



Faculty of Technology and Science

## PROGRAMME STUDY PLAN

<b>Programme Code</b>	TACBR
<b>Programme Approval</b>	The Programme Study Plan was approved by the Faculty Board of Technology and Science on 11 February 2010 and is valid from the autumn semester of 2010 at Karlstad University.
<b>Programme Title</b>	Master of Science in Engineering: Computer Engineering, Master of Science in Engineering: Environmental and Energy Engineering Master of Science in Engineering: Industrial Engineering and Management Master of Science in Engineering: Chemical Engineering Master of Science in Engineering: Mechanical Engineering Master of Science in Engineering: Engineering Physics
<b>Credits</b>	300 ECTS
<b>Language of Instruction</b>	Swedish yrs 1-3, English or Swedish yrs 4-5
<b>Degree Level</b>	Master
<b>Degree Type</b>	Professional degree
<b>Prerequisites</b>	General admission requirements plus upper secondary school level Mathematics D, Physics B, and Chemistry A.  Field-specific eligibility: 9

### General Information

The programme leads to the award of Master of Science Degree in the area of computer science, environmental and energy engineering, industrial engineering and management, chemical engineering, mechanical engineering or engineering physics.

A central objective of the programme is that students develop technological excellence in their selected area along with highly developed skills in working with others. An

engineering graduate from Karlstad University can work with planning, development, design, production and technologically advanced systems.

The programme develops an understanding of the roles of technology and engineering in society, economically and socially, and prepares for positions involving great responsibility. Students acquire nationally and internationally competitive knowledge and skills and sound theoretical and practical knowledge of basic science and technology subjects and mathematics as well as develop personal qualities and attitudes.

The progression requirements for the Master's degree are satisfied in the way expected learning outcomes are designed to provide successive specialisation throughout the programme as well as be possible to examine and assess. The programme employs a variety of pedagogical models for teaching and modes of learning and assessment, all of which contribute to the successive specialisation in science, methodology, subject, language and engineering. The research basis is of special importance to the students' gradual progression in science and methodology development.

Quality assurance is ongoing and based on the university's ambition to provide good education and committed teachers. Course evaluations, alumni networks and student representation in governing bodies are important means to ensure quality of education. Professional relevance is maintained through community cooperation and external representation in governing bodies.

#### **Aims**

Upon completion of the Master of Science in Engineering programme, students are prepared for further studies in the field and have acquired a basis for life-long learning and the ability to keep up with technological developments.

For a Master of Science Degree in Engineering, students at Karlstad University must meet the requirements specified in the *Higher Education Ordinance, SFS 2006:1053* as follows:

- **General qualifications:** For a degree of Master of Science in Engineering, students must demonstrate the knowledge and skills required for them to work independently as a graduate engineer.

- **Knowledge and understanding**

For a degree of Master of Science in Engineering students must

- demonstrate knowledge of the scientific basis and proven experience of their chosen area of engineering, together with insight into current research and development work; and

- demonstrate both broad knowledge in their chosen area of engineering, including knowledge of mathematics and natural sciences, and substantially deeper knowledge in certain parts of the field.

- **Skills and abilities**

For a degree of Master of Science in Engineering students must

- demonstrate an ability, from a holistic perspective, to critically, independently and creatively identify, formulate and deal with complex issues, and to participate in research and development work so as to contribute to the development of knowledge;
- demonstrate an ability to create, analyse and critically evaluate different technical solutions;
- demonstrate an ability to plan and, using appropriate methods, carry out advanced tasks within specified parameters;
- demonstrate an ability to integrate knowledge critically and systematically and to model, simulate, predict and evaluate events even on the basis of limited information;
- demonstrate an ability to develop and design products, processes and systems taking into account people's situations and needs and society's objectives for economically, socially and ecologically sustainable development;
- demonstrate an ability to engage in teamwork and cooperation in groups of varying composition; and
- demonstrate an ability to clearly present and discuss their conclusions and the knowledge and arguments behind them, in dialogue with different groups, orally and in writing, in national and international contexts.

- **Judgement and approach**

For a degree of Master of Science in Engineering students must

- demonstrate an ability to make assessments, taking into account relevant scientific, social and ethical aspects, and demonstrate an awareness of ethical aspects of research and development work;
- demonstrate insight into the potential and limitations of technology, its role in society and people's responsibility for its use, including social and economic aspects, as well as environmental and work environment aspects; and
- demonstrate an ability to identify their need of further knowledge and to continuously upgrade their capabilities.

