AALBORG UNIVERSITET

CURRICULUM FOR THE MASTER OF SCIENCE PROGRAMME IN ADVANCED POWER ELECTRONICS, 2025

MASTER OF SCIENCE (MSC) IN ENGINEERING
ESBJERG

Link to this studyline

Link(s) to other versions of the same line:

Curriculum for the Master's Programme (MSc) in Advanced Power Electronics 2020
Curriculum for the Master's Programme in Advanced Power Electronics, 2022
Curriculum for the Master of Science Programme in Advanced Power Electronics, 2023
Curriculum for the Master of Science Programme in Advanced Power Electronics, 2024

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§ 1: PREFACE

Pursuant to consolidation Act 391 of April 10, 2024 on Universities (the University Act), the following is established.

The programme also follows the Examination Policies and Procedures incl. the Joint Programme Regulations for Aalborg University.

§ 2: BASIS IN MINISTERIAL ORDERS

The Master's programme is organised in accordance with the Ministry of Higher Education and Science's Order no. 2285 of December 1, 2021 on Full-time University Programmes (the University Programme Order) with subsequent change and Ministerial Order no. 2271 of December 1, 2021 on University Examinations (the Examination Order) with subsequent change. Further reference is made to Ministerial Order no. 69 of January 26, 2023 (the Admission Order) and Ministerial Order no. 1125 of July 4, 2022 (the Grading Scale Order).

§ 3: CAMPUS

The programme is offered in Esbjerg.

§ 4: FACULTY AFFILIATION

The Master's programme falls under the The Faculty of Engineering and Science, Aalborg University.

§ 5: STUDY BOARD AFFILIATION

The Master's programme falls under the Study Board of Build, Energy, Electronics and Mechanics in Esbjerg.

§ 6: AFFILIATION TO CORPS OF EXTERNAL EXAMINERS

The Master's programme is associated with the external examiners corps on Civil engineering corps of external examiners.

§ 7: ADMISSION REQUIREMENTS

Applicants with a legal claim to admission (retskrav)

- Bachelor of Science (BSc) in Engineering (Applied Industrial Electronics), Aalborg University

Applicants without a legal claim to admission

- Bachelor of Science (BSc) in Engineering (Energy Engineering), Aalborg University
- Bachelor of Science (BSc) in General Engineering, Aalborg University
- Bachelor of Science in Engineering (Robotics), Aalborg University
- Bachelor of Science in Electronics Systems Engineering, Aalborg University
- Bachelor of Science (BSc) in Engineering (Robot Systems Engineering), University of Southern Denmark
- Bachelor of Science (BSc) in Engineering (Electronics), University of Southern Denmark
- Bachelor of Science in Computer Engineering, Aarhus University
- Bachelor of Science in Electrical Engineering, Aarhus University
- Bachelor of Science in Electrical Engineering from Danish Technical University
- Bachelor of Engineering in Electrical Engineering from Danish Technical University
- Bachelor of Engineering in Electronics from Southern Danish University
- Bachelor of Engineering in Electrical Power Technology from Aarhus University

All applicants without a legal claim must prove that their English language qualifications is equivalent to level B (Danish level) in English.

Admission to the master's programme in Advanced Power Electronics requires that the applicant has passed a relevant qualifying Bachelor of Science or Bachelor of Engineering degree programme. A Bachelor of Science or Bachelor of Engineering is defined as relevant if the degree programme provides competencies to a minimum of ECTS within the following subject areas:

- Mathematics skills at bachelor's level with a scope of at least 20 ECTS, covering the subjects: calculus, linear algebra, probability, statistics and numerical methods.
- Physics skills at bachelor's level with a scope of at least 10 ECTS, which cover the subjects: classical physics and basic electrical subjects, as well as basic knowledge of energy systems
- Competences at bachelor's level with a scope of at least 5 ECTS, which cover basic control theory and digital control
- Competences at bachelor's level with a scope of at least 10 ECTS, covering the subjects: electrical machines and power electronics
- Competences at bachelor's level with a scope of at least 10 ECTS, which cover programming languages

As a prerequisite for admission to the master's programme, students must have completed a bachelor programme in technical sciences, a bachelor of engineering programme or a bachelor in natural science.

