MFAN Medical Imaging BMETENTMsOMTST-00 Dosimetry in Radiotherapy

2.3. Professional Competencies

2.3.1. Programme and Outcome Requirements

Competencies of Graduates of the Programme (as specified in the Programme and Outcome Requirements (KKK)):

Knowledge

Upon completion of the programme, graduates:

a1) possess knowledge of the theoretical, experimental and computational methods of medical physics (radiation therapy, nuclear medicine and diagnostic imaging), as well as those areas of mathematics and computer science that are relevant to medical physics;

[1] https://sdgs.un.org/goals

a2) are familiar with the clinical, laboratory and practical materials, instruments and methods related to medical physics that are necessary for the advanced practice of the profession;

a3) have knowledge of the physical principles of ionising and non-ionising radiation, the fundamentals and legal framework of radiation protection, and the design and operating principles of therapeutic and diagnostic devices;

a4) understand the operating principles of medical devices and are familiar with national and international quality assurance regulations;

a5) understand the fundamentals of radiation treatment planning, are familiar with the parameters characterising treatment plans, and are able to apply the professional terminology required for their work in the healthcare sector;

a6) possess advanced knowledge of the natural sciences, radiobiology and human anatomy, together with the practical applications based on these disciplines, and are able to organise and systematise such knowledge;

a7) are familiar with the concepts and terminology describing the processes of medical physics and its clinical applications, and possess broad knowledge of the relevant scientific literature;

a8) understand the theoretical and practical methodology of metrology related to ionising and non-ionising radiation, as well as the relevant international regulations;

a9) have a comprehensive understanding of the processes, systems and scientific issues within their field of expertise.

Skills

Upon completion of the programme, graduates are able to:

b1) understand scientific principles, relationships and problems; formulate original ideas; independently apply and utilise acquired knowledge; and perform risk assessments related to radiation-related activities;

b2) carry out medical physics and radiation protection tasks associated with clinical, research and industrial activities involving radioactive materials and ionising or non-ionising radiation, and actively participate in development, design and research projects;

b3) design, implement and evaluate dosimetric and metrological research projects based on their advanced knowledge of the physical sciences;

b4) develop and operate industrial, clinical, information technology and measurement systems based on physical laws and advanced technologies to a high professional standard;

b5) continuously update their professional knowledge through lifelong learning and effectively apply new scientific results in medical physics in their professional activities;

b6) analyse the processes and systems of their field using methods accepted in the physical and medical sciences;

b7) provide professional advice regarding the characteristics and application of medical devices and actively participate in their procurement and installation;

b8) develop radiation protection strategies and ensure compliance with radiation safety requirements;

b9) effectively apply quality standards and regulatory requirements related to healthcare services.

Attitudes

Upon completion of the programme, graduates:

c1) recognise the importance of scientific thinking and precise use of concepts and formulate their opinions accordingly;

c2) strive to become familiar with new developments in medical physics and to promote their broad application;

c3) demonstrate initiative, decision-making ability and personal responsibility;

c4) actively cooperate with colleagues, contribute constructively to teamwork and, where appropriate, undertake leadership responsibilities;

c5) perform their work in a disciplined and highly precise manner, seeking the most effective solutions while adhering to applicable regulations;

c6) treat patients with empathy, strive for fair and professional relationships, accept the ethical, legal and radiation protection requirements relevant to their profession, and endeavour to comply with and uphold them;

c7) are open to continuous professional development, networking, collaboration and communication in both Hungarian and foreign languages at least at a basic level;

c8) are committed to quality assurance, quality control and compliance with legal regulations.

Autonomy and Responsibility

Upon completion of the programme, graduates:

d1) perform their professional duties independently and seek support from colleagues or supervisors when necessary;

d2) are capable of self-assessment and independent correction of errors;

d3) cooperate effectively with members of multidisciplinary professional teams and assume responsibility for compliance with health protection and radiation protection requirements;

d4) carry out their professional activities with full awareness of their responsibilities;

d5) participate in and support cooperation with organisations operating in interdisciplinary areas of the natural and health sciences;

d6) take responsibility for the calculations, professional plans and data under their supervision;

d7) demonstrate a high level of environmental awareness during laboratory and field activities;

d8) conduct scientific research in accordance with the highest ethical standards;

d9) recognise the importance of scientific thinking and precise conceptualisation, and form their professional judgement accordingly.

2.3.2. Programme-Specific Competencies

The Medical Physics Master's programme offered by the University aims not only to ensure that students acquire the knowledge and skills defined in the Programme and Outcome Requirements, but also to provide them with up-to-date, practice-oriented and research-based expertise that prepares them to perform clinical, academic and industrial tasks with professional commitment and in accordance with ethical standards.

In line with the distinctive features of the programme, graduates will possess the following competencies in addition to those specified in the Programme and Outcome Requirements.

Competency Area	*2.3.2. Programme-Specific Competency*
Knowledge	
	possess in-depth knowledge of the operating principles and application possibilities of digital technologies and information systems used in medical physics
	are familiar with the terminology of the various fields of medical physics in English
	understand the potential future directions and limitations of the field of medical physics
Skills	
	collect and process relevant data for solving problems arising in the field of medical physics and identify and utilise the relevant scientific literature
	communicate their knowledge effectively to both professional and non-professional audiences
	formulate and present scientifically sound arguments
Attitudes	
	are open to professional dialogue and collaboration with experts from disciplines beyond medical physics
	are committed to acquiring new competencies and continuously broadening their scientific perspective and professional knowledge
	are committed to scientific and professional integrity, as well as to the principles of open science and responsible innovation
Autonomy and Responsibility	

Competency Area	2.3.2. Programme-Specific Competency
	share their knowledge and experience with others and participate in mentoring activities or interdisciplinary teamwork
	ensure the protection of personal data obtained during data collection and processing activities and comply with the requirements of the General Data Protection Regulation (GDPR)
	are capable of realistically evaluating the outcomes and quality of their own work

2.4. Main Structural Elements of the Programme

2.4.1. Professional Internship

Credit value of the professional internship: non-credit-bearing compulsory requirement (criterion requirement)

Recommended semester for completion: Semester 3

Duration of the professional internship: 1 week

2.4.2. Thesis

Credit value of the thesis: 30 credits

2.4.3. Optional courses

Credits allocated to optional courses: 8 credits

2.4.4. Knowledge Areas

The knowledge areas defined in the Programme and Outcome Requirements (KKK), the classification of individual courses within these knowledge areas, and the persons responsible for the respective knowledge areas are as follows:

Knowledge Area (Credit Range Specified in the Programme and Outcome Requirements)	Courses (Course Code and Credit Value)	Total Credits Allocated to the Knowledge Area	Knowledge Area Coordinator
Natural Sciences Foundation Knowledge **33 credits**	Medical Physics Laboratory, BMETENT-MsOFLAB-00, 4 Physical Basis of X-Ray Diagnostic, BMETENT-MsORTDG-00, 4 Physical Basis of Radiotherapy, BMETE80MF94, 4 Nuclear Medicine, BMETE80MFAR, 4 Radiobiology, BMETE80MF70, 3	33	Dr. Czifrus Szabolcs