- **Independent project (degree project)**

For a degree of Master of Science in Engineering students must have completed an independent project (degree project) worth at least 30 higher education credits, within the framework of the course requirements.

In addition, a Master of Science in Engineering at Karlstad University must:

- demonstrate in-depth knowledge in one of the fields of computer science, energy and environmental engineering, industrial engineering and management, chemical engineering, mechanical engineering, or engineering physics,
- demonstrate ability and experience of active participation in academic, public or industrial research and development projects,
- demonstrate ability to plan and carry out projects,
- demonstrate ability to work in a group showing gender awareness and with regard to equality of treatment,
- demonstrate ability to apply the perspective of sustainable development, for instance, in choosing materials or processes.

## **Programme Structure**

The programme is divided into two levels, Bachelor's level (1st cycle, 180 ECTS credits) and Master's level (2<sup>nd</sup> cycle, 120 ECTS credits). In the first year all students take the same courses in mathematics, basic natural science and technology. The benefits of common study as a basis for different specialisations are the enhancement of understanding and knowledge of various aspects of engineering graduates' broad professional field and the opportunities provided for students to be acquainted with the major fields before choosing a specialisation. The first year is called Broad Curricular Base in Engineering.

Students can choose specialisation when they apply for admission or after the first year. Information of the main fields of study, that is, courses included, research activities and future prospects, is provided in the first year.

Successful completion of the programme gives eligibility for doctoral studies.

Throughout the programme students are brought into contact and cooperation with the community and possible future occupational areas.

The Bachelor's level comprises three academic years (six semesters, 180 ECTS cr.) and covers studies in mathematics, natural science, engineering, and some courses in the humanities and social sciences. At this level students also develop skills in project work, report writing and communication. Students prepare for Master-level studies while having the opportunity to earn a Bachelor's degree in computer science, chemical engineering, mechanical engineering, environmental and energy engineering or engineering physics.

The Master's level comprises two academic years (four semesters, 120 ECTS cr.) and consists of studies in a chosen specialisation field of at least 60 ECTS cr including a degree project of at least 30 ECTS cr.

All students admitted to the programme at Karlstad University are guaranteed a place on the Master's level.

### **Internationalisation**

Karlstad University promotes cooperation and exchange with other universities and has agreements with many universities in Sweden and abroad as well as a support organisation for incoming and outgoing students.

Programme students are encouraged to study a period abroad, especially for Master-level courses and degree project.

## Programme Curriculum

### Broad curricular base (first year Bachelor-level)

First-year students on the Master of Science programme, Majors programmes and broad curricular base programme all start with a foundational year of natural science, technology and engineering courses.

### Aims

On completion of the broad curricular base, students should be able to demonstrate that they have:

- acquired the basic natural science and technology knowledge required for the chosen degree specialisation
- acquired basic training in the methods and procedures appropriate to engineering practice
- the ability to work in a group and to communicate results to an audience
- acquired information on engineering specialisations offered at the university.

In the first year (semesters 1-2), students study basic subjects acquiring a solid foundation for further specialised studies. The pathways offered are: computer science, environmental and energy engineering, industrial engineering and management, chemical engineering, mechanical engineering or engineering physics. Students can indicate their pathway choice when applying or simply opt for broad curricular base and decide on a specialisation after the first year. Students who choose or have chosen industrial economy must also choose one of the area profiles of computer science, environment and energy engineering, chemical engineering or mechanical engineering.

Semester 1 includes mathematics, experimental computer-based problem-solving, programming and project methods and planning. Report writing, communication and presentation skills are integrated course components. The courses in computer-based problem-solving and programming support each other as the emphasis is on the use of computers and programming in experimental problem-solving.

Semesters 2 and 3 centre on mathematics and the foundational engineering subjects of mechanics, electrical engineering, physics, materials engineering, chemistry, thermodynamics and energy technology.

