Competences imparted: MSc program in Environmental Engineering

Competence Profile (MSc)

A graduate from the Technical University of Denmark (DTU) has a research-based education at a high technological level that qualifies the graduate to take on specialized business functions and participate in scientific development. A master's degree in Engineering also gives access to further education within research (e.g. research positions or a PhD).

The graduate has:

- basic understanding and knowledge of the natural sciences and technological principles. The graduate can use this knowledge for innovative purposes such as solving technological problems in business or societal contexts.
- extensive technological expertise within a specific area and knowledge of current trends and opportunities within this area.
- a clear professional profile which includes elements of current research at an international level. The graduate has the ability to use this knowledge in developing new ideas and solving new problems.
- a thorough understanding of how elements of a technological problem interact. The graduate is able to develop relevant models, systems and processes to solve the problem in question using creative analysis and modeling.
- the ability to assess and delimit complex issues, put them into a broad professional and societal context, and, on this basis, propose relevant courses of action.
- the ability to combine technological expertise with knowledge of economics, management, organization and project work. The graduate is able to examine technological solutions in a business and societal perspective.

General competences (MSc)

The graduate:

- is proficient in both oral and written communication, and is able to present professional results in a convincing manner
- commands technical problem solving at a high level, primarily through project-related approaches. The graduate is able to handle all phases of a project, including the drafting of project timelines, design and solution proposals, and documentation
- can use and assess technological solutions, while applying principles of ethics and sustainability
- has experimental experience and is familiar with lab culture within his/her professional sphere.

Formal conditions (MSc)

- Admission requirements: BSc Eng (180 ECTS points)
- Program duration: The master's program covers two years of full-time study (equal to 120 ECTS). This framework ensures that all graduates acquire professional core competencies through technological specialization (minimum 30 ECTS) and a master's thesis (minimum 30 ECTS). Program participants also acquire specialized knowledge through elective courses (minimum 30 ECTS). The program also includes 30 elective ECTS credit points.
- Title: Master of Science in Engineering, cand. polyt.
- Further education: Research, PhD (3 years)
- Executive order: The master's program complies with executive order BEK 338 dated May 6, 2004 (and subsequent amendments) issued by the Danish Ministry of Science, Technology and Innovation.

PROFESSIONAL COMPETENCE OBJECTIVES (MSc)

The MSc program in Environmental Engineering

MSc graduates in Environmental Engineering design and implement technical solutions to environmental problems. They assess and manage the impact of human activities on the environment with the goal of sustainable and optimal use and reuse of resources. An environmental engineer achieves these goals through an understanding of physical, chemical and biological processes in the water, soil, air and living environments. The properties, fate and transport of contaminants in the environment are considered. Environmental engineers distinguish themselves through the ability to quantitatively assess environmental problems. Management, legal and economic skills complement the technical background of an environmental engineer. Graduates of the MSc in Environmental Engineering are internationally competitive leaders in research and innovation.

The graduate can:

- describe the most important environmental and health problems and the most essential technical solutions to those problems
- provide in-depth analysis and solutions to complex multidisciplinary problems
- design and conduct laboratory and field experiments
- analyze the chemical and biological fate of contaminants in the environment
- employ state-of-the-art technological methods (IT and experimental) to analyze environmental problems
- employ conservation laws to describe environmental flows and transport
- construct and solve mathematical models and employ statistical methods to describe environmental problems
- conceive, design, implement and operate appropriate technologies for managing environmental problems based on detailed understanding of chemical, physical, biological and organizational processes
- provide written and oral analysis of environmental problems
- frame environmental problems within a societal, technical, economic and legal context

Facts about DTU

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PROFESSIONAL COMPETENCE OBJECTIVES (MSc)

The MSc program in Environmental Engineering – Environmental Management

Graduates of the Environmental Management study-line promote sustainable development in all parts of society, including business and households, nationally and globally. They have a theoretical and practical grounding in the systematic mapping of environmental problems, in analyzing the technological, economic, social and cultural context and seeking sustainable solutions. Environmental activities in industry are emphasized, including designing environmental solutions into industrial products and processes. Graduates are employed in industry, consultancies, research and development and public authorities.

The graduate can:

- describe the fundamental relationships within ecosystems and the interplay between humans and nature
- explain how environmental problems impact water, air and soil and suggest measures for the prevention and mitigation of those impacts
- plan and execute life-cycle assessments for products and systems
- map and assess environmental impacts related to production processes and develop solutions that mitigate those impacts
- analyze energy and material flows in a wider societal perspective
- analyze the interplay within global product chains and assess the implications for environmental business strategies
- assess and develop socially responsible environmental strategies and policies for companies
- plan and manage processes of change in cooperation with companies, employees, public authorities, and citizens
- compare and assess different socio-economic perspectives on environmental problems and solution strategies
- identify the social and cultural differences that are relevant to environmental problems in various countries

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PROFESSIONAL COMPETENCE OBJECTIVES (MSc)

The MSc program in Environmental Engineering – Environmental Chemistry, Microbiology and Ecotoxicology

Graduates of the Environmental Chemistry, Microbiology and Ecotoxicology study-line can analyze the fate and effect of contaminants such as toxic chemicals, hazardous materials and pathogens. They use laboratory and computational methods for fate, hazard, exposure and risk assessment and for the development of mitigation strategies. The core disciplines in this study-line are environmental chemistry, microbiology and ecotoxicology. The scientific basis for risk assessment, the legislative frameworks and selected case studies are examined for organic micropollutants, nano-particles, pathogens, or endocrine disruptors.