Knowledge Area (Credit Range Specified in the Programme and Outcome Requirements)	Courses (Course Code and Credit Value)	Total Credits Allocated to the Knowledge Area	Knowledge Area Coordinator
	Radiation Protection in Medical Physics, BMETE80MFAL, 5 Basics of Functional Anatomy, BMETENTMsOFANA-00, 4 Medical Imaging, BMETE80MFAN, 5		
Economic and Humanities Studies* **2 credits**	Investments, BMEGT35M004, 2 English for university studies, en B2+, BMEGT60LNGA501-01, 3 Communication Strategies English B2, en B2, BMEGT60LNGA406-01, 3 Technical English B2, en B2, BMEGT60LNGA403-01, 3 Academic writing, en C1, BMEGT60LNGA605-01, 3 Public speaking, en B2, BMEGT60LNGA502-01, 3	2	Dr. Wenszky Nóra
Core Professional Knowledge **47 credits**	Independent Laboratory MP1, BMETE80MF85, 7 Independent Laboratory MP2, BMETENTMsOPOL2-00, 10 Seminar MP1, BMETE80MF81, 2 Seminar MP2, BMETE80MF82, 2 Seminar MP3, BMETE80MF83, 2 Seminar MP4, BMETE80MF84, 0 Essential Medical Physiology, BMETENTMsORETN-00, 4 Ethical Aspects of Medical Research, BMEVIEUM300, 4 Dosimetry in Radiotherapy, BMETENTMsOMTST-00, 3 Brachytherapy, BMETE80MFAQ, 3	47	Dr. Stelczer Gábor

Knowledge Area (Credit Range Specified in the Programme and Outcome Requirements)	Courses (Course Code and Credit Value)	Total Credits Allocated to the Knowledge Area	Knowledge Area Coordinator
	Quality Assurance and Legislation, BMETENTMsOMBJS-00, 4 Radiotherapy 2, BMETENTMsOSUG2-00, 3 Ultrasound Diagnostics, BMETENTMsOUHDG-00, 3 Radionuclide Production and Application in Medical Biology, BMETE80MFAM, 4 Migration of Radioactive Species in Environmental and Biological Matter, BMETE80MF32, 4 Safety of Radioactive Wastes, BMETE80MF31, 4 Magnetic Resonance and Clinical Applications, BMETE80MFAK, 3 Magnetic Resonance and Clinical Applications 2, BMETE80MF75, 3 Neutron and Gamma Transport Methods, BMETE80MFA6, 4 Monte Carlo Methods, BMETE80MFAD, 5 Monte Carlo Particle Transport Methods, BMETE80MFA9, 3 Physics of Semiconductors, BMETE11MF26, 3 Computer Simulation in Physics, BMETE15MF74, 5 Physical Optics, BMETE12MF79, 5 Industrial and Biological Applications of Lasers, BMETE12MF58, 3 Optical Information Processing and Data Storage, BMETE12MF19, 3		

Knowledge Area (Credit Range Specified in the Programme and Outcome Requirements)	Courses (Course Code and Credit Value)	Total Credits Allocated to the Knowledge Area	Knowledge Area Coordinator
	Optical Design, BMETE12MF78, 6 Optical Devices in Medicine, BMEGEMINMOE, 4 Artificial Intelligence in Data Science, BMETE15MF75, 5 Nanotechnology and Materials Science, BMETE11MF58, 4 Introduction to Machine Learning, BMETE15AP61, 4 Data-Science-Aided Measurements, BMETEFTBsPATTM-00, 3 Biostatistics, BMEGEMIMSOBIOS-00, 3 Reseach Methodology, BMEGEMIPHDKMT1-01, 3		
Optional Courses **8 credits**	Optional subjects	8	
Thesis **30 credits**	Diploma Work MP, BMETE80MF71, 30	30	Dr. Pesznyák Csilla
Criterion Requirements **0 credits**	Professional Training MP, BMETENTMsOS-GYK-00, 0 Basics of Medical Physics, BMETENTMsOK-RAI-00,0	0	Dr. Pesznyák Csilla

* The courses belonging to the Economic and Humanities Studies knowledge area are offered as compulsory elective courses, from which students must complete one course worth at least 2 credits.

2.4.5. Specialisations

Not relevant and not applicable to this programme, as no specialisations are offered.

2.5. Assessment and Evaluation Methods

The assessment and evaluation methods, procedures and rules applicable to individual courses are specified in detail in the respective course descriptions (course specifications), in accordance with the Study and Examination Regulations currently in force and the present programme description.

Only those assessment and evaluation methods that are defined in this programme may be used in the individual courses.

General Description and Objectives of the Assessment Methods (Compliance with ESG 1.3):

The assessment and evaluation methods applied in the Medical Physics Master's programme are designed to measure reliably the achievement of the intended learning outcomes associated with each course, promote students’ active participation, autonomy and development, and support the implementation of student-centred learning. Assessment constitutes an integral part of the learning process; it serves not only as a means of evaluation but also as one of the most important forms of feedback and development.

The programme employs a variety of assessment methods tailored to the objectives and pedagogical characteristics of individual courses. These include individual and group projects, written examinations, assignments, presentations, oral examinations, laboratory reports, programming assignments and practical exercises. This diversity ensures that knowledge, skills and attitudes are all appropriately assessed.

Courses within the programme are completed with a course grade, an examination grade, or a signature (pass requirement). Students must obtain a signature in the criterion courses Seminar MP4, Basics of Medical Physics, and Professional Training MP. During the semester, instructors evaluate students’ continuous work through tests, laboratory reports, project assignments, homework, programming assignments and written reports. Students are required to submit written reports on their Independent Laboratory courses and on the Professional Internship. In courses concluding with an examination, assessment is conducted through oral examinations, written examinations, or a combination of both. In several examination-based courses, instructors also take semester performance into account by awarding bonus points and weighting test, assignment and examination results.

2.5.1. Methods for Assessing Academic Performance

A he following table presents a detailed description of the types of academic performance assessment methods used in the programme. Assessment methods applied in individual courses may not substantially deviate from these and must be implemented consistently throughout the programme.

Assessment Method	Methodological Description and Typical Forms of Implementation	Average Duration or Typical Time Frame of the Assessment	Average Student Preparation Time
Oral Examination	An oral assessment conducted partly or entirely in the form of dialogue, with preparation time provided (typically 10–20 minutes). The examination may be based on responses to structured	20–30 minutes	45 hours

Assessment Method	Methodological Description and Typical Forms of Implementation	Average Duration or Typical Time Frame of the Assessment	Average Student Preparation Time
	questions (e.g., examination topics or predefined subject areas) or on an unstructured sequence of questions and answers, such as solving application-oriented problems.		
Written Examination	The examination may focus on theory (concepts, models and their interpretation) or practical applications (analysis and calculation tasks). It may include both closed-ended (multiple-choice) and open-ended (essay-type) questions. Entry tests may be used to verify fundamental knowledge. The examination may be conducted electronically (e.g., via Moodle) or in paper-based format.	60–180 minutes	45 hours
Mid-Semester Test	A written assessment conducted during the semester. It may focus on theory (knowledge and interpretation of concepts and models) or practical applications (analysis and calculation tasks). It may include both closed-ended and open-ended questions and may be conducted electronically or in paper-based format.	30–120 minutes	20 hours
Partial Performance Assessment	Examples include homework assignments, laboratory reports and project tasks.		– Regular homework assignment or laboratory report (deadline up to one week): approximately 3 hours; – Complex homework assignment (deadline of two to three weeks): approximately 10 hours; – Comprehensive homework or programming assignment (deadline of at least

Assessment Method	Methodological Description and Typical Forms of Implementation	Average Duration or Typical Time Frame of the Assessment	Average Student Preparation Time
			one month): approximately 36 hours; – Semester-long project-type assignment: approximately 72 hours
Diagnostic Assessment (Entry Quiz)	A short diagnostic test administered at the beginning of laboratory sessions to assess preparedness regarding the laboratory material. Failure to pass the quiz results in the laboratory session being considered not completed.	5–10 minutes	3 hours

2.5.2. Professional Language Competencies

Not relevant and not applicable, as the programme is delivered entirely in English.