The following courses are included in Broad Curricular Base and in all specialisation pathways in the first two semesters plus first study period (IV) of semester 3:

Level	Year	Semester	Study Period	Broad Curricular Base, Computer Science, Environmental and Energy Engineering, Industrial Engineering and Management, Chemical Engineering, Mechanical Engineering and Engineering Physics
Bachelor	Year 1	Semester 1	4	Foundation Course in Mathematics (7,5 ECTS) Project Methodology with Project Planning(3 ECTS)  Experimental Scientific Methods with Computer Aid (6 ECTS)
			5	Experimental Scientific Methods with Computer Aid, continued (6 ECTS) Programming Techniques for Engineers (6 ECTS) Calculus in One Variable (7,5 ECTS)

		Semester 2	1	Calculus in Several Variables (7,5ECTS) Mechanics for Engineers (7,5 ECTS)
			2	Matter (7,5 ECTS) Wave Physics and Electric Circuits (7,5) hp
Year 2		Semester 3, plus part of	4	Linear Algebra and Vector Calculus (7,5 hp) Fundamentals for Engineering Thermodynamics (7,5 ECTS)
<i>After study period IV in semester 3, students embark on their chosen specialisation for which the respective course of study is presented below.</i>				

## Computer Science

Development is rapid in the field of computer science, which is why students at Karlstad University are trained to develop abilities to retrieve and apply new knowledge. Students learn to develop, design and evaluate computer-based systems for different purposes.

### Aims

In addition to the objectives stated in the *Higher Education Ordinance, SFS 2006:1053* and to the local stipulations, for a Master of Science degree in Computer Science students at Karlstad University, must be able to

- demonstrate in-depth knowledge of computer technological principles and their employment in engineering to develop applications in computer communication, computer security and program design,
- define, handle and solve engineering tasks in a multidisciplinary way,
- present human-computer interaction in a holistic perspective and its contribution to sustainable development,
- design appropriate testing and analysis methods for computer products and analyse the outcome,
- demonstrate ability to and experience of active participation in research and development work on computer products and services and cooperation with others.

The first academic year and the first half of the second year first semester involve broad curricular base studies in mathematics, natural science and programming. The rest of the second year consists of basic courses in computer technology and specialised mathematics. The third year centres on central computer science areas such as operative systems, computer structures and algorithms, computer communication and database technique. The third year also allows for optional courses and is normally concluded with a Bachelor's Degree project.

The autumn semester of the fourth year focuses on specialisation courses in computer communication, computer security and software design. Courses in the spring semester are optional and can preferably be taken abroad. The fifth year autumn semester offers optional courses in computer science and preparatory courses for the spring semester Master's Degree project.

From the second half of semester 3, the courses offered are specialisations in computer science.

Besides the joint courses in year 1 and 2, the following courses are required:

Level	Year	Semester	Study Period	Computer Science
Bachelor	Year 2	Semester 3, part of	5	Programming Techniques II (7,5 ECTS cr) Discrete Mathematics (7,5 ECTS cr)
		Semester 4	1	Computer Engineering (7,5 ECTS cr) Digital Electronics (7,5 ECTS cr)
			2	Stochastic methods in mathematics (7,5 ECTS cr) Theoretical Computer Science (7,5 ECTS cr)
	Year 3	Semester 5	4	Operating Systems (7,5 ECTS cr) Data Structures and Algorithms (7,5 ECTS cr)
			5	Optional courses in the Computer Science (15 ECTS cr)
		Semester 6	1	Computer Networking I (7,5 ECTS cr) Programming Languages (7,5 ECTS cr) or Database Techniques (7,5 ECTS cr)
			2	Bachelor's Degree Project in Computer Science (15 ECTS cr)
	Master	Year 4	Semester 7	4
5				Compiler Construction (7,5 ECTS) Perspectives on Computer Science (7,5 ECTS)
Semester 8			1-2	Optional courses (30 ECTS cr) (elective courses, prerequisite to courses in semester 9)
Year 5		Semester 9	4	Optional courses in Computer Science at Master's level (15 ECTS cr)
			5	Engineering Project in Computer Science (15 ECTS cr)
		Semester 10	1-2	Master's Degree Project in Computer Science (30 ECTS cr)

## Environmental and Energy Engineering

A graduate in Environmental and Energy Engineering at Karlstad University has modern and specialized knowledge of energy and purification engineering, other environmental technologies, measuring techniques and modelling as well as the optimisation of energy systems. The broad and flexible qualifications are attractive to employers.