§ 8: THE PROGRAMME TITLE IN DANISH AND ENGLISH

The Master's programme entitles the graduate to the Danish designation Civilingeniør, Cand. polyt. i avanceret effektelektronik. The English designation is: Master of Science (MSc) in Engineering (Advanced Power Electronics).

or

The Master's programme entitles the graduate to the Danish designation Civilingeniør, Cand. polyt. i avanceret effektelektronik med specialisering i AI og Autonome Systemer. The English designation is: Master of Science (MSc) in Engineering (Advanced Power Electronics with specialisation in AI and Autonomous Systems).

§ 9: PROGRAMME SPECIFICATIONS IN ECTS CREDITS

The Master's programme is a 2-year, research-based, full-time study programme. The programme is set to 120 ECTS credits.

§ 10: RULES CONCERNING CREDIT TRANSFER (MERIT), INCLUDING THE POSSIBILITY FOR CHOICE OF MODULES THAT ARE PART OF ANOTHER PROGRAMME AT A UNIVERSITY IN DENMARK OR ABROAD

The Study Board can approve that passed programme elements from other educational programmes at the same level replaces programme elements within this programme (credit transfer).

Furthermore, the Study Board can, upon application, approve that parts of this programme is completed at another university or a further education institution in Denmark or abroad (pre-approval of credit transfer).

The Study Board's decisions regarding credit transfer are based on an academic assessment.

§ 11: EXEMPTIONS

The Study Board's possibilities to grant exemption, including exemption to further examination attempts and special examination conditions, are stated in the Examination Policies and Procedures published at this website: https://www.studyservice.aau.dk/rules

§ 12: RULES FOR EXAMINATIONS

The rules for examinations are stated in the Examination Policies and Procedures published at this website: https://www.studyservice.aau.dk/rules

§ 13: RULES CONCERNING WRITTEN WORK, INCLUDING THE MASTER'S THESIS

In the assessment of all written work, regardless of the language it is written in, weight is also given to the student's formulation and spelling ability, in addition to the academic content. Orthographic and grammatical correctness as well as stylistic proficiency are taken as a basis for the evaluation of language performance. Language performance must always

be included as an independent dimension of the total evaluation. However, no examination can be assessed as 'Pass' on the basis of good language performance alone; similarly, an examination normally cannot be assessed as 'Fail' on the basis of poor language performance alone.

The Study Board can grant exemption from this in special cases (e.g., dyslexia or a native language other than Danish).

The Master's Thesis must include an English summary. If the project is written in English, the summary can be in Danish. The summary is included in the evaluation of the project as a whole.

§ 14: REQUIREMENTS REGARDING THE READING OF TEXTS IN A FOREIGN LANGUAGE

It is assumed that the student can read academic texts in English and use reference works, etc., in other European languages.

§ 15: COMPETENCE PROFILE ON THE DIPLOMA

The following competence profile will appear on the diploma:

A Candidatus graduate has the following competency profile:

A Candidatus graduate has competencies that have been acquired via a course of study that has taken place in a research environment.

A Candidatus graduate is qualified for employment on the labour market based on his or her academic discipline as well as for further research (PhD programmes). A Candidatus graduate has, compared to a Bachelor, developed his or her academic knowledge and independence so as to be able to apply scientific theory and method on an independent basis within both an academic and a professional context.

§ 16: COMPETENCE PROFILE OF THE PROGRAMME

The competence profile depends on the chosen programme. Below you will find the requirements for each programme.

MSc in Advanced Power Electronics

The graduate of the Master's programme has the following qualifications:

Knowledge

- Knowledge about the state-of-the-art research within their field of specialisation
- Knowledge on a scientific basis to reflect over subject areas related to advanced power electronics and identify scientific problems of different types within that area
- Knowledge about the ethics related to the social, economic and environmental impact of research
- Knowledge and comprehension within innovation and entrepreneurship in relation to project work and courses
- Advanced skills in probability theory and statistics, reliability, system identification and diagnosis, advanced control methods, simulation techniques and optimisation
- Knowledge about artificial intelligence
- Advanced knowledge and comprehension within efficient usage of electrical energy, intelligent energy conversion using power electronic systems and electrical machines
- Understanding of the operation, function and interaction between various components and sub-systems used in power electronic converters, electrical machines and adjustable speed drives
- Knowledge enabling the design, modelling, simulation and synthesis of power converter-based systems used for conversion of electrical energy

