Chapter 9
The programme-specific part of the curriculum for the programme:

CIVILINGENIØR, CAND. POLYT. I ELEKTRONIK
Master of Science in Engineering (Electronics)

Curriculum 2016, Version 1.1

Applicable to students admitted February 2016 onwards

The Curriculum is divided into a section with general provisions (Chapters 1-8), a programme-specific section (Chapter 9), and a section with descriptions of the programme's individual course modules. The student is advised to examine all three sections in order to get a complete overview of the provisions regulating the programme.

§1 Job profiles

The development in electronics engineering requires engineers capable of working creatively across industrial disciplines and within research.

The Master's programme in Electronics Engineering ensures a broad research-based study of two electronics-related areas: power electronics and embedded systems. The breadth of the disciplines included in the programme provides the student with the skills and expertise required to make the electronics of the future for energy technology and embedded electronic systems.

Graduates are employed mainly for research and development assignments in development-intensive companies working in the fields of power electronics, electric energy conversion, and embedded electronic systems.

A Master of Science in Electronics Engineering works primarily in the private sector. In overall terms, a Master of Science in Electronics Engineering works with:

- Research and development
- Implementation of research methodologies and research results
- Entrepreneurship and innovation
- Counselling and project management

within

- Energy conversion and energy storage technology
- Power electronics
- Embedded systems
- Green technology – electric energy production
- Transport vehicles and transport systems
- Aerospace technology
- Industrial production – automation
- The electronics industry in general

§2 Competence profile

After successfully completing the Master of Electronics Engineering programme, the graduate is able to accomplish technical research and development assignments within the field of electronics engineering in general and the field of power electronics and embedded systems in particular.

After successfully completing the programme, the graduate will in general terms obtain:

Knowledge:

- a broad research-based knowledge of Electronics Engineering.
- knowledge of international research of the highest level within one or more of the research areas.

Skills:

- the ability to use the scientific methodologies and tools of electronics engineering, and use the general skills associated with work within this profession.
- the ability to assess and select among the scientific theories, methodologies, tools and general skills of electronics engineering and establish new models for analysis and problem solving on a scientific basis.
- the ability to communicate research-based knowledge and discuss professional and scientific problems with both colleagues and non-specialists.
- the ability to manage work and development conditions which are complex and unpredictable and require development of new problem solving models.

Competences:

- the ability to manage complex and unpredictable work-related and developmental situations that require new solution models.
- the ability to independently initiate and implement professional and interdisciplinary co-operation and assume professional responsibilities.
- the ability to independently assume responsibility for his/her own professional development and specialisation.
- the ability to scientifically reflect on the knowledge acquired and identify scientific problems within the areas of power electronics and embedded systems.
- the required qualifications to apply for and commence a PhD programme.

The aim and professional qualification profile of the Master of Electronics Engineering is delineated below according to the Danish Qualifications Framework for Higher Educations describing the learning outcome within the categories knowledge, skills, and competences.

Qualifications matrix

GRADUATES WILL HAVE ACQUIRED …	EK-PWE (1st sem)	EK-EBS (1st sem)	EK-DC (1st sem)	EK-PRO1 (1st sem)	EK-ADCC (2nd sem)	EK-ESD (2nd sem)	EK-SS (2nd sem)	EK-MC (2nd sem)	EK-PRO2 (2nd sem)	EK-PEC (3rd sem)	EK-PES (3rd sem)	RMEMB3 (3rd sem)	EK-RTS (3rd sem)	EK-SP30/40 (4rd sem)
RESEARCH-BASED KNOWLEDGE OF														
Electrical safety in general and electrical safety in the laboratory				X					X					X
Electrical drive systems including motor and control			X	X										
Platforms for embedded systems, software architectures and hardware architectures		X	X	X		X			X				X	X
Data communication for embedded systems		X		X					X				X	X
Modelling techniques for embedded systems		X		X		X			X				X	X
Real-time systems including system architectures, operating systems, and communication		X											X	X
Programmable electronics (FPGAs)		X		X					X			X		X
Power electronic components and applications	X			X	X					X	X			X
Power converter topologies	X			X	X			X	X		X			X
Power electronic protection circuitry				X	X				X					
Layout of printed circuit board including the effects of parasitic elements	X			X					X	X				X