### Aims

In addition to the objectives stated in the *Higher Education Ordinance, SFS 2006:1053* and to the local stipulations, for a Master of Science degree in Environmental and Energy Engineering students at Karlstad University, must be able to

- Knowledge and understanding
  - demonstrate the specialised knowledge in the field of environmental and energy engineering corresponding to the course requirements for a Bachelor's degree (90 ECTS cr) and for a Master's degree (90 ECTS cr),

- demonstrate specialised knowledge of the conditions for economically, socially and ecologically sustainable development corresponding to course requirements of 10 ECTS cr at Bachelor's level and 5 ECTS cr at Master's level,
- demonstrate knowledge of sustainable application of technology corresponding to course requirements of 75 ECTS cr at Bachelor's level and 60 ECTS cr at Master's level.
- Skills and abilities
  - demonstrate ability to and experience of active participation in industrial research and development work,
  - demonstrate ability to design and write a project report for different types of client requirements including the academic conference genre,
  - demonstrate ability to search for and assess current research results in environmental and energy engineering, especially in the form of articles in international journals.
- Judgement and approach
  - demonstrate ability to make assessment in the environment field with consideration given to relevant scientific, social and ethical aspects,
  - demonstrate further insight into the potentials and limitations of environment technology, its role in society and our responsibility for its use, including social and economic aspects,
  - demonstrate ability to identify knowledge gaps and to formulate action alternatives in view of these, especially in regard to the principle of caution.

Following on the two semesters of broad curricular base courses, the environmental and energy Bachelor's level specialisation consists of four semesters (120 ECTS cr) and includes basic studies of environment and energy engineering, mathematics, engineering and some social science and humanities components. Students also develop skills in project work, report writing and communication. Students prepare for Master-level studies while having the opportunity to earn a Bachelor's degree in environmental and energy engineering.

The Master's level comprises four semesters, 120 ECTS cr. and consists of specialisation courses in environmental and energy engineering of at least 90 ECTS cr including a degree project of 30 ECTS cr.

In the choice of pedagogical methods and content of courses, the student learning process is at the centre. Instruction is designed to support the learning process. The result of the learning process, i.e. meeting the learning outcome requirements is the starting-point for programme and course design which also offers a variety of pedagogical models and forms of instruction and examination. Students are trained successively to take responsibility for their own learning. Small student groups and close cooperation with industry and research are important factors in the learning process. Authentic professional practice, such as projects, and work situations are systematically used in teaching and examination. The many written examinations and reports provide writing practice for students. Oral skills are also practised a great deal.

The most important factors in the continuous quality assurance efforts are respect for student opinion in course evaluations and the established alumni networks.

Besides the joint courses in year 1 and 2, the following courses are required for the environmental and energy engineering profile:

Level	Year	Semester	Study Period	Environmental and Energy Engineering
Bachelor	Year 2	Semester 3, part of	5	Environmental engineering (7.5 ECTS cr) Heat transfer and fluid mechanics (7,5 ECTS cr)
			Semester 4	1
		2		Environmental chemistry (7,5 ECTS cr) Stochastic methods in mathematics (7,5 EC cTS cr)
		Year 3	Semester 5	4-5
	Semester 6		1	Mechanics of materials (7,5 ECTS cr)  Materials engineering (7,5 ECTS cr)
				2
Master	Year 4	Semester 7	4	Heat and mass transport (15 ECTS cvr)
			5	Measurement technology and modeling (15 ECTS cr) (part-time) Optional courses (7.5 ECTS cr)
		Semester 8	1	Measurement technology and modeling, continued (15 ECTS cr)(part-time) Energy and environmental optimization (15 ECTS cr) (part-time)
			2	Energy and environmental optimization,, continued (15 ECTS cr) (part-time) Engineering design (7,5 ECTS cr)
	Year 5	Semester 9	4	Optional courses (15 ECTS cr)
			5	Research and Development Project (15 ECTS cr)
		Semester 10	1-2	Master's Degree Project in Environmental and Energy Engineering (30 ECTS cr)

## Industrial Engineering and Management

A Degree in industrial engineering and management from Karlstad University means having qualifications in engineering and science combined with the knowledge of business and leadership required to solve problems that go with the management and control of technologically-based enterprises. Such graduates can function as a link between engineers and scientists on the one hand and business people on the other.

