

# Competences imparted: MSc program in Advanced and Applied Chemistry

## 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.

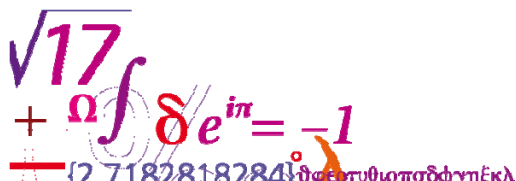
## General competences (MSc)

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 Advanced and Applied Chemistry

Advanced and Applied Chemistry involves the design of environmentally-friendly materials, processes and chemical/biochemical products e.g. polymers, catalysts and pharmaceuticals. A prerequisite for such designs is a thorough understanding of the interactions between organic synthesis, characterization, structure and properties.

Common to the MSc program in Advanced and Applied Chemistry is a focus on the design of chemical products with tailor-made properties. This is achieved via the key disciplines of organic synthesis, characterization methods and physical chemistry, which are taught at both molecular and nano-scale levels. Courses in product design and characterization methods are mandatory.

Within this MSc program, students can choose study-lines in Polymers, Catalysis and Nanotechnology or Pharmaceutical Technology, areas of great technical and scientific interest. Alternatively, students can design their own study program based on their interests, e.g. analytical/organic chemistry, materials, environmental chemistry and physical chemistry.

### The graduate:

- can describe chemical reactions and identify methods for the synthesis of chemical compounds
- can select and use analytical (instrumental) methods for characterizing chemical compounds and measuring the chemical and physical properties of materials
- can interpret the physico-chemical and mechanical properties of chemical or biochemical-based materials and relate them to their structure and applications
- can work independently or collaboratively in the fields of product development and quality control, including analysis of market needs and the creation and selection of the best product-concepts and develop recipes for the synthesis of products on a laboratory scale
- can employ theoretical (including computerized) tools and experimental methods for the synthesis, characterization and design of materials/products
- can collaborate with specialists in other disciplines such as chemists or pharmacists depending on the study-line/study program chosen
- can independently carry out experimental or theoretical research projects in the field of Advanced and Applied Chemistry and present and analyze the results orally or in writing

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### Facts about DTU

The Technical University of Denmark (DTU) is one of the largest Northern European research and education institutions in the engineering field. DTU educates more than 750 Masters and 300 Bachelors of Engineering and 150 PhDs a year. On January 2007 DTU merged with 5 sectorial research institutions becoming a broad-based technical university and center of excellence. The university has more than 6,000 students and over 4100 employees.

DTU offers a 3½-year business-oriented Bachelor of Engineering, a 3-year Bachelor of Science in Engineering and a 2-year Master of Science in Engineering, MSc Eng. DTU also offers a 2-year Master of Science and Technology (MSc Techn) for Bachelors of Science and a Bachelor and Master's program in Food Science in collaboration with the University of Copenhagen.



## PROFESSIONAL COMPETENCE OBJECTIVES (MSc)

### The MSc program in Advanced and Applied Chemistry – Polymers

The Polymers study-line gives a comprehensive competence in the areas of polymers and polymer-based products. Courses in polymer chemistry include an introduction to research into controlled synthesis of polymer molecules with specified branching and functional-group architecture. The study-line also includes training in chemical and physical characterization of a variety of soft materials and complex fluids (polymer solutions and melts, emulsions, colloidal systems). The graduate is equipped for employment in the manufacture of polymer-based products (injection molding, film blowing, extrusion and thermoforming). Graduates with this specialization are qualified for research and industrial work within academia and the Danish polymer industry.

#### The graduate:

- can synthesize polymers and use analytic methods for chemical and physical characterization of the products
- can choose polymers for given applications.
- can interpret the thermal properties of amorphous and semi-crystalline polymers (glass transition and melting point) and relate these to the chemical structure
- can identify monomer- and polymerization techniques for the synthesis of selected polymers
- can predict the applicability of characterization methods for given polymers (Size Exclusion Chromatography [SEC], Infrared Analysis [FTIR], Nuclear Magnetic Resonance [NMR], Differential Scanning Calorimetry [DSC], Thermo Gravimetric Analysis [TGA] and interpret the results in terms of structure
- can formulate criteria for gelation and the formation of continuous networks
- can predict the mechanical properties of polymer gels and networks
- can suggest polymer processing techniques for given polymers and products (injection molding, film blowing, spin coating etc.)
- can conduct an experimental or theoretical research project in polymer science and technology and report the results orally and in writing

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## PROFESSIONAL COMPETENCE OBJECTIVES (MSc)

### The MSc program in Advanced and Applied Chemistry – Catalysis and Nano-technology

The Catalysis and Nano-technology study-line comprises courses in synthesizing and characterizing catalysts and nano-particle-based materials and applying them to fine and bulk chemical production, energy production and bio- and environmental technology. Graduates will be able to relate structure and properties at molecular and macroscopic levels and will be fully conversant with reaction kinetics and process technology.

Graduates will be fully qualified for R&D and industrial production in the field of advanced materials.

#### The graduate:

- can synthesize catalysts and nano-materials
- can characterize these materials by advanced instrumental and surface methods
- can test the efficiency of catalysts for selected processes
- can describe the relation between the structure and properties of materials in relation to the design of industrial processes and advanced materials technology
- can describe the most important industrial catalytic processes and catalysts
- can analyze complicated reaction kinetics and reaction problems by mathematic modeling
- can formulate and carry out experimentally-based research projects and present the results orally and in writing

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## PROFESSIONAL COMPETENCE OBJECTIVES (MSc)

### The MSc program in Advanced and Applied Chemistry – Pharmaceutical Technology

The Pharmaceutical Technology study-line deals with the development of drugs with a focus on the molecular foundations of modern medicine. The program will provide practical competence in experimental synthetic chemistry, accompanying analytical techniques and the application of computer modeling in medicinal chemistry. The MSc graduate will have in-depth knowledge of one area of medicinal chemistry and will be capable of providing solutions to complex problems in medicinal chemistry and of interacting with professionals in related fields such as medical doctors, pharmacists and process chemists.

#### The graduate:

- can select the appropriate method for the administration of a drug
- can determine whether a molecule has potential as a drug
- can apply knowledge of potential-target localization in drug design
- can apply simple, computer-based tools in drug design and interpret the more complex datasets derived from such methods
- can predict reactivity and binding interactions for complex, multifunctional molecules
- can suggest synthetic routes to potential drug candidates using retrosynthetic analysis
- can use the chemical literature to find synthetic routes to known compounds and suggest methods for preparing new compounds
- can apply modern analytical chemical techniques for compound identification and evaluating purity and relate these to the drug development process
- can carry out an independent, experimentally-based research project in medicinal chemistry and present the results orally and in writing and put the results in a broader perspective

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Det bli'r til noget