2.5.3. Professional Internship

1. Requirements Related to the Professional Internship
   a) Prerequisites: A prerequisite for completing the professional internship is that the student's thesis topic has been finalised. Accordingly, the internship will typically take place after the completion of the course Independent Laboratory MP 1.
   b) Requirements for the Host Institution: The placement location is designated by the course coordinator of Professional Training MP. The primary consideration is that the host institution's profile should match the student's chosen thesis topic. Recommendations from the student, the supervisor, the external professional supervisor and/or the external consultant may also be considered. In addition, the host institution must provide a prior declaration confirming its willingness and ability to host the student and that it possesses the necessary infrastructure to support the student's work.
2. Organisation of the Internship
   a) Responsible organisational unit: Institute of Nuclear Techniques
   b) Communication method: electronic correspondence
3. Reporting Requirements
   a) Content and Formal Requirements: Before starting the internship, the student must prepare a work plan in consultation with the supervisor and the responsible staff member designated by the host institution. The student is

required to document the practical work continuously and submit a written report after completing the internship. The report shall describe the professional challenges encountered, how these were addressed in cooperation with staff members at the host institution, and how knowledge acquired during university studies was applied. The report shall also explain the student's professional development and the competencies acquired during the internship. The report must be submitted using the designated electronic form and must include the information required for student identification, the location and duration of the internship, the contact details of the supervisor and the responsible staff member at the host institution, as well as their recommendation.

b) Submission Method: The report must be submitted electronically as an attachment to an e-mail sent to the course coordinator of Professional Training MP.

c) Submission Deadline: The report must be submitted within two weeks following completion of the internship.

4. Evaluation of the Professional Internship

   a) Requirements for Successful Completion: Based on the submitted report and the recommendations of the supervisor and the responsible staff member at the host institution, the course coordinator evaluates the student's internship activities and decides whether to grant or withhold the course signature.

   b) Revision of a Rejected Report: If the student's internship activity meets expectations but the report is incomplete, contains substantive errors, or fails to satisfy the formal requirements, the student may submit a revised version within two weeks of receiving notification of the deficiencies.

   c) Repetition of an Unsuccessful Internship: An internship that is not accepted may be repeated after consultation with the course coordinator.

2.5.4. Criterion Requirements

The following criterion requirements must be fulfilled during the programme, and their completion is a prerequisite for obtaining the final certificate (absolutorium):

1. obtaining a course signature in Basics of Medical Physics
2. successful completion of Professional Training MP
3. obtaining a course signature in Seminar MP4

2.5.5. Thesis Preparation

1. Prerequisites for Enrolment in the Thesis Preparation Course:

   Successful completion of the following courses is required prior to enrolment in the thesis preparation course:

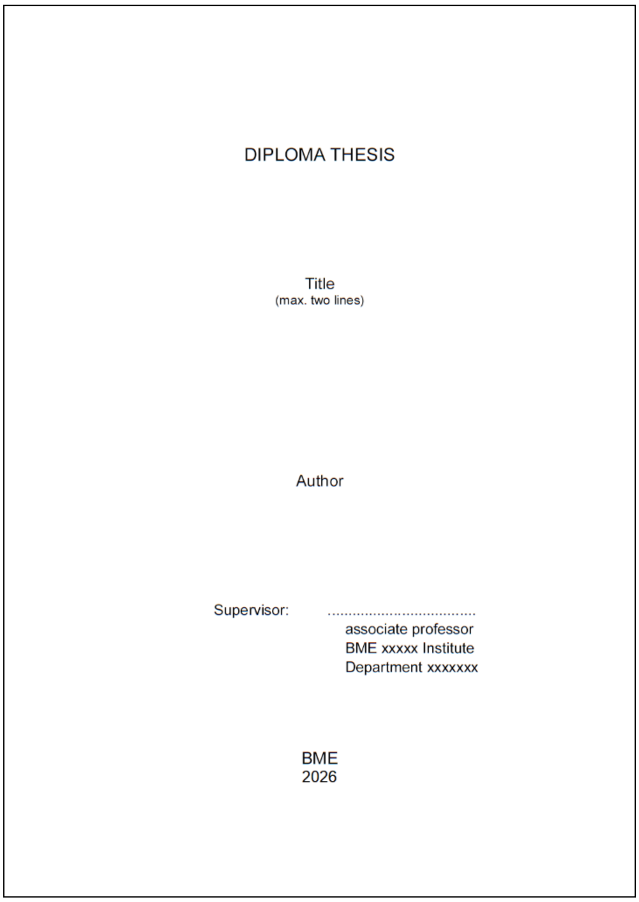
Independent Laboratory MP1

Independent Laboratory MP2

2. Content and Formal Requirements of the Thesis:
   - Content Requirements:
     - The thesis is a written report presenting the independent research or research and development results achieved by the student under the supervision of a thesis advisor. The thesis topic must be aligned with the profile of the programme and must include a clearly formulated research question or hypothesis, a relevant review of the literature, a detailed methodology, and empirical data analysis. The author shall present the investigated topic, discuss the relevant problems, and provide a detailed account of the results obtained. The thesis must be based on the knowledge acquired during the Medical Physics MSc programme and must constitute the student's own independent work.
     - If the work, in whole or in part, has already been implemented in practice, the student shall present the practical application and utilisation of the findings and conclusions.
     - The thesis and its abstract must be submitted in English.
   - Structure of the Thesis
     - Required Order and Formal Elements

       The thesis shall contain the following elements in the order listed below:
       - title page;
       - original copy of the approved thesis topic description;
       - table of contents and, where applicable, a list of appendices;
       - main text of the thesis (well-structured and comprehensive discussion);
       - summary of the principal conclusions, achieved results and expected future developments at the end of the main text;
       - list of figures and tables (if not included within the text);
       - references;
       - appendices.

       Recommended length of the thesis: 35–60 pages.


DIPLOMA THESIS

Title
(max. two lines)

Author

Supervisor: ....
associate professor
BME xxxxx Institute
Department xxxxxxx

BME
2026

- Organisation of the Content
  - The thesis shall contain a clear and concise summary of the field under investigation.
  - The chapters should follow the structure of the assigned thesis task, although the author may further divide them into sections and subsections with clear and meaningful headings.
- Language and Style

  Technical terminology should be used in English whenever possible, in accordance with the definitions accepted in the professional literature of the field. If alternative interpretations cannot be avoided, explanatory definitions should be provided in footnotes. Where no established English equivalent exists, it is advisable to provide an English translation of the term and indicate the original expression in a footnote at its first occurrence. Non-English terminology should generally be used only if it has become widely accepted in scientific or technical usage. Symbols and units of measurement shall conform to the conventions accepted within the relevant field.
- Tables, Figures and Equations
  - Figures and tables should preferably be original electronically prepared graphics and tables; however, high-quality digital photographs are also acceptable.

  - The notation used in equations, figures, tables and throughout the thesis shall be applied consistently and shall follow established scientific and technical conventions.
- Numbering and Cross-Referencing
  - Since tables and figures cannot always be placed exactly where they are discussed in the text, they should be referred to by numbering. Although not mandatory, it is recommended that each figure and table be given a concise and descriptive title.
  - Equation numbers should appear at the right margin on the same line as the equation, enclosed in parentheses and without a full stop.
  - References cited in the text shall use bracketed numbering corresponding to the numbering used in the reference list.
- References
  - The bibliography shall include the following bibliographic information for all sources used in preparing the thesis::
    - author(s) (in the case of multi-authored works and handbooks, only the editor(s) should be listed, with the editor's name appearing after the title rather than preceding it),
    - exact title of the work,
    - place of publication,
    - series title, where applicable.
  - Only works that are explicitly cited or used in the thesis may appear in the reference list; each entry must be identifiable through a corresponding citation in the text.
- Abstract

  The purpose of the abstract is not to reproduce the table of contents or restate the structure of the thesis, but rather to provide a concise and clear presentation of the main objectives, approach, results, conclusions and key findings of the work in English. The abstract should not be incorporated into the thesis itself but should be submitted as a separate document accompanying the thesis. Recommended length of the abstract: approximately one page.

3. Language of the Thesis:

   The thesis must be prepared in English.

4. Thesis Preparation Process:

   Each semester, the Dean's Office of the Faculty invites the departments of the Institute of Physics and the Institute of Nuclear Techniques to propose thesis topics. External research institutes, other higher education institutions and industrial partners may also propose thesis topics through the departments, provided that they can ensure the conditions necessary for conducting the planned research and the associated one-week professional internship.