### Aims

In addition to the objectives stated in the *Higher Education Ordinance, SFS 2006:1053* and to the local stipulations, for a Master of Science degree in Industrial Engineering and Management students at Karlstad University, must be able to

- Knowledge and understanding
  - demonstrate the knowledge and understanding required in one of the areas of computer science, environmental and energy engineering, chemical engineering or mechanical engineering to be able to follow and contribute to the development in the area with an understanding of economic circumstances,
  - demonstrate broad knowledge of economy and specialised knowledge in some areas, and
  - demonstrate the ability to critically review and assess decisions based on economic and technological perspectives.
- Skills and abilities
  - demonstrate the ability to define and analyse problems in industrial research and development based on economic models and knowledge of the management and control of organisations and projects, and
  - demonstrate the ability to work in groups in international and interdisciplinary environments.
- Judgement and approach
  - demonstrate insight into the potential and limitations of the economic sciences, their role in society and our responsibility for their use, and
  - demonstrate insight into the importance of leadership and its performance.

Following on the two semesters of broad curricular base courses, the industrial engineering and management profile offers a number of courses in the profile area chosen by the students for their Master's degree in industrial Management. The profiles are Computer Science, Environmental and Energy Engineering, Chemical Engineering and Mechanical Engineering.

Besides the joint courses in year 1 and 2, the following courses are required for the respective profile:

Level	Year	Semester	Study Period	Industrial Engineering and Management		
				Computer Science	Environmental and Energy Engineering	Chemical Engineering
Bachelor	Year 2	Semester 3, part of	5	Industrial engineering and management (7,5 ECTS)		
				Programming techniques I, (7,5 ECTS)	Environmental engineering (7,5 ECTS)	Chemical calculations (7,5 ECTS)
		Semester 4	1	Macro economy (7,5 hp) Management Accounting and Financial Statement Analysis(7,5 ECTS)		
			2	Stochastic methods in mathematics (7,5 ECTS)		
	Year 3	Semester 5	4	Computer engineering (7,5 ECTS cr)	Environmental chemistry (7,5 ECTS cr)	An introduction to Chemical Engineering including project work (7,5 ECTS cr)
				Optional courses in Computer Science	Design and sustainable	Organic chemistry (7,5 ECTS cr)

				(7.5 hp)	development (7,5 ECTS cr)		
			5	Optional courses in Computer Science (7.5 hp)	Heat transfer and fluid mechanics (7,5 ECTS)	Automatic control (7,5 ECTS)	
				Marketing (7,5 ECTS)			
		Semester 6	1	Logistics Optimizing (4,5 ECTS cr) Corporate finance Produktionsekonomi (3 ECTS cr) Project management (7,5 ECTS)			
			2	Programming languages (7,5 ECTS cr) Digital electronics (7,5 ECTS cr)	Purification treatments technology (15 ECTS cr.)	Heat and mass transfer including chemical reactors (7,5 ECTS cr) Unit operations in Chemical Engineering (7,5 ECTS cr)	
<b>Master</b>	Year 4	Semester 7	4	Computer security (7,5 ECTS cr) Computer Networking (7.5 ECTS cr)	Heat and mass transport (15 ECTS cr)	Pulp, paper, surface treatment and graphic technology (15 ECTS cr)	
			5	Optional course Computer Science (7.5 ECTS cr)	Optional engineering courses (7.5 ECTS cr)	Pulp technology, advanced course I (7,5 ECTS cr) Paper technology, advanced course I (7,5 ECTS cr)	
			Optional courses in Industrial Engineering and Management (7.5 ECTS cr)				
		Semester 8	1	Optional courses in Industrial Engineering and Management (7.5 ECTS cr)			
				Optional course Computer Science (7.5 hp)	Energy- and environmental-optimization (15 ECTS cr) (part-time)	Optional courses in Chemistry and Chemical Engineering (7,5 hp)	
			2	Optional course Computer Science (15 ECTS cr)	Environmental economics (7,5 ECTS cr) Energy- and environmental - optimization, continued (15 ECTS cr) (part-time)	Optional courses in Chemistry and Chemical Engineering (15 ECTS cr)	