Skills

- Be proficient in the scientific methods, tools and general skills related to employment within the subjects of advanced power electronics
- Have obtained advanced skills in simulation techniques and mathematical methods
- Be able to evaluate and select among the scientific theories, methods, tools and general skills of the subject area(s) and, on a scientific basis, develop new analyses and solutions
- Be able to communicate research-based knowledge and discuss professional and scientific problems with both peers and non-specialists

- Be able to obtain skills which are related to his/her field within advanced power electronics
- Be able to use advanced laboratory test set-ups and data collection methods
- Experience in the design of controllers for power electronic drive systems using classical and modern control theory
- Experience with the practical implementation of controllers using for example digital signal processors
- The ability to develop, construct, operate and test power electronic converters and drives in the laboratory
- Experience in relation to renewable energy and grid connected converters

Competences

- Be able to demonstrate an understanding of research work and be able to become a part of a research environment
- Be able to manage work and development in situations that are complex, unpredictable and require new solutions within the area of energy engineering
- Be able to independently initiate and implement discipline-specific and interdisciplinary cooperation and assume professional responsibility
- Be able to independently take responsibility for own professional development and specialisation and be able to collaborate in groups according to the PBL Model
- Be able to work with different kinds of projects like discipline oriented, cross-disciplinary projects, multi projects (where several groups within the department are working together on a larger project, solving different parts of the project; or projects, where groups from several departments are involved in a large project contributing each within their specific area for a total solution).

Upon completion of the MSc programme, the student has achieved advanced professional competences in advanced power electronics and electrical machines together with design, control, modelling, simulation and optimisation of energy or mechatronic systems. The competences should advance the student's ability to perform in functions within planning, development, consulting and research in Danish as well as international industries or public institutions. Examples could be research and development departments or top management positions in energy supply companies, such as wind power, machine manufacturing, or process industries as well as electro-technical and consultancy companies, etc.

MSc in Advanced Power Electronics with specialisation in AI and Autonomous Systems

The graduate of the Master's programme has the following qualifications:

Knowledge

- Knowledge about the state-of-the-art research within their field of specialisation
- Knowledge on a scientific basis to reflect over subject areas related to AI and Autonomous Systems and identify scientific problems of different types within that area
- Knowledge about the ethics related to the social, economic and environmental impact of research
- Knowledge and comprehension within innovation and entrepreneurship in relation to project work and courses
- Advanced skills in probability theory and statistics, condition monitoring, machine learning, system identification and diagnosis, advanced control methods, simulation techniques and optimisation
- Advanced knowledge and comprehension within usage of artificial intelligence and deep learning systems
- Understanding of the operation, function and interaction between various components and sub-systems used in autonomous robotics systems
- Knowledge enabling the design, modelling, simulation and synthesis of autonomous robotic systems

Skills

- Be proficient in the scientific methods, tools and general skills related to employment within the subjects of AI and Autonomous Systems
- Have obtained advanced skills in simulation techniques and mathematical methods
- Be able to evaluate and select among the scientific theories, methods, tools and general skills of the subject area(s) and, on a scientific basis, develop new analyses and solutions
- Be able to communicate research-based knowledge and discuss professional and scientific problems with both peers and non-specialists

- Be able to obtain skills which are related to his/her field within AI and Autonomous Systems
- Be able to use advanced laboratory test set-ups and data collection methods
- Experience in the design of controllers for autonomous robotic systems using artificial intelligence and machine learning
- Experience with the practical implementation of controllers for autonomous robotic systems
- The ability to develop, construct, operate and test autonomous robotic systems in the laboratory
- Experience in relation to vision based autonomous systems

Competences

- Be able to demonstrate an understanding of research work and be able to become a part of a research environment
- Be able to manage work and development in situations that are complex, unpredictable and require new solutions within the area of AI and autonomous systems
- Be able to independently initiate and implement discipline-specific and interdisciplinary cooperation and assume professional responsibility
- Be able to independently take responsibility for own professional development and specialisation and be able to collaborate in groups according to the PBL Model
- Be able to work with different kinds of projects like discipline oriented, cross-disciplinary projects, multi projects (where several groups within the department are working together on a larger project, solving different parts of the project; and projects where groups from several departments are involved in a large project contributing each within their specific area for a total solution).

Upon completion of the MSc programme, the student has achieved advanced professional competences in AI and Autonomous Systems and machine learning together with design, control, modelling, simulation and optimisation of autonomous robotic systems. The competences should advance the student's ability to perform in functions within planning, development, consulting and research in Danish as well as international industries or public institutions. Examples could be research and development departments or top management positions in robotic and IT companies, as well as electro-technical and consultancy companies, etc.