A supervisor, external professional supervisor or external consultant must hold a PhD degree or have at least five years of professional experience in the relevant field. In the case of an external supervisor or consultant, an internal supervisor must also be appointed by the department.

The Programme Director or Deputy Programme Director decides on the publication of the proposed thesis topics. Approved topics shall be made available to students in the academic information system no later than the end of the tenth week of the study period.

The thesis preparation process consists of several stages:

- The courses Independent Laboratory MP1, Independent Laboratory MP2, and the Professional Training MP form integral parts of the thesis preparation process.
- Students are required to select a thesis topic during the registration period of the second semester, simultaneously with enrolment in Independent Laboratory MP1.
- If a mobility semester is undertaken, Independent Laboratory MP1 may already be taken in the first semester. In this case, the thesis topic must be selected at the beginning of the second semester simultaneously with enrolment in Independent Laboratory MP2.
- Under normal circumstances, following the completion and evaluation of Independent Laboratory MP1, either the student or the supervisor may decide to discontinue their collaboration. In such cases, the student must select a new thesis topic during the registration period of the third semester.
- In the fourth semester, students complete the compulsory course Diploma Work MP, which is assessed by a semester grade.

5. Assessment Criteria for Thesis Preparation:
   The grade awarded for the course Thesis Preparation in Medical Physics is determined by the supervisor. In the case of an external thesis topic, the internal supervisor evaluates the student's work in consultation with the external professional supervisor and/or consultant. A prerequisite for successful completion is that the thesis has reached a stage at which it can be independently finalised by the student. Additional assessment criteria include:
   - whether the assigned tasks have been completed and whether the relative emphasis of the work is consistent with the original thesis specification,
   - which tasks were not completed or were completed unsatisfactorily, and whether any additional tasks beyond those assigned were completed,

- an overall evaluation of the student's abilities, independence, judgement and the scope of work carried out.

6. Criteria for the Academic Evaluation of the Thesis:

   Reviewers evaluate the submitted thesis in accordance with the official evaluation guidelines. The principal criteria include:

   - the logic and validity of the methodology and line of reasoning employed,
   - the appropriateness of the computational and experimental methods used and the correctness of their application,
   - the identification and assessment of errors and their significance,
   - the scientific value, originality and practical applicability of the results obtained,
   - the overall presentation, structure and professional quality of the thesis.

2.5.6. Final Examination

The requirements for admission to the final examination are set out in the Study and Examination Regulations. In accordance with these regulations, a student may be admitted to the final examination if they:

- have successfully completed all compulsory courses and criterion requirements of the programme,
- have obtained the prescribed number of credits from the compulsory elective course groups and accumulated a total of 120 credits, including free elective courses, and
- have obtained the final certificate (absolutorium).

A student may not be admitted to the final examination if they:

- have outstanding financial obligations towards the University,
- have not returned equipment belonging to the University that was provided for their use, or
- have failed to submit their thesis by the prescribed deadline.

The purpose of the final examination is to enable the Examination Board to verify that the graduating student:

- is capable of applying the knowledge acquired during the programme in the preparation of the thesis,
- has acquired and thoroughly understood the expertise required for the thesis topic,
- possesses sound knowledge not only in the area directly related to the thesis but also in broader fields of medical physics and is able to apply the knowledge acquired during the programme appropriately.

The final examination consists of the following components:

- Thesis defence
- Oral examination covering two examination subject groups

1. Thesis Defence

During the thesis defence, the candidate delivers a 10–15 minute presentation providing a detailed overview of the problem or task defined in the thesis assignment, the methods employed to solve it, and the results achieved. The candidate is expected to highlight their own independent contribution and provide substantive responses to the comments and questions of the reviewer, as well as to questions raised by members of the Examination Board.

2. Oral Examination in Two Subject Groups

In the second part of the final examination, the student draws one question from each of two examination topic groups: one from the General topic group and one from the Detailed topic group.

The Detailed topic group relates closely to the student's thesis subject area, whereas the General topic group covers a broader field of medical physics that is less directly related to the thesis topic. Specifically:

- if the thesis is primarily related to diagnostic imaging, the student draws a question from the General Radiation Therapy topic group;
- if the thesis is more closely related to radiation therapy, the student draws a question from the General Diagnostic Imaging topic group.

The final examination is considered successful if the candidate obtains at least a passing grade in every component of the examination. A successful final examination may not be retaken for grade improvement. If a candidate fails one of the final examination subject-group examinations, only that part must be retaken. A failed resit examination may be repeated once; no further opportunities for grade improvement are available.

Final Examination Subject Groups

Final Examination Subject Group Code	Final Examination Subject Group Title	Courses Included in the Final Examination Subject Group (Course Title, Course Code)
ZVETE80MFKEPA	General Diagnostic Imaging Topic Group	Medical Imaging BMETE80MFAN Physical Basis of X-Ray Diagnostic BMETENTMsORTDG-00 Magnetic Resonance and Clinical Applications BMETE80MFAK Nuclear Medicine BMETE80MFAR

Final Examination Subject Group Code	Final Examination Subject Group Title	Courses Included in the Final Examination Subject Group (Course Title, Course Code)
		Ultrasound Diagnostics BMETENT-MsOUHDG-00
ZVETE80MFSTA	General Radiation Therapy Topic Group	Physical Basis of Radiotherapy BMETE80MF94 Radiotherapy 2 BMETENT-MsOSUG2-00 Brachytherapy BMETE80MFAQ
ZVETE80MFNUKMED	Detailed Nuclear Medicine Topic Group	Nuclear Medicine BMETE80MFAR
ZVETE80MFKEPR	Detailed Medical Imaging Systems Topic Group	Medical Imaging BMETE80MFAN
ZVETE80MFMC	Detailed Monte Carlo Methods Topic Group	Monte Carlo Methods BMETE80MFAD
ZVETE80MFMRI	Detailed MRI Topic Group	Magnetic Resonance and Clinical Applications BMETE80MFAK
ZVETE80MFSTR	Detailed Radiation Therapy Topic Group	Physical Basis of Radiotherapy BMETE80MF94 Radiotherapy 2 BMETENT-MsOSUG2-00 Brachytherapy BMETE80MFAQ

General Final Examination Subject Groups

General Diagnostic Imaging Topic Group [ZVETE80MFKEPA]

1. **X-ray diagnostics and planar imaging**. X-ray sources and detectors; interaction of X-rays with matter; contrast mechanisms in the human body; factors affecting image quality; the evolution of CT; Hounsfield units; fan-beam reconstruction; basic concepts of projection imaging (image magnification, source magnification); the linear convolution model of projection imaging; image formation of point sources and objects; slit images; transfer functions.
2. **Nuclear medicine imaging: Gamma camera and SPECT**. The Anger principle; collimators; pinhole and multi-pinhole imaging; gamma-camera planar imaging in nuclear medicine; types of sources used (radiopharmaceuticals); efficiency; achievable image parameters; spatial resolution; noise sources; organs examined and clinical applications. The principles of SPECT, implementation methods, factors affecting image quality, and areas of application.