	Year 5	Semester 9	4	Project Computer Science, business management focus (15 ECTS cr)	Environmental risk management (7,5 ECTS cr) Research and development project (15 ECTS cr) (part-time)	Optional courses in Chemical Engineering (15 ECTS cr)
			5	Optional courses in Industrial Engineering and Management (15 ECTS cr)	Research and development project, continued. (15 ECTS cr) (part time) Optional courses in Industrial Engineering and Management (7.5 ECTS cr)	Optional courses in Industrial Engineering and Management (15 ECTS cr)
		Semester 10	1-2	Master's Degree Project in Industrial Engineering and Management		

## Chemical Engineering

A chemical engineering graduate from Karlstad University can work in many areas. A common area is the pulp and paper industry but also industries such as the petrochemical, the pharmaceutical, the food industry or environmental control services are likely employers. A chemical engineer combines the properties of miniscule building blocks into new materials or substances with completely different properties – first in small-scale laboratory experiments and then in large-scale industrial production.

### Aims

In addition to the objectives stated in the *Higher Education Ordinance, SFS 2006:1053* and to the local stipulations, for a Master of Science degree in Chemical Engineering and Management students at Karlstad University, must be able to

- demonstrate specialized knowledge of the principles of chemistry and their usefulness in development of chemical engineering applications,
- demonstrate ability to define, handle and solve engineering tasks with a multidisciplinary approach,
- present a holistic perspective on how the choice of raw material and processing affect the properties of products, energy consumption and the environment,
- plan the use of appropriate testing and analysis methods for chemical products and analyse and interpret readings,

- demonstrate ability to and experience of active participation in industrial research and development work on chemical engineering products and processes,
- work in groups,
- apply an approach that contributes to sustainable development for clients, for instance, in the choice of material and processes.

Following on the two semesters of broad curricular base courses, students study the basics of chemistry including stoichiometry and thermodynamics in the second half of the third semester. The fourth semester covers chemical engineering and mathematics' and in the fifth semester students continue studying the basics of chemistry and chemical engineering while also broadening the knowledge base with courses in automatic control and industrial economy. In the sixth semester students choose optional courses to suit their planned Master-level profile and the Bachelor degree requirements.

At the Master's level students can choose to specialise in *pulp technology, paper technology and surface treatment and paper material printing*, alternatively *molecular chemical engineering*.

Besides the joint courses in year 1 and 2, the following courses are required:

Level	Year	Semester	Study Period	Chemical Engineering		
				<u>Pulp, paper, surface treatment and printing of paper material</u>	<u>Molecular chemical engineering</u>	
Bachelor	Year 2	Semester 3, part of	5	Chemical calculations (7,5 ECTS) Biochemistry (7,5 ECTS)		
			Semester 4	1	An introduction to Chemical Engineering including project work (7,5 ECTS cr) Heat and mass transfer including chemical reactors (7,5 ECTS)	
		2		Unit operations in Chemical Engineering (7,5 ECTS) Stochastic methods in mathematics (7,5 ECTS)		
	Year 3	Semester 5	4	Organic chemistry (7,5 ECTS) Continued studies of Chemical Engineering (7,5 ECTS)		
			5	Automatic control (7,5 ECTS) Industrial engineering and management (7,5 ECTS)		
		Semester 6	1	Thermodynamics (7,5 ECTS cr) Analytical chemistry (7,5 ECTS cr)		
			2	Organic chemistry (7,5 ECTS cr) Optional course (7.5 ECTS cr)		
	Master	Year 4	Semester 7	4	Pulp, paper, surface treatment and graphic technology (15 ECTS cr)	Specialisation courses in Chemistry and bioengineering (60 ECTS cr). Optional courses in technology and natural science (30 ECTS cr)
				5	Pulp technology, advanced course I (7,5 ECTS cr) Paper technology, advanced course I (7,5 ECTS cr)	

		Semester 8	1	Surface treatment and graphic technology, advanced course I (7,5 ECTS cr) Optional course in Chemical Engineering (7.5 ECTS cr)	
			2	Optional courses in Chemical Engineering (15 ECTS cr)	
	Year 5	Semester 9	4-5	Optional courses in technology and natural science (30 ECTS cr)	
		Semester 10	1-2	Master's Degree Project in pulp engineering, paper engineering or surface treatment and paper printing, (30 ECTS cr.)	