The graduate can:

- define and describe fundamental concepts, terms, and processes in environmental chemistry, microbiology, ecotoxicology and risk assessment
- comprehend and describe contaminant degradation pathways, kinetics and chemical, physical, and biological fate based on the contaminant's chemical structure
- describe how various physical/chemical/biological factors affect the structure and function of perturbed ecosystems, with specific emphasis on the fate of pollutants
- quantify and predict the fate and effect of contaminants, including assessment of exposure routes, bioaccumulation and metabolism, using experimental and mathematical methods
- design, perform and interpret experiments using modern chemical, ecotoxicological and microbiological laboratory methods
- synthesize knowledge from available sources and compare, rank and propose substitution methods or treatment alternatives for contaminants and contaminant mixtures
- synthesize knowledge from various sources to identify uncertainties in fate, exposure, hazard and risk assessment
- perform risk assessments following legal frameworks and best-science approaches to determine the impact of contaminants on humans and the environment
- advise on risk management decisions for environmental contaminants

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PROFESSIONAL COMPETENCE OBJECTIVES (MSc)

The MSc program in Environmental Engineering – Water Resources Engineering

Water Resources Engineering is concerned with quantity and quality of water in surface and groundwater systems. Graduates of this study-line can quantitatively describe the physical, chemical and biological processes affecting water and the fate of natural and anthropogenic contaminants. They can work at all scales, from small-scale process-oriented laboratory and field studies to basin-scale and global hydrological systems. They can acquire the data required to characterize water-resource systems and contamination problems in soil and groundwater. Their advanced modeling skills include the ability to integrate field and experimental data into those models. Graduates can design technical solutions to water-resource problems and develop remediation technologies.

The graduate can:

- formulate mass balances for surface and subsurface water bodies and contaminant transport
- work in the field and laboratory to collect data to characterize water-resource systems and contamination problems
- apply geophysical methods and remote sensing to analyze the state of water resources
- apply statistical techniques to analyze water quantity and quality data
- formulate conceptual and mathematical models of hydrological and biogeochemical processes
- apply, calibrate and optimize analytical and numerical models at different scales and interpret the results
- utilize remediation technologies to mitigate soil and groundwater contamination
- synthesize multidisciplinary water-resource problems for improved management, risk assessment and engineering design
- evaluate water-resource problems in their social, political, economic and legal context

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PROFESSIONAL COMPETENCE OBJECTIVES (MSc)

The MSc program in Environmental Engineering – Urban Water Engineering

Graduates in the Urban Water Engineering study-line manage the urban water cycle with respect to water quantity and quality. Focus areas are technical systems for water supply for domestic, municipal, industrial and recreational use, collection of domestic and industrial sewage, management of storm water and treatment processes. Graduates are skilled in hydraulics, urban hydrology, environmental chemistry and microbiology, physicochemical and biochemical unit operations, process engineering and computational and analytical techniques and can apply them to quantitatively analyze urban water problems. Their technical solutions for sustainable management of urban water address the complex economic, societal and legal constraints governing urban water.

The graduate can:

- analyze urban water hydraulics, including flows in pipes and channels and urban flooding
- analyze and design water treatment processes and systems for waste water and drinking water, using state-of-the-art computational methods
- analyze and design urban water distribution and drainage systems
- use computational tools to simulate urban water systems in order to monitor, optimize and control the systems via information technologies
- quantify the chemical and biological transformation processes in urban water systems, from intensively engineered treatment processes to broader urban environments
- quantify processes affecting major chemical pollutants, including organic and inorganic trace contaminants and hygienic parameters
- apply the most recent developments in physicochemical and microbial processes to develop new water treatment trains and optimize existing ones
- choose, apply and interpret experimental and field assays to measure water-quality parameters
- describe and quantify how different parameters impact water-quality from technical, ecological and public-health perspectives
- evaluate and manage the risk to environmental or human recipients of use or reuse of a given water quality
- apply engineering concepts to sustainably manage urban water in its social, economic, legal and political context

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PROFESSIONAL COMPETENCE OBJECTIVES (MSc)

The MSc program in Environmental Engineering – Residual Resources Engineering

Graduates of the Residual Resources Engineering study-line work to sustainably manage, reuse, and minimize the impact of residual resources (such as waste) generated by human activity. Society is facing an immense demand for resources and energy and at the same time generating increasing amounts of residues. In order to use this residual resource and avoid the impacts of the contaminants in the residues, a holistic technological approach is needed. This requires characterization of the residues, understanding of mass and substance flows, design of conversion technologies, assessment of environmental impacts and energy efficiencies. Skills in mass and energy balances, process engineering and life- cycle assessment are integrated into a social, legal and economic framework for optimizing waste management and utilization strategies. An important use of residual resources is to meet the demand for renewable energy through production of energy carriers by biological methods (biogas, biohydrogen, bioethanol) and thermal methods (solid fuels from waste, direct production of electricity and heat).

The graduate can:

- characterize residual resources, including their resource value and contaminant contents.
- design and implement technologies for residual resources collection, treatment, recycling, utilization and disposal
- evaluate the impact of residual resources management in terms of emissions to air, soil and water resources
- conduct life-cycle assessments of residual resource management systems.
- work with industry to identify and implement appropriate technologies for the sustainable management of residual resources
- explain the processes, stoichiometry, kinetics, biochemistry and microbiology for transforming residual resources
- design bioenergy production systems, evaluate reactor configurations and process technologies for bioenergy production
- develop models for process monitoring, control and optimization
- apply engineering concepts to sustainably manage residual resources in the social, economic, legal and political context

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