3. **Nuclear medicine imaging: PET**. Principles of PET and coincidence detection techniques; timing considerations; true, random and scatter coincidences; relationship between activity and count rate; noise-equivalent count rate (NEC); single rate and random rate; positron range; non-collinearity of annihilation photons; characteristics of PET detectors; factors affecting image quality; clinical and research applications.
4. **Ultrasound imaging and linear transmission systems**. Ultrasound sources and detectors; interaction of ultrasound with matter; tissue models; A-, B- and M-mode imaging; Doppler mode. Linear systems, shift-invariant transformations, the principle of superposition, Fourier, Laplace, Z and Walsh transforms, filtering, discrete Fourier transform, and the sampling theorem.
5. **Magnetic Resonance Imaging (MRI)**. Basic concepts of MRI (excitation, spin, Larmor frequency, gyromagnetic ratio); spin alignment and relaxation in an external magnetic field; T1 and T2 relaxation; Bloch equations; structure and operation of MRI systems; free induction decay (FID); spin-echo and inversion-recovery sequences; three-dimensional MRI imaging.
6. **Properties of diagnostic images**. The concept of an image; digital images; properties of 2D images (hue, saturation, brightness); fundamental image-quality characteristics (contrast, noise, resolution); combined image-quality measures (MTF, SNR, DQE); image-recognition models and performance metrics, including the Rose model and its application to Poisson statistics, ROC analysis; elements of digital image processing; the DICOM standard.
7. **Properties of the two-dimensional Radon transform and inverse Radon transform**. Parameterisation of a line; transformation properties and theorems; convolution; the Central Slice/Fourier Slice Theorem; Fourier inversion formula; back-projection operator; adjoint Radon transform; Hilbert transform and its role in Radon inversion; filtered back-projection; discrete filtered back-projection; Ram-Lak, Shepp–Logan and cosine filters.
8. **Iterative reconstruction methods in deterministic models and analytical image reconstruction in higher dimensions**. Voxel-based Radon transform; Kaczmarz iteration; maximum-likelihood estimation; maximum a posteriori estimation; the ML-EM algorithm; E and M steps of emission tomography reconstruction; MAP-LM and OSEM reconstruction methods; higher-dimensional Radon transforms; multidimensional inversion formulas; general inversion formulas in arbitrary dimensions; ray transforms; extension of the ray transform to the complete Fourier transform; three-dimensional filtered back-projection; medical applications of CT.

General Radiation Therapy Topic Group [ZVETE80MFSTA]

1. **Fundamentals of radiation physics, development of the dose concept, and characteristics of dosimeters**. Radiation dose measuring instruments; structure and characteristic parameters; types of ionisation chambers, conditions of applicability, construction and calibration factors; film dosimetry; thermoluminescent dosimeters (TLDs). The role, types and principal properties of radiotherapy phantoms. The role of irradiation devices in radiation therapy; characteristics of deep-therapy X-ray units; properties and structure of cobalt units; operating principles, structure and key parameters of linear accelerators.
2. **Photon and electron beam calibration**. Dosimetric quantities; parameters of photon therapy; inverse square law; irradiation fields; equivalent field size; field matching; photon beam transmission through the patient; collimator factors; percentage depth dose (PDD); PDD measurements in water and air; characteristics of SSD and SAD irradiation techniques; determination and measurement of TAR, TPR and TMR; beam profiles; inhomogeneity corrections.
3. **Treatment planning in photon teletherapy**. Workflow of treatment planning; patient immobilisation and setup; the role of imaging modalities (PET, CT, MRI) in radiation therapy; delineation of organs at risk and target volumes; treatment-planning techniques; beam-modifying devices; evaluation of treatment plans; dose-volume histograms (DVHs) and their applications; verification of treatment plans; portal films and electronic portal imaging devices (EPIDs); types of treatment errors and available correction methods.
4. **Application of electron radiation in radiotherapy**. Interaction of electrons with absorbing media; clinical electron energy ranges; measurement and characteristics of depth-dose curves; inverse square law; practical range (Rp); CSDA range; electron dose gradients; electron spectra; beam quality parameters; electron-beam dosimetry; dose profile characteristics; use of applicators; requirements for clinical application.
5. **Brachytherapy**. Brachytherapy techniques; characteristics of brachytherapy sources; afterloading treatments; structure and quality assurance of HDR systems; use of applicators and dose-prescription methods; definitions of dose-rate quantities; beta-emitting isotopes; dosimetry of interstitial brachytherapy.
6. **Advanced radiation therapy techniques**. Fundamentals of intensity-modulated radiation therapy (IMRT); characteristics of inverse treatment planning; IMRT delivery techniques; operating principles of tomotherapy systems and CyberKnife systems; dosimetric verification of IMRT plans; technical possibilities of image-guided radiation therapy

(IGRT); patient setup uncertainties; systematic and random errors; fundamentals of radiosurgery; physical principles of proton therapy.

7. **Quality assurance in radiation therapy**. Basic concepts of quality assurance; quality control of treatment machines; quality assurance of treatment-planning systems; the significance of international protocols; familiarity with IAEA TRS-398 and TRS-430 protocols.
8. **Radiation protection and radiobiology in radiation therapy**. Natural and artificial radiation sources; temporal development of biological effects; direct and indirect effects; free-radical formation; LET, RBE and BED concepts; biological effects of radiation; factors influencing radiation response; dose limits for the public and occupationally exposed workers; the linear-quadratic (LQ) model; fractionated radiotherapy; BED calculations in teletherapy, brachytherapy and proton therapy; radiation protection tasks in radiation therapy centres.

Deatailed Final Examination Subject Groups

Detailed Nuclear Medicine Topic Group [ZVETE80MFNUKMED]

1. **Scintillation materials and detectors**. Comparison of the main properties of scintillation materials, including detection efficiency and afterglow time. Principles of operation and types of photomultiplier tubes (PMTs), quantum efficiency, signal shape and temporal characteristics. Avalanche photodiodes (APDs), silicon photomultipliers (SiPMs/GAPDs), position-sensitive PMTs (PS-PMTs), and the applicability of CZT detectors.
2. **Implementation of gamma-camera systems**. Operating principle of the Anger camera, analogue and digital cameras, statistical position estimation. Collimation techniques, applied radiopharmaceuticals, efficiency, attainable imaging parameters, spatial resolution, noise sources, organs examined, clinical objectives, image corrections and calibration procedures.
3. **Single Photon Emission Computed Tomography (SPECT)**. Principles of SPECT, implementation methods, factors influencing image quality and fields of application. Analytical and ML-EM reconstruction methods, conjugate projections, compensation for scatter and attenuation within the body, and calibration procedures for SPECT systems.
4. **Positron Emission Tomography (PET)**. Fundamental concepts including true, random and scatter coincidences, line of response (LOR), the relationship between activity and count rate, noise-equivalent count rate (NEC), single rate and random rate, pile-up, dead time, intrinsic activity

of lutetium-containing detectors, positron range, and non-collinearity of annihilation photons.

5. **Production and preparation of radionuclides for PET**. Production of PET isotopes in particle accelerators and preparation for clinical use. Radiation protection in radiopharmaceutical production. Patient dose and dose monitoring. Dose estimation in PET/CT and SPECT/CT examinations. Radiation protection aspects of nuclear medicine diagnostics.
6. **Hybrid imaging systems**. Integration of SPECT and PET with CT; motivation for hybrid imaging; attenuation correction using CT-derived attenuation maps; advantages and clinical significance of SPECT/CT and PET/CT; integration with MRI.
7. **Image noise and filtering methods**. Sources of image noise, noise reduction strategies, hardware- and software-based noise suppression techniques, low-pass filters, and Butterworth filtering.

Detailed Medical Imaging Systems Topic Group [ZVETE80MFKEPR]

I. Planar Imaging and Linear Systems

a. **Digital imaging**. Concept and generation of digital images; properties of 2D images (hue, saturation, brightness); 2D and 3D images; fundamental image-quality metrics (contrast, noise, spatial resolution); noise characteristics; combined image-quality indicators (MTF, SNR, DQE); image-recognition models and performance measures, including the Rose model and ROC analysis.
b. **Linear systems**. Linear systems, shift-invariant transformations, the principle of superposition, Fourier transform, filters, discrete Fourier transform, sampling theorem, and the generation of Fourier-space artefacts.
c. **Digital image processing**. Grayscale transformations (contrast enhancement, inversion, histogram equalisation, histogram matching); spatial-domain filtering (linear filters, convolution, smoothing, digital derivatives, sharpening, unsharp masking); image enhancement in the frequency domain.
d. **Planar imaging as a linear system**. Basic concepts of projection imaging (image magnification and source magnification); linear convolution model of projection imaging; image formation of a point source, point object and slit; transfer functions.
e. **DICOM file format and communication**. Structure of DICOM files, separation of image and textual information, DICOM tags, data representation, and the DICOM coordinate system.