§ 17: STRUCTURE AND CONTENTS OF THE PROGRAMME

The programme is structured in modules and organised as a problem-based study. A module is a programme element or a group of programme elements, which aims to give students a set of professional skills within a fixed time frame specified in ECTS credits, and concluding with one or more examinations within specific exam periods. Examinations are defined in the modules of the present curriculum.

The programme is based on a combination of academic, problem-oriented and interdisciplinary approaches and organised based on the following work and evaluation methods that combine skills and reflection:

- lectures
- project work
- workshops
- exercises (individually and in groups)
- e-learning in different ways such as flipped class-room, blended learning, game or quiz, etc.
- teacher feedback
- reflection
- portfolio work
- study circle
- self-study

1st to 4th semesters of the programme are taught in English, and projects are to be written in English.

AAU micro modules

During the study programme, a number of AAU micro modules are offered.

AAU micro modules are small voluntary learning modules within a defined subject. AAU micro modules can be used as supporting learning modules in connection with projects as well as other modules of the study programme.

§ 18: OVERVIEW OF THE PROGRAMME

All modules are assessed through individual grading according to the 7-point grading scale *or* Passed/Not passed. All modules are assessed by the supervisor/lecturer together with an external examiner (external assessment) or with an additional examiner (internal assessment).

Instead of doing the project work and the elective courses, the student can do project work in a company as an individual or as a part of a group. See details in Moodle. **However, the student's special preferences for the semester must be approved by the Study Board in advance.**

MSc in Advanced Power Electronics

Offered as: 1-professional						
Module name	Course type	ECTS	Applied grading scale	Evaluation method	Assessment method	Language
1 SEMESTER						
Diagnosis and Maintenance (25E-APEL1-1)	Project	15	7-point grading scale	Internal examination	Oral exam based on a project	English
Machine Learning and Condition Monitoring (25E-APEL1-2)	Course	5	7-point grading scale	Internal examination	Written or oral exam	English
Probability Theory, Stochastic Processes and Applied Statistics (22KMATSPASTA)	Course	5	7-point grading scale	Internal examination	Written or oral exam	English
System Identification and Diagnosis (25E-SEE1-3)	Course	5	7-point grading scale	Internal examination	Oral exam	English
2 SEMESTER						
Control of Power Electronic Systems (25E-APEL2-1)	Project	15	7-point grading scale	External examination	Oral exam based on a project	English
Advanced Power Electronics and Applications (N-EE-K2-12C)	Course	5	7-point grading scale	Internal examination	Oral exam	English
Dynamic Modelling of Electrical Machines and Control Systems (25E-APEL2-3)	Course	5	7-point grading scale	Internal examination	Oral exam based on a project	English
Non-linear Control and Reliability (25E-APEL2-2)	Course	5	7-point grading scale	Internal examination	Oral exam	English
3 SEMESTER Option 1						
Advanced Control Of Electronic Systems (25E-APEL3-1)	Project	20	7-point grading scale	Internal examination	Oral exam based on a project	English
Elective Courses Third Semester MSc Two courses must be chosen	Course	10				
3 SEMESTER Option 2						
Project-Oriented Study in an External Organisation	Project	30	7-point grading scale	Internal examination	Oral exam based on a project	English

(25E-SEE3-2)						
3-4 SEMESTER Option 3						
Master's Thesis (25E-APEL3-2)	Project	50	7-point grading scale	External examination	Master's thesis/final project	English
Elective Courses Third Semester MSc Two courses must be chosen	Course	10				
4 SEMESTER Master's Thesis						
Master's Thesis (25E-APEL4-1)	Project	30	7-point grading scale	External examination	Master's thesis/final project	English

MSc in Advanced Power Electronics with specialisation in AI and Autonomous Systems