## Mechanical Engineering

The Karlstad graduate in mechanical engineering has a technologically broad base in construction, production and materials for the manufacturing, application and development of mechanical products and processes.

### Aims

In addition to the objectives stated in the *Higher Education Ordinance, SFS 2006:1053* and to the local stipulations, for a Master of Science degree in Mechanical Engineering students at Karlstad University, must be able to

- Knowledge and understanding
  - participate in applying and developing new technology for product and process design,
  - demonstrate basic knowledge of construction and manufacturing techniques and materials technology,
  - present an overall picture of the construction process including the relation between materials engineering, construction and manufacturing techniques to which a sustainable, environment-friendly perspective can be applied,
  - give an account of and discuss specialised knowledge in the field based on a materials technological foundation describing the relation between the production, structure and use of materials and resulting properties.
- Skills and abilities
  - apply basic principles of mechanical engineering, follow and use knowledge development in the field and be able to apply a creative and critical approach to defining and exploring problems while using modern methods and tools,
  - use theoretical knowledge and experimental skills in analysing, simulating and modelling for construction, production and materials use,
  - handle choice of material, materials development and materials use based on industrially environment-friendly and sustainable perspective. This means a system in which objective, function, performance and economy are balanced against affects on the environment,
  - demonstrate language skills in Swedish and English and skills in leadership and communication in working with systematic project management methodology for the planning, performance and evaluation of minor project assignments as an engineer in a leading position or as a leader in a technologically intensive

- company, as well as having developed the ability through practice and reflection to work efficiently in a group,
- demonstrate the ability to actively participate in industrial research and development.
  - Judgement and approach
    - demonstrate a considered and responsible approach to ethical issues in technological, organisational, economic, ecological and social systems, adapting a perspective of sustainable development in the design and choice of materials and processes.

In the first three years students acquire basic knowledge of mechanical engineering related to materials, design and computation. There are also courses in energy engineering and economy.

At Master's level the focus is on materials engineering in an overall mechanical engineering perspective including design and manufacturing techniques. Students develop a solid engineering basis by practising CAD design and computation with the finite element method, by acquiring broad knowledge of materials and by practising advanced materials analysis including functional materials and construction materials in manufacturing processes, designs and products. Studies include the themes i) materials, design and manufacturing, ii) materials, models and simulation, iii) materials and mechanical properties and a concluding degree project. Students partly work with group projects.

Besides the joint courses in year 1 and 2, the following courses are required for the mechanical engineering profile:

Level	Year	Semester	Study Period	Mechanical Engineering
Bachelor	Year 2	Semester 3, part of	5	Heat transfer and fluid mechanics (7,5 ECTS cr) Environmental engineering (7,5 ECTS cr)
			Semester 4	1
		2		Engineering design (7,5 ECTS cr) Stochastic methods in mathematics (7,5 ECTS)
	Year 3	Semester 5	4	Industrial engineering and management (7,5 ECTS cr) Manufacturing technology (7,5 ECTS cr)
			5	Materials selection (7,5 ECTS cr) Automatic control (7,5 ECTS cr)
		Semester 6	1	Numerical methods (7,5 ECTS cr) Finite element calculations (7,5 ECTS cr)
			2	Hydraulics and pneumatics (7,5 ECTS cr), optional Production systems (7,5 ECTS cr), optional Bachelor's Degree Project in mechanical engineering (15 ECTS cr.), optional
Master	Year 4	Semester 7	4	Materials in industrial applications (7,5 ECTS cr) Machine design and CAD (7,5 ECTS cr)
			5	Project work on engineering design (7,5 ECTS cr) Materials characterization (7,5 ECTS cr)

		<b>Semester</b> 8	1	Deformation and failure (7,5 ECTS cr) Simulation and modeling (7,5 ECTS cr)
			2	Project management (7,5 ECTS cr) Project work on simulation and modeling (7,5 ECTS cr)
	Year 5	<b>Semester</b> 9	4	Polymers and composites (7,5 ECTS cr) Project work on future materials (7,5 ECTS cr)
			5	Surface technology and tribology (7,5 ECTS cr) Optional course (7.5 ECTS cr)
		<b>Semester</b> 10	1.2	Master's Degree Project in mechanical engineering (30 ECTS cr)

### Engineering Physics

An engineering physics graduate has the broad qualifications in basic and applied physics that are useful in many technological areas. Advanced theoretical understanding of physical phenomena is vital to the development of new technological applications. One such example is nanotechnology in which the quantum structure of material is used to find new areas of application, for instance, molecular electronics, organic solar cells and quantum computers.

