National University of Science and Technology

POLITEHNICA Bucharest

Faculty of Applied Sciences

Master's Program in Engineering and Applications of Lasers and Accelerators

Description

Laser technologies and particle accelerators have become indispensable tools in modern science, engineering, medicine, and industry. Their applications range from advanced manufacturing, materials characterization, and medical diagnostics to nuclear physics, radiation therapy, homeland security, and fundamental scientific research. The growing development of large-scale international research infrastructures has created an increasing demand for engineers capable of designing, operating, and optimizing these highly sophisticated systems.

The **Master's Program in Engineering and Applications of Lasers and Accelerators** provides advanced interdisciplinary training in laser engineering, particle accelerator technologies, photonics, nuclear engineering, and experimental physics. The curriculum combines fundamental knowledge in optics, electromagnetism, plasma physics, quantum mechanics, and nuclear physics with practical engineering skills required for the development and operation of complex laser and accelerator facilities.

A distinctive feature of the program is its close integration with internationally recognized research institutions and large-scale scientific infrastructures. Students benefit from exposure to cutting-edge technologies and research projects, preparing them for careers at the forefront of high-performance engineering and applied physics.

Relevance to the Job Market

The increasing use of advanced laser systems and particle accelerators in research laboratories, medical centers, aerospace, semiconductor manufacturing, materials science, and high-tech industries has generated strong demand for highly specialized engineers.

Graduates are prepared for careers in research and development, laser engineering, accelerator technology, photonics, medical physics, radiation technologies, scientific instrumentation, and advanced manufacturing. Typical career paths include **Laser Systems Engineer**, **Accelerator Engineer**, **Photonics Engineer**, **Medical Physics Engineer**, **Research Engineer**, **Scientific Instrumentation Specialist**, **Radiation Protection Engineer**, and **Experimental Physicist**.

Through its academic and research partnerships, the program also prepares students for participation in major international scientific initiatives, including **Extreme Light Infrastructure – Nuclear Physics (ELI-NP)**, offering excellent opportunities for doctoral studies and international research careers.

Competencies Acquired

Upon completion of the program, graduates will be able to:

- Design, analyze, and operate complex laser and particle accelerator systems.
- Apply advanced principles of optics, photonics, plasma physics, and nuclear physics to engineering applications.
- Develop and optimize optical, mechanical, and electronic subsystems for high-performance scientific facilities.
- Design measurement systems for ionizing radiation and perform radiation dosimetry.
- Utilize computational methods for modeling, simulation, and analysis of laser and accelerator systems.
- Integrate multidisciplinary engineering solutions involving optics, electronics, vacuum technologies, and control systems.
- Conduct experimental investigations using advanced laser and photon beam technologies.
- Work effectively within multidisciplinary international research teams and contribute to large-scale scientific projects.

Selected Courses

The curriculum includes advanced courses such as:

- Laser and Accelerator Technologies: Current Developments and Professional Perspectives
- Electromagnetism and Plasma Physics for Engineering
- Quantum Mechanics for Engineering Applications
- Atomic and Nuclear Physics for Engineering
- Optics and Lasers for Applications
- Engineering and Applications of Particle Accelerators
- High-Power Laser Engineering
- Measurement and Dosimetry of Ionizing Radiation
- Applications of Photon and Particle Beams in Materials Science and Medicine

- Ultra-Precision Mechanical Systems and Vacuum Technology
- Electronics for Experimental Sciences
- High-Performance Computing Methods and Programming

Research Areas

Students have the opportunity to participate in research projects covering topics such as:

- High-power laser systems
- Particle accelerator technologies
- Photonics and optical engineering
- Laser-matter interactions
- Monte Carlo simulation of radiation detectors
- Radiation detection and dosimetry
- Accelerator-based photon sources
- Materials characterization using photon and particle beams
- Optical system design and characterization
- Experimental methods in nuclear and applied physics

Program Highlights

- Interdisciplinary curriculum combining physics, engineering, photonics, and computational methods.
- Direct exposure to advanced laser and particle accelerator technologies.
- Strong collaboration with leading Romanian research institutes and international scientific infrastructures.
- Opportunities to participate in research projects associated with **ELI-NP**, **CERN**, and **FAIR**.
- Excellent preparation for careers in high-tech industry, medical technologies, national laboratories, and international research organizations.

Additional Information

- **Language of instruction:** Romanian
- **Duration:** 2 years (120 ECTS)
- **Degree awarded:** Master of Science (M.Sc.) in Applied Engineering Sciences
- **Contact person:** Conf.dr. Gabriel SULIMAN, gabriel.suliman@upb.ro