II. Tomography

f. **Properties of the two-dimensional Radon transform**. Parameterisation of lines, line integrals, transformation properties and theorems (symmetry, linearity, rotation, translation, scaling), convolution, image of a point source, sinogram representation of a line source, and digital Radon transforms.
g. **Analytical inverse Radon transform**. Central/Fourier Slice Theorem, Fourier inversion formula, back-projection operator, adjoint Radon transform, Hilbert transform and its role in inversion, filtered back-projection, discrete filtered back-projection, Ram-Lak, Shepp–Logan and cosine filters, and inversion using orthogonal polynomial systems.
h. **Analytical image reconstruction in higher dimensions**. Higher-dimensional Radon transforms, multidimensional inversion formulas, general inversion formulas in arbitrary dimensions using Riesz potentials, ray transforms, completion of ray transforms to the full Fourier transform, filtered back-projection on the Orlov sphere.
i. **Iterative reconstruction in deterministic models**. Voxel-based Radon transform, linearised systems of equations, generalised inverse as an L^2 minimum solution, calculation of the generalised inverse, and Kaczmarz iteration.
j. **Iterative reconstruction in probabilistic models**. Maximum Likelihood estimation, Maximum A Posteriori estimation, Poisson models for particle detection, ML-EM algorithms, E and M steps in emission and transmission tomography, MAP-LM and OSEM reconstruction methods.

Detailed Monte Carlo Methods Topic Group [ZVETE80MFMC]

a. True random numbers and pseudorandom numbers; physical and algorithmic random-number generators; generation of uniformly distributed random numbers; middle-square, middle-product, multiplicative and mixed congruential methods; periodicity and aperiodic sections of random-number sequences.
b. Statistical tests of random-number sequences: goodness-of-fit tests, χ^2 tests, tests for uniformity and independence, one- and multidimensional frequency tests, digit-frequency, poker, gap, run, and subsequence tests.
c. Monte Carlo sampling of discrete probability distributions and acceleration techniques for sampling.
d. Various methods for sampling continuous random variables defined by a probability density function. The inverse cumulative distribution function (inverse transform) method and the von Neumann acceptance–rejection (rejection sampling) method. The efficiency of rejection sampling and techniques for improving its efficiency. The composition method and its application to the efficient sampling of approximately uniform

random variables. Tabular sampling methods and the evaluation of the approximations they provide based on their analogy with the inverse cumulative distribution function method.

e. Generalised rejection methods and exact sampling of normal distributions; approximate sampling of normal distributions using sums of canonical random variables.
f. Sampling isotropic directional distributions in three-dimensional space by various methods: (1) based on the theorem concerning the partitioning of a sphere into slices by equidistant parallel planes; (2) using normally distributed directional components; (3) by applying rejection sampling to points uniformly distributed within the cube circumscribing the unit sphere, rejecting those falling outside the sphere; and (4) using Marsaglia's method. Sampling a cosine-weighted directional distribution with respect to the normal vector of a plane.
g. Sampling isotropic directional distributions in two-dimensional space and acceleration of rejection methods using double-angle techniques.
h. Monte Carlo simulation of particle transport; analogue and non-analogue simulations; particle-associated Monte Carlo parameters; main components of particle transport codes; collision routines and post-collision direction sampling.
i. Modelling free path length in homogeneous, piecewise homogeneous and heterogeneous media; Woodcock method.
j. Monte Carlo modelling of Compton scattering; transformation of the Klein–Nishina angular distribution; Carlson, Kahn and Koblinger methods.
k. Variance-reduction techniques in particle transport simulation; statistical weights, spatial importance, Russian roulette and trajectory splitting methods.
l. Monte Carlo interpolation of multivariable functions.

Detailed MRI Topic Group [ZVETE80MFMRI]

a. Dynamics of magnetic moments: classical and quantum-mechanical descriptions.
b. The MR signal: induction, demodulation and basic experiments.
c. Spatial encoding and image formation: gradients, k-space, gradient echo and spin echo techniques, two-dimensional imaging.
d. Sampling: properties of the Fourier transform, FFT, effects of sampling and relaxation processes.
e. Signal-to-noise ratio and image contrast.
f. Steady-state imaging: coherent and incoherent cases, contrast mechanisms and stimulated echoes.

g. Advanced acceleration techniques.
h. Technical background: magnets, gradient systems, amplifiers and radio-frequency (RF) systems.

Detailed Radiation Therapy Topic Group [ZVETE80MFSTR]

a. Fundamentals of external beam radiotherapy treatment planning and its dosimetric verification (2D, 3D conformal radiotherapy and IMRT).
b. Fundamentals of brachytherapy and advanced brachytherapy techniques.
c. Advanced radiation therapy techniques, including tomotherapy systems, CyberKnife, radiosurgery and the physical principles of proton therapy.
d. Quality assurance in radiation therapy: basic concepts of quality assurance, quality control of treatment units, quality assurance of treatment-planning systems, and the significance of international protocols, including IAEA TRS-398 and TRS-430.
e. Radiation protection tasks in radiation therapy centres and radiobiology.
f. Measurement techniques in radiation therapy: ionisation chambers, semiconductor detectors, TLDs, OSLDs and dosimetric measurement protocols.

2.6. Labour Market Relevance

The programme contributes to the development of the following labour-market competencies, classified according to the ESCO[2] framework:

ESCO Competency (Short Title)	Detailed Description
Application of radiation protection regulations	Ensuring protection against ionising radiation for patients, staff and the environment in accordance with the ALARA principle.
Operation of medical imaging equipment	Safe and effective operation of diagnostic and therapeutic imaging systems (CT, MRI, PET, SPECT).
Interpretation of medical imaging data	Analysis of medical images, identification of errors, and extraction of quantitative and qualitative information.
Application of statistical methods	Data analysis, hypothesis testing, regression analysis and uncertainty estimation in research and clinical environments.
Use of computer simulation tools	Modelling physical processes (e.g. radiation therapy dose distributions) and performing Monte Carlo simulations.
Calibration of measuring instruments	Verification and calibration of medical physics equipment (e.g. dosimeters and phantoms).

[2] ESCO: https://esco.ec.europa.eu/hu/classification/skill_main

ESCO Competency (Short Title)	Detailed Description
Compliance with quality management requirements	Application of ISO and healthcare quality standards in clinical and research processes.
Application of physical modelling techniques	Use of mathematical and numerical models to describe biological and medical systems.
Processing of research data	Organisation and analysis of large datasets using statistical and machine-learning methods.
Use of medical software and PACS systems	Operation of image archiving and communication systems while maintaining data security.
Communication within multidisciplinary teams	Effective collaboration with physicians, engineers, IT specialists and researchers.
Application of ethical and legal requirements	Protection of patient data and compliance with GDPR and healthcare regulations.
Management of projects and documentation	Planning, monitoring and documenting research and clinical projects.
Application of risk analysis methods	Assessment and mitigation of risks associated with radiation therapy and diagnostic procedures.
Use of programming languages	Application of Python, MATLAB and R for data processing and simulation.
Application of machine-learning methods	Use of AI and machine-learning algorithms in image processing and predictive modelling.
Compliance with clinical protocols	Application of national and international imaging and radiation therapy protocols.
Application of data visualisation techniques	Preparation of graphs and three-dimensional models for research and clinical data.
Preparation of scientific publications	Presentation of research results in accordance with international scientific standards.
Development of educational and training materials	Preparation of presentations, teaching materials and e-learning resources for clinical and research purposes.

2.7. Specialisation within the Programme

Not relevant and not applicable to this programme, as no specialisations are offered.