GRADUATES WILL HAVE ACQUIRED …	EK-PWE (1st sem)	EK-EBS (1st sem)	EK-DC (1st sem)	EK-PRO1 (1st sem)	EK-ADCC (2nd sem)	EK-ESD (2nd sem)	EK-SS (2nd sem)	EK-MC (2nd sem)	EK-PRO2 (2nd sem)	EK-PEC (3rd sem)	EK-PES (3rd sem)	RMEMB3 (3rd sem)	EK-RTS (3rd sem)	EK-SP30/40 (4rd sem)
RESEARCH-BASED KNOWLEDGE OF (continued)														
Design and simulation of high frequency transformers and inductors					X				X					X
Thermal losses in power converters and management of these losses	X			X	X				X	X				X
Power electronic systems in renewable energy applications											X			X
Classic and state-space digital control			X	X				X	X					X
Switching topologies for power converters	X			X	X				X	X	X			X
Deterministic and stochastic signals							X	X						X
Digital signal analysis and processing			X	X			X	X		X				X
Numerical analysis of continuous and discrete time systems							X							X

GRADUATES WILL HAVE ACQUIRED …	EK-PWE (1st sem)	EK-EBS (1st sem)	EK-DC (1st sem)	EK-PRO1 (1st sem)	EK-ADCC (2nd sem)	EK-ESD (2nd sem)	EK-SS (2nd sem)	EK-MC (2nd sem)	EK-PRO2 (2nd sem)	EK-PEC (3rd sem)	EK-PES (3rd sem)	RMEMB3 (3rd sem)	EK-RTS (3rd sem)	EK-SP30/40 (4rd sem)
THE FOLLOWING SKILLS (ON A SCIENTIFIC BASIS)														
Select, use, and evaluate relevant measurement techniques and methods in given electronic contexts				X					X					X
Modelling and simulation of control systems in electronic applications			X	X				X	X					X
Develop and implement interfaces between analogue and digital electronics in embedded systems		X			X				X					X
Model-driven and component-based design of embedded software		X		X		X			X				X	X
System level modelling of real-time embedded systems		X		X		X			X				X	X
Use standard and advanced components in programmable electronics		X		X					X			X		X
Application of methods for mapping algorithms onto application-specific architecture, manually and by modern tools												X		X

GRADUATES WILL HAVE ACQUIRED …	EK-PWE (1st sem)	EK-EBS (1st sem)	EK-DC (1st sem)	EK-PRO1 (1st sem)	EK-ADCC (2nd sem)	EK-ESD (2nd sem)	EK-SS (2nd sem)	EK-MC (2nd sem)	EK-PRO2 (2nd sem)	EK-PEC (3rd sem)	EK-PES (3rd sem)	RMEMB3 (3rd sem)	EK-RTS (3rd sem)	EK-SP30/40 (4rd sem)
THE FOLLOWING SKILLS (continued)														
Dimensioning of power converters including selection of power semiconductor components	X			X	X				X					X
Calculation of losses in power converts including losses in passive components, semiconductor components, and magnetic components,	X			X	X				X		X			X
Design and simulation of power electronic systems	X				X				X	X				X
Determination and verification of control parameters by calculation and simulation			X	X			X	X	X					X
System identification by deterministic and stochastic methods							X							X
Design and implementation of digital filters in control systems			X	X			X	X	X					X
Management and application of project-based and development-oriented working methods, independently as well as in collaboration with other project group members with the same or different professional or cultural background				X					X					X
Documentation and communication of results in an understandable, well-structured and reproducible oral and written form				X					X					X

GRADUATES WILL HAVE ACQUIRED …	EK-PWE (1st sem)	EK-EBS (1st sem)	EK-DC (1st sem)	EK-PRO1 (1st sem)	EK-ADCC (2nd sem)	EK-ESD (2nd sem)	EK-SS (2nd sem)	EK-MC (2nd sem)	EK-PRO2 (2nd sem)	EK-PEC (3rd sem)	EK-PES (3rd sem)	RMEMB3 (3rd sem)	EK-RTS (3rd sem)	EK-SP30/40 (4rd sem)
THE FOLLOWING COMPETENCES (ACADEMIC AND INTERDISCIPLINARY)														
Analysis, design, and implementation of an electrical drive system for a given application	X		X	X										X
Design and development of functional systems combining relevant software and hardware		X		X		X			X			X	X	X
Design and implementation of model-based software architectures		X		X		X			X					X
Schedulability and timing analysis of real-time systems		X		X									X	X
Design and implementation of application-specific programmable electronics		X		X					X			X		X
Analysis, design, and modelling of power converter topologies	X			X	X				X		X			X
Analysis, design, modelling and simulation of high frequency transformers and inductors	X			X	X				X					X
Analysis, design, and implementation of a control system for a given application		X	X	X				X	X					X
Identify, formulate and solve engineering development projects in the field of power converters and embedded systems				X					X					X