### Aims

In addition to the objectives stated in the *Higher Education Ordinance, SFS 2006:1053* and to the local stipulations, for a Master of Science degree in Engineering Physics students at Karlstad University, must be able to

- demonstrate advanced knowledge of the laws of physics and their use in engineering to develop technical applications, especially in materials engineering and in the nanotechnology area,
- demonstrate the ability to and experience of active participation in industrial research and development,
- demonstrate the ability to formulate, handle and solve engineering tasks,
- demonstrate the ability to search for and assess current research results in engineering physics, especially in the form of articles in international journals,
- apply an approach that contributes to sustainable development for clients in the field of engineering physics, for instance, in the choice of material and processes.

The profile engineering physics follows on the broad curricular base course, which ends with study period IV in Semester 3, offering a number of courses designed for the profile.

Besides the joint courses in year 1 and 2, the following courses are required for the engineering physics profile:

Level	Year	Semester	Study Period	Engineering Physics
Bachelor	Year 2	Semester 3, part of	5	Optional: Environmental engineering (7,5 ECTS cr) or Heat transfer and fluid mechanics (7,5 ECTS cr) Mathematical physics I (7,5 ECTS cr)
		Semester 4	1	Quantum physics I (7,5 ECTS cr) Electromagnetic field theory (7,5 ECTS cr)

			2	Stochastic methods in mathematics (7,5 ECTS) Materials engineering (7,5 ECTS cr)
	<b>Year 3</b>	<b>Semester 5</b>	4	Industrial engineering and management (7,5 ECTS cr) Solid state physics (7,5 ECTS cr)
5			Nanoscience I (7,5 ECTS cr) Optional: Automatic control (7,5 ECTS cr) or Analytical mechanics (7,5 ECTS cr)	
<b>Semester 6</b>		1	Mechanics of materials (7,5 ECTS cr) Numerical methods (7,5 ECTS cr)	
		2	Optional courses or Bachelor's Degree Project (15 ECTS cr) Recommended courses: Modern Experimental Physics (7.5 ECTS cr), Project Management (7.5 ECTS cr)	
<b>Master</b>	<b>Year 4</b>	<b>Semester 7</b>	4	Mathematical physics II (7,5 ECTS cr) Materials characterization (7,5 ECTS cr)
			5	Quantum physics II (7,5 ECTS cr)  Solid state electronics (7,5 ECTS cr)
		<b>Semester 8</b>	1	Computational physics (7,5 ECTS cr) Nanoscience II (7,5 ECTS cr)
			2	Functional materials (7,5 ECTS cr) Surface physics (7,5 ECTS cr)
	<b>Year 5</b>	<b>Semester 9</b>	4	Optional course in engineering physics or technology (15 ECTS cr), Recommended courses: Advanced quantum mechanics (7.5 ECTS cr) and Scanning probe microscopy (7,5 ECTS cr)
			5	Optional courses (15 ECTS cr)
		<b>Semester 10</b>	1-2	Master's Degree Project in Engineering Physics (30 ECTS cr)

**Degree Title**

Students who meet the requirements for a degree may request that the university issue a degree certificate. Requests should be submitted to the Degree Office.

The degree title is:

Master of Science in Engineering, Computer Engineering

Master of Science in Engineering, Environmental and Energy Engineering

Master of Science in Engineering, Industrial Engineering and Management

Master of Science in Engineering, Chemical Engineering

Master of Science in Engineering, Mechanical Engineering

Master of Science in Engineering, Engineering Physics

**Credit Transfer**

According to the *Higher Education Ordinance* (Ch 6, § 12-14), students may transfer credits from previously completed university courses subject to approval. Transfer of credits for a course module, or university studies generally, is subject to the approval by the course examiner. Transfer of credits for a full course is subject to the approval by the Rector.

**Additional Information**

Students who enrolled in the programme before 1 July 2007 will complete their studies in accordance with the requirements of the earlier curriculum. Upon completion students may request degree and course certificates to be issued under the current ordinance if they meet its requirements.