2.8. Specific Features of the Master's Programme

2.8.1. Admission Requirements

1. Bachelor's Degrees Accepted Without Additional Conditions:
   a) Bachelor's degree in Physics
   b) Bachelor's degree in Physics Engineering
2. Bachelor's Degrees Accepted Conditionally:

   Qualifications obtained in Bachelor's or Master's programmes, or in programmes established under Act LXXX of 1993 on Higher Education, may be accepted subject to an individual credit evaluation and approval by the Faculty Credit Transfer Committee.

3. Excluded Qualifications

   No specific excluded qualifications are listed; eligibility is determined through the credit recognition procedure described above.

2.8.2. Competencies Required for Entry to or Continuation of the Programme

In the case of conditionally accepted qualifications, the minimum required competencies or knowledge areas, together with the minimum number of credits required in each area for admission to or continuation in the programme, are as follows:

Conditionally Accepted Degree Programme	Required Competencies or Knowledge Areas and Minimum Credit Requirements
Qualifications obtained in bachelor's or master's degree programmes, or in programmes governed by Act LXXX of 1993 on Higher Education, which are accepted by the Credit Transfer Committee following an assessment of the knowledge underlying credit recognition.	The minimum number of credits required for admission to the Master's programme is 65 credits, distributed across the following subject areas: • at least 25 credits in physics, physical chemistry, electronics, or engineering physics; • at least 18 credits in mathematics, computer science, programming, or computing, including a minimum of 10 credits in mathematics; • at least 15 credits in natural science studies, including chemistry, materials science, nuclear sciences, environmental sciences, measurement techniques, process control, and automation . A prerequisite for admission is that applicants possess at least 40 recognised credits from previous studies. Any missing credits must be completed in accordance with the University's Study and Examination Regulations.

2.8.3. Acquisition of Missing Competencies

If the total number of recognised credits specified in Section 2.8.2 is at least 40 but fewer than 65, the missing credits (up to a maximum of 25 credits) must be completed concurrently with the Master's programme within the first two active semesters following admission, in accordance with the BME Study and Examination Regulations.

As part of the admission procedure, during the preliminary credit recognition process, the Faculty Credit Transfer Committee determines which supplementary courses must be completed. These courses are selected from those listed in Section 2.8.4 according to the applicant's missing knowledge areas.

Successful completion of these supplementary requirements is certified at the end of the second active semester by the awarding of a signature in the criterion course Basics of Medical Physics.

2.8.4. Courses Ensuring the Acquisition of Missing Competencies

Competency or Knowledge Area	Course Code(s)	Course Title(s) (hu): Hungarian-, (en): English-language
Mathematics (Analysis)	BMETE93AF21 BMETE92AP62	Többváltozós analízis fizikusoknak (hu) Multivariable Calculus (en)
Mathematics (Probability Theory)	BMETE95AF00 BMETE95AP45	Valószínűségszámítás fizikusoknak (hu) Probability Theory (en)
Mathematics and Other Natural Sciences	BMETE80AF38	A méréskiértékelés matematikai módszerei / Mathematical Methods of Experimental Data Evaluation (hu)/(en)
Computer Science	BMEVIEEA024 BMEVIEEAA00	Programozás (hu) Basics of Programming 1 (en)
Physics	BMETENTBsPMFAI-00	Nuclear Physics Fundamentals (en)
Other Natural Sciences	BMETE80AF42	Nukleáris méréstechnika / Radiation Detection and Measurement (hu)/(en)

Where two courses are listed, students may choose between the Hungarian-language and English-language versions.

3. Competence Assessments

The purpose of competence assessments is to monitor students' development throughout the entire duration of the programme. To achieve this, three main assessment points are distinguished:

- Entry-level assessment: conducted at the beginning of the programme to identify students' prior knowledge and competencies;
- Mid-term assessment: conducted at designated points during the programme to evaluate students' progress;
- Exit-level assessment: conducted at the end of the programme to verify the achievement of the intended learning outcomes..

Structure of the Competence Framework to be Assessed:

1. Knowledge

Assessment Stage	*Sample Competencies Assessed*
Entry-level	*Knowledge of fundamental concepts (basic logic, mathematics, and physics)*
Mid-term	*Understanding and application of theoretical models in simple problem-solving situations*
Exit-level	*Synthesis of professional theories and interpretation of complex systems*

2. Skills

Assessment Stage	*Sample Competencies Assessed*
Entry-level	*Reading comprehension, basic problem-solving ability, and digital skills*
Mid-term	*Data interpretation, drawing conclusions, and use of professional tools*
Exit-level	*Independent problem-solving, analytical skills, and research-based thinking*

3. Attitudes

Assessment Stage	*Sample Competencies Assessed*
Entry-level	*Learning motivation and openness to new knowledge*
Mid-term	*Critical thinking and willingness to cooperate*
Exit-level	*Responsible professional attitude and ethical awareness*

4. Autonomy and Responsibility

Assessment Stage	*Sample Competencies Assessed*
Entry-level	*Basic study organisation and time-management skills*
Mid-term	*Independent learning and willingness to undertake tasks within a team*
Exit-level	*Responsible decision-making in professional situations and self-reflection*

Recommended Assessment Methodology

Assessment Stage	*Recommended Methodology*
Entry-level	*Diagnostic test, questionnaire, interview*
Mid-term	*Homework assignment, laboratory exercise, seminar presentation, mid-semester test, examination*
Exit-level	*Thesis, final examination, thesis defence*

3.1. Entry-Level Competence Assessment

1. Purpose of the assessment: to map students' prior knowledge, skills and attitudes, identify differences resulting from previous educational backgrounds, and determine their level of preparedness for the programme.
2. Timing of the assessment: during the registration week of the first semester.
3. Competencies assessed: primarily knowledge of fundamental concepts, reading comprehension and digital skills, learning motivation, and the ability to organise independent learning. In addition, students' previously achieved results (e.g. competition achievements), declared skills and competencies (e.g. professional interests and hobbies) are recorded.
4. Assessment methodology: diagnostic test, questionnaire, and interview.

3.2. Mid-Term Competence Assessment(s)

1. Purpose of the assessment(s): to monitor students' academic progress, with particular emphasis on the ability to apply theoretical models, the development of research-based thinking, and the strengthening of collaborative skills.
2. Timing of the assessment(s): continuous throughout the programme.
3. Competencies assessed: application of theoretical models in practical situations, data interpretation skills, critical thinking, use of professional tools, willingness to cooperate, independent learning, and presentation skills.

4. Assessment methodology: homework assignments, laboratory exercises, seminar presentations, mid-semester tests, and examinations.

3.3. Exit-Level Competence Assessment

1. Purpose of the assessment: to determine whether students have achieved the intended learning outcomes of the programme by graduation, with particular emphasis on the integration of professional theories, independent problem-solving, and responsible professional and ethical conduct.
2. Timing of the assessment: at the end of the final semester.
3. Competencies assessed: students' ability to independently analyse complex medical physics problems; develop research-based solutions; demonstrate strategic thinking; make responsible decisions in professional and ethical contexts; exercise professional autonomy; and engage in self-reflection.
4. Assessment methodology: thesis, final examination, and thesis defence.

4. Mobility Window

4.1. Semester(s) Designated as the Mobility Window

To support international student mobility, the programme provides a mobility window, which designates one or more semesters during which students may participate in a period of study abroad without extending the duration of their studies or falling behind the recommended curriculum.

Designated mobility-window semesters: Semester 3 or Semester 4.