GRADUATES WILL HAVE ACQUIRED …	EK-PWE (1st sem)	EK-EBS (1st sem)	EK-DC (1st sem)	EK-PRO1 (1st sem)	EK-ADCC (2nd sem)	EK-ESD (2nd sem)	EK-SS (2nd sem)	EK-MC (2nd sem)	EK-PRO2 (2nd sem)	EK-PEC (3rd sem)	EK-PES (3rd sem)	RMEMB3 (3rd sem)	EK-RTS (3rd sem)	EK-SP30/40 (4rd sem)
THE FOLLOWING COMPETENCES (ACADEMIC AND INTERDISCIPLINARY) (continued)														
Design, build, test, verify and, evaluate a system based on electronic programmable components using up-to-date research-based theories and methods including evaluation of uncertainties, evaluation of sources of errors, and expediency of the applied methods				X					X					X
Initiate as well as participate professionally and collaborate in interdisciplinary development projects where methods and techniques obtained in the central courses of the master programme are applied				X					X					X
Independently take responsibility for structuring and develop own knowledge, skills and competences				X					X					X

§3 Academic progression

The programme has two profiles and a constituent part.

Constituent part:

- Scientific methodology.
- Power electronic components and power converters.
- Power devices and converter topologies.
- Control, drives, and protection circuits.
- Embedded programming and programmable electronics.
- Digital electronics and microprocessors.
- Digital signal processing.
- Drives and control.
- Modelling of signal and linear time-invariant systems.

Research area: Power Electronics

- Single-phase and three-phase power factor controllers (PFC).
- AC-DC, DC-AC, and DC-DC converters.
- Magnetic designs.
- Electromagnetic Interference (EMI) filters.
- Motor drives.
- Battery chargers and Uninterruptible Power Supplies (UPS).
- Thermal management.
- Flexible AC Transmission Systems (FACTS).
- High Voltage DC (HVDC).

Research area: Embedded systems

- Programmable electronics (FPGAs).
- Digital control systems
- Hardware/software co-design.
- Hardware-near programming.
- Data communication.

§4 Programme structure

The programme consists of three elements:

- Common constituent courses, which are mandatory for all students, and intended to provide the students with a broad common skills platform within the fields of power electronics and embedded systems.
- Optional courses intended to define the individual student's technical profile and equip the student with the skills required to write a specialised thesis within a given professional field.
- The thesis intended to synthesize the student's skills in a specialized contemplation of a particular theme within power electronics and embedded systems.

If the thesis is of an experimental nature, the student may choose to use the optional 10 ECTS on the 3rd semester as part of the thesis. This will extend the scope of the thesis to 40 ECTS. The student also has the option of project/development work for a company on the 3rd semester (in-company period). The extent of this work must be 15 ECTS all of which are taken from the elective pool, thus ruling out the possibility of a 40 ECTS thesis.

The student acquires research-based knowledge, skills and competences within the two profiles/research areas.

In addition, the student acquires knowledge, skills, and competences based on international research at the highest level within at least one of the profiles.

§5 Programme structure and modules

Profile: Power Electronics

Semester	Modules																													
4th	EK-SP30/40 Thesis																													
3rd (a) *eller*	Study abroad at a partner university[1]																													
3rd (b)	EK-PES Power Electronic Systems					EK-PEC Power Electronic Components					Elective course					Elective course/ In-company period[1]					Elective course / Thesis / In-company period[1]					Elective course / Thesis / In-company period[1]				
2nd	EK-ADCC Advanced DC/DC converters					EK-ESD Embedded Software Design					EK-SS Signals and Systems					EK-MC Modelling and Control					EK-PRO2 Project 2								
1st	EK-PWE Power Electronics					EK-EBS Embedded Systems					EK-DC Drives and Control										EK-PRO1 Project 1								
ECTS POINTS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30

1) If the thesis is of an experimental nature, the student may choose to use the optional 10 ECTS on the 3rd semester as part of the thesis. This will extend the scope of the thesis to 40 ECTS. The in-company period/project work is 15 ECTS (see above).

2) Students are encouraged to complete the third semester at a foreign university. Please note that the courses must be approved by the Academic Study Board of the Faculty of Engineering.

Colour codes	Compulsory courses	Elective courses	Study abroad

Profile: Embedded Systems

Semester	Modules																												
4th	EK-SP30/40 Thesis																												
3rd (a) *eller*	Study abroad at a partner university[1]																												
3rd (b)	EK-RST Real-time Systems					RMEMB3 Advanced Programmable Electronics					Elective course					Elective course/ In-company period[1]					Elective course / Thesis / In-company period[1]					Elective course / Thesis / In-company period[1]				
2nd	EK-ADCC Advanced DC/DC converters					EK-ESD Embedded Software Design					EK-SS Signals and Systems					EK-MC Modelling and Control					EK-PRO2 Project 2							
1st	EK-PWE Power Electronics					EK-EBS Embedded Systems					EK-DC Drives and Control										EK-PRO1 Project 1							
ECTS POINTS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30

1) If the thesis is of an experimental nature, the student may choose to use the optional 10 ECTS on the 3rd semester as part of the thesis. This will extend the scope of the thesis to 40 ECTS. The in-company period/project work is 15 ECTS (see above).

2) Students are encouraged to complete the third semester at a foreign university. Please note that the courses must be approved by the Academic Study Board of the Faculty of Engineering.

Colour codes	Compulsory courses	Elective courses	Study abroad

§6 Semester description for 1st semester

The modules taught during the 1st semester will present the two different profile subjects of the Electronic Engineering programme to the student through the courses “Power Electronics” and “Embedded Systems”. These two courses introduce the students to basic technologies and theories in the area of modern switch-mode power electronics and in the area of embedded hardware and software.

The course “Drives and Control” will provide students with in-depth knowledge and understanding of drive systems and their components and technologies.

The semester project is a practical engineering project with emphasis on finding a robust solution to an industrial challenge within the field of electrical drives and control. Students will work in an experimental environment designing and building a prototype. By experimental methods, students will demonstrate and verify theoretical results.

The following courses constitute the 1st semester:

EK-PWE – Power Electronics (5 ECTS)
EK-EBS – Embedded Systems (5 ECTS)
EK-DC – Drives and Control (10 ECTS)
EK-PRO1 – Project 1 (10 ECTS)

§7 Semester description for 2nd semester

The theme of the 2nd semester is power conversion. The aim of the two courses “Advanced DC/DC converters” and “Embedded Software Design” is to strengthen the students’ knowledge, skills and competences in both profiles.

These courses will provide students with detailed knowledge required to design, analyse and build advanced high performance isolated dc-dc converters, and software design for an embedded system, focusing on the competences and practical skills needed to develop software that is inherently correct by design. The courses “Signals and Systems” and “Modelling and Control” will provide the students with knowledge, skills and competences related to basic techniques and methods in discrete-time implementation of algorithms used in power electronics and in electronics in general, and related to classical and modern digital control theory and control strategies in the area of power electronics and electronics in general.

The semester project is a practical engineering project with focus on an industrial challenge in the field of power converters and embedded systems. Furthermore, the course includes scientific methods such as literature search on a specific research topic, assessing the scientific worth of papers, validating research results by experimentation and by building prototypes, and writing a scientific paper.

The following courses constitute the 2nd semester:

EK-ADCC – Advanced DC/DC Converters (5 ECTS)
EK-ESD – Embedded Software Design (5 ECTS)
EK-SS – Signals and Systems (5 ECTS)
EK-MC – Modelling and Control (5 ECTS)
EK-PRO2 – Project 2 (10 ECTS)

§8 Semester description for 3rd semester

In the third semester, the student specializes in one of the profiles and can obtain further specialization through elective courses. Should the students want to go abroad for an exchange stay, this would typically be scheduled for the 3rd semester.

On the 3rd semester the following mandatory courses are offered:

Profile: Power Electronics:

- EK-PES – Power Electronic Systems (5 ECTS)
- EK-PEC – Power Electronic Components (5 ECTS)

These profile courses will provide students with knowledge, skills and competences in a range of subjects: Power electronic applications ranging from low over medium to high power levels, and covering consumer, automation, renewable energy and utility applications, and characteristics, operation and performance of power electronic components, ranging from power semiconductors to capacitors and EMI filters.

Profile: Embedded Systems:

- EK-RST – Real-time Systems (5 ECTS)
- RMEMB3 – Advanced Programmable Electronics (5 ECTS)

These profile courses will provide students with knowledge, skills and competences of modern programmable electronics (FPGAs) embedded design as well as real-time system architectures, including real-time operating systems and real-time communication used in embedded systems.