4.2. Recognition of Courses Completed During the Mobility Window

The recognition of compulsory and compulsory elective courses completed during the mobility window shall be carried out as follows:

a) Any course completed abroad during the mobility semester may be recognised if its learning outcomes correspond, to at least 50%, to the learning outcomes of a compulsory or compulsory elective course in the curriculum of the programme. In the case of prior credit recognition, the corresponding home-university course may be registered for the mobility semester and the grade may subsequently be recorded on the basis of the transcript issued by the host institution. Decisions on course equivalency are made by the Faculty Credit Transfer Committee, taking into account the opinion of the Programme Director or Deputy Programme Director.

b) If a corresponding course for a compulsory or compulsory elective subject is not available at the host institution, the home-university course may still be taken during the mobility semester, and an individual study arrangement (e.g. distance-learning mode) may be granted where permitted by the teaching methodology of the course. This option is not available for laboratory courses.

c) A professionally relevant course completed (or intended to be completed) abroad may be recognised as a compulsory elective course even if it cannot be matched to a specific course in the curriculum, provided that its learning outcomes are consistent with those defined for the programme. The Programme Director is responsible for determining this equivalence. If approved, the course will be entered into the academic system under its original title and original ECTS credit value, and the original grade (or its equivalent) will be recorded. The recognition must be officially documented by indicating the relevant compulsory elective course group.

d) To avoid credit loss, the procedure described in point (c) may also supplement the recognition process described in point (a) if the ECTS value of the course completed abroad exceeds that of the corresponding course in the curriculum. In such cases, the recognised credit value may equal the difference between the credits awarded abroad and those assigned to the matched curriculum course.

g) Upon prior agreement, and in accordance with the Study and Examination Regulations, thesis work extending over several semesters may be continued during the mobility period in cooperation with the home supervisor through electronic communication. By mutual agreement, staff members of the host institution may also participate in the supervision of the work.

h) The compulsory one-week professional internship may also be completed abroad within the framework of international mobility.

i) To avoid delays in study progression, the planned mobility studies must be discussed in advance with the Programme Director or Deputy Programme Director. This consultation should begin before the mobility application is submitted and should be based on the student's preliminary study plan.

j) When selecting courses to be taken abroad, students must also ensure that they remain adequately prepared to meet the requirements of the final examination.

k) Students who follow an individual study plan different from the recommended curriculum may also request assistance from the Programme Director or Deputy Programme Director in planning their participation in international mobility.

l) Students may also receive guidance in selecting courses for mobility periods outside the designated mobility-window semesters. However, in such cases there is a higher risk of delay in study progression; therefore, participation during the designated semester is recommended.

e) The compulsory courses designated for the mobility semester are listed in the table below. As a general rule, recognition of these courses is governed by the provisions set out in points (a), (b) and (d); any exceptional cases are also indicated in this column.

Third Semester:

Course Code	Course Title	Credits	Method of Recognition
BMETENTMsOSGYK-00	Professional Training MP	0	To be completed during the summer preceding Semester 3, either at BME or abroad in accordance with point (h)
BMETENTMsOPOL2-00	Independent Laboratory MP2	10	In accordance with point (g), or may be completed in Semester 2
BMETE80MF83	Seminar MP3	2	In accordance with points (a) and (b), or may be completed in Semester 4

Fourth Semester:

Course Code	Course Title	Credits	Method of Recognition
BMETE80MF84	Seminar MP4	0	In accordance with points (a) and (b)
BMETE80MF71	Diploma Work MP	30	May also be completed at a host institution in accordance with point (g)

f) As a general rule, recognition of compulsory elective courses follows the procedures described in points (a)–(d). For laboratory courses, the procedures described in points (a), (c), and (d) apply. The completion and recognition of such courses must be discussed in advance with the Programme Director or Deputy Programme Director as specified in point (i).

Course Code	Course Title	Credits	Method of Recognition
BMEVIEUM300	Ethical Aspects of Medical Research	4	In accordance with points a), b), c) and d)
BMETEFTBsPATTM-00	Data-Science-Aided Measurements	3	In accordance with points a), c) and d)
BMETE12MF79	Physical Optics	5	In accordance with points a), b), c) and d)
BMETE15AP61	Introduction to Machine Learning	4	In accordance with points a), c) and d)
BMETE12MF58	Industrial and Biological Applications of Lasers	3	In accordance with points a), b), c) and d)
BMETE80MF75	Magnetic Resonance and Clinical Applications 2	3	In accordance with points a), b), c) and d)
BMETE15MF75	Artificial Intelligence in Data Science	5	In accordance with points a), b), c) and d)
BMETENTMsOMBJS-00	Quality Assurance and Legislation	4	In accordance with points a), c) and d)
BMETE80MFA9	Monte Carlo Particle Transport Methods	3	In accordance with points a), b), c) and d)
BMETE11MF58	Nanotechnology and Materials Science	4	In accordance with points a), b), c) and d)
BMETE12MF19	Optical Information Processing and Data Storage	3	In accordance with points a), b), c) and d)
BMETE80MF32	Migration of Radioactive Species in Environmental and Biological Matter	4	In accordance with points a), b), c) and d)
BMETE80MF31	Safety of Radioactive Wastes	4	In accordance with points a), c) and d)
BMETENTMsORETN-00	Essential Medical Physiology	4	In accordance with points a), c) and d)
BMETENTMsOSUG2-00	Radiotherapy 2	3	In accordance with points a), b), c) and d)

4.3. Special Provisions Relating to the Mobility Window

1. Recommendations for Selecting a Partner Institution

– The partner institution must be an accredited higher education institution within the European Higher Education Area (EHEA).

– Preference is given to institutions whose educational offer is aligned with the discipline in terms of subject matter, methodology, or academic profile.

When selecting a partner institution, consideration is given to the quality of teaching, international reputation, range of available courses, and the linguistic and infrastructural support provided by the host institution.

2. Quality Assurance of International Study Periods

– The host institution must ensure that its academic requirements are transparent, that course learning outcomes are documented, and that credits are structured according to the ECTS system.

– A Learning Agreement is mandatory and must be approved and signed in advance.

3. Student Satisfaction Monitoring

Following the mobility period, student satisfaction and academic progress are evaluated through questionnaires and interviews. The results may be used to further develop the programme and the list of partner institutions.

4. Guidelines for Courses Completed Abroad

The selected courses should be professionally relevant and should cover at least 40–50% of the intended learning outcomes of the corresponding programme courses. Students should also ensure that their course selection supports adequate preparation for the final examination.

5. Other Information

4.4. Special Rules for Professional Internships Completed Within the Mobility Window

Within the framework of international mobility, the compulsory one-week professional internship may be completed abroad. The purpose of the internship is to apply and deepen the knowledge acquired during the theoretical and practical components of the programme in a real clinical, research-and-development, or research environment. During the internship, students develop numerous skills defined in the programme and outcome requirements under authentic workplace conditions.

4.5. Special Rules for Thesis Preparation Within the Mobility Window

Within the framework of international mobility and subject to prior agreement, thesis work extending over several semesters may be continued in collaboration with the home supervisor through electronic communication. By mutual agreement, the host institution and its staff members may also be involved in the supervision and execution of the thesis project.

5. Provisions Relating to Micro-Credentials and Modules

This programme does not contain any modules; therefore, this section is not relevant and not applicable.

6. Recommended Curriculum

6.1. Recommended Curriculum

6.2. Course Equivalencies with the Previous Recommended Curriculum

Courses in the Previous (2024) Recommended Curriculum		Equivalent Courses in the New (2026) Recommended Curriculum	
Course Code	**Course Title**	**Course Code**	**Course Title**
BMEGT60W68A	English for University Studies - B2+	BMEGT60LNGA501-01	English for University Studies B2+
BMEGT60W60A	Communication Strategies English B2	BMEGT60LNGA406-01	Communication Strategies English B2
BMEGT60W64A	Technical English B2	BMEGT60LNGA403-01	Technical English B2
BMEGT60W71A	Professional Writing - English C1	BMEGT60LNGA605-01	Academic Writing C1
BMEVIEUM000	Basics of Functional Anatomy	BMETENTMsO-FANA-00	Basics of Functional Anatomy
BMEVIEUM273	Essential Medical Physiology	BMETENTMsO-RETN-00	Essential Medical Physiology
BMETE80AF43	Experimental Nuclear Physics	BMETENTBsPMFAI-00	Nuclear Physics Fundamentals