For both profiles, there are 20 elective ECTS points.

On the 3rd semester, the student will have to make a choice about the extent of the thesis. The thesis must be of either 40 ECTS or 30 ECTS. The former is recommended, and in that case, the project must be defined no later than by March 1st.

In case the student chooses a 30 ECTS thesis, there will be 20 ECTS either for one elective course (5 ECTS) and an in-company period (15 ECTS), or only elective courses.

In case the student chooses a 40 ECTS thesis, only 10 ECTS will be available for elective courses.

STUDY ABROAD
It is possible to spend the third semester at a university abroad, provided the courses are approved by the Academic Study Board of the Faculty of Engineering.

§9 Semester description for 4th semester

On the 4th semester, the student will prepare a 30 ECTS thesis or continue the work on a 40 ECTS thesis, which commenced in the 3rd semester.

As a rule, the thesis project will be completed by a group consisting of two students.

§10 Qualifying degrees

10.1. Qualifying degrees

Based on 10.2 – 10.4 the university has assessed that the below degrees qualify for admission to Master of Science in Engineering (Electronics). The list is not exhaustive.

- BSc in Engineering (Physics and Technology) – University of Southern Denmark
- BSc in Engineering (Robot Systems) – University of Southern Denmark
- BSc in Engineering (Electronics and Computer Engineering) – Aalborg University
- BSc in Engineering (Electrical and Electronic Engineering) – Technical University of Denmark
- BEng Electrical and Electronic Engineering – University of Southern Denmark, Technical University of Denmark and Aarhus University.
- BEng Electronics and Computer Engineering – University of Southern Denmark, Technical University of Denmark and Aarhus University.
- BEng in Power Engineering – University of Southern Denmark, Technical University of Denmark and Aarhus University.
- BEng in Electrical Energy Technology – University of Southern Denmark, Technical University of Denmark and Aarhus University.

10.2. Level and content of qualifying degrees

Qualifying bachelor and professional bachelor degrees where the level and content of the scientific and technical courses correspond to a Danish bachelor of science in engineering or professional bachelor of engineering degree in the subject area of the MSc in Engineering (Electronics) programme.

10.3 Academic content of qualifying degree

MSc in Engineering (Electronics) admits applicants with a relevant bachelor degree in accordance with article 10.2 provided that the degree covers:

Subject knowledge		Extent
Mathematics	15 ECTS	
Physics, mechanics and electro physics	15 ECTS	
Electronics – analogue and digital		40 ECTS
Signal processing, control and regulation	10 ECTS	
Programming and simulation tools		10 ECTS

10.4 Additional courses

Should the applicant's degree fail to meet the requirements mentioned in 10.1 - 10.3, it is possible to acquire the necessary skills through additional courses offered at the University of Southern Denmark. The extent of additional courses cannot exceed 15 ECTS.

Additional courses have to be taken after admission to the programme and before the end of the first semester of the programme. Additional courses are restricted to courses offered by the University of Southern Denmark as summer courses or parallel to the first year of the master programme.

10.5 Admission with a foreign degree
Applicants with a bachelor degree or professional bachelor degree from a foreign university who meet the requirements of 10.2 and 10.3 are eligible for admission subject to an academic assessment and comparison of whether the applicant's academic qualifications correspond to those of qualifying Danish degree.

10.6 Possible exemptions
Applicants whose bachelor degree or professional bachelor degree fails to meet the terms stated in 10.1 - 10.5 are not eligible for admission.

Applicants who do not hold a bachelor degree or a professional bachelor degree but who have the academic qualifications equivalent thereto are eligible for admission should their qualifications, based on an academic assessment and comparison, correspond to those of a qualifying Danish degree.

Two-year transitional arrangement regarding additional courses:
It is possible to add any additional courses passed, e.g. single courses from existing bachelor programmes, to the application for admission to a master programme until 31 August 2016.

§ 11 Corps of Censors and Board of Studies

The programme belongs under the Academic Study Board of the Faculty of Engineering and the national Corps of external examiners for engineering programmes.

§12 Effect and amendments

1. Curriculum 2016 approved by the Academic Study Board of the Faculty of Engineering and the Director of Studies on behalf of the Dean of the Faculty of Engineering on 11 December 2015 (Version 1.0).

2. Amendments approved by the Academic Study Board of the Faculty of Engineering and the Director of Studies on behalf of the Dean of the Faculty of Engineering on 24 October 2016 (Version 1.1).