Offered as: 1-professional Specialisation: AI and Autonomous Systems						
Module name	Course type	ECTS	Applied grading scale	Evaluation method	Assessment method	Language
1 SEMESTER						
Robotic Based Condition Monitoring (25E-AIAS1-1)	Project	15	7-point grading scale	Internal examination	Oral exam based on a project	English
Machine Learning and Condition Monitoring (25E-APEL1-2)	Course	5	7-point grading scale	Internal examination	Written or oral exam	English
Probability Theory, Stochastic Processes and Applied Statistics (22KMATSPASTA)	Course	5	7-point grading scale	Internal examination	Written or oral exam	English
System Identification and Diagnosis (25E-SEE1-3)	Course	5	7-point grading scale	Internal examination	Oral exam	English
2 SEMESTER						
Autonomous Robotic Systems (25E-AIAS2-1)	Project	15	7-point grading scale	External examination	Oral exam based on a project	English
Deep Learning Systems (25E-AIAS2-2)	Course	5	7-point grading scale	Internal examination	Written or oral exam	English

Non-linear Control and Reliability (25E-APEL2-2)	Course	5	7-point grading scale	Internal examination	Oral exam	English
Probabilistics Robotics (25E-AIAS2-3)	Course	5	7-point grading scale	Internal examination	Written or oral exam	English
3 SEMESTER Option 1						
Advanced Control Of Electronic Systems (25E-APEL3-1)	Project	20	7-point grading scale	Internal examination	Oral exam based on a project	English
Elective Courses Third Semester MSc Two courses must be chosen	Course	10				
3 SEMESTER Option 2						
Project-Oriented Study in an External Organisation (25E-SEE3-2)	Project	30	7-point grading scale	Internal examination	Oral exam based on a project	English
3-4 SEMESTER Long Master's Thesis						
Master's Thesis (25E-APEL3-2)	Project	50	7-point grading scale	External examination	Master's thesis/final project	English
Elective Courses Third Semester MSc Two courses must be chosen	Course	10				
4 SEMESTER Master's Thesis						
Master's Thesis (25E-APEL4-1)	Project	30	7-point grading scale	External examination	Master's thesis/final project	English

Elective courses on 3rd semester MSc

In addition to the project work "Advanced Control of Electronic Systems", the student can choose 10 ECTS courses on the 3rd semester. The Study Board offers a portfolio of elective courses covering the technical aspects for the Advanced Power Electronics programme with reference to well-defined research programmes which reflect the current research focus of the Department of Energy. Each year the Study Board selects a number of the courses below to be announced

as the year's elective courses (6 to 10). Based on the number of students assigned to each of these courses, 2 to 6 courses will be taught.

The elective courses approved by the Study Board are given in the following overview

Elective Courses Third Semester MSc Two courses must be chosen						
Module name	Course type	ECTS	Applied grading scale	Evaluation Method	Assessment method	Language
Adaptive and Predictive Control (25E-APEL3-3)	Course	5	7-point grading scale	Internal examination	Oral exam	English
Advanced Modelling and Control of Voltage Source Converters (N-EE-K3-9A)	Course	5	7-point grading scale	Internal examination	Oral exam based on a project	English
Applied Optimisation for Energy Systems Engineering: Theory and Practice (N-EE-K3-23B)	Course	5	7-point grading scale	Internal examination	Oral exam	English
Artificial Intelligence (25E-APEL3-4)	Course	5	7-point grading scale	Internal examination	Written or oral exam	English
Artificial Intelligence in Energy Systems (N-EE-K3-27A)	Course	5	7-point grading scale	Internal examination	Oral exam based on a project	English
Battery Energy Storage Systems (N-EE-K3-11C)	Course	5	7-point grading scale	Internal examination	Oral exam based on a project	English
Control of Grid Connected Photovoltaic and Wind Turbine Systems (N-EE-K3-14B)	Course	5	7-point grading scale	Internal examination	Oral exam based on a project	English
Fault Tolerant Control (N-EE-K3-17B)	Course	5	7-point grading scale	Internal examination	Written exam	English
Future Power System in Denmark (N-EE-K3-18B)	Course	5	7-point grading scale	Internal examination	Oral exam based on a project	English
Hybrid Power Plants (N-EE-K3-28)	Course	5	7-point grading scale	Internal examination	Oral exam based on a project	English
Modern Electrical Drives (N-EE-K3-19B)	Course	5	7-point grading scale	Internal examination	Oral exam based on a project	English
Modern Power Electronic Devices and their Models (N-EE-K3-20A)	Course	5	7-point grading scale	Internal examination	Oral exam based on a project	English
Performance Assessment and Modelling of Batteries (N-EE-K3-24C)	Course	5	7-point grading scale	Internal examination	Oral exam based on a project	English
Reliability of Power Electronics Based Power Systems (N-EE-K3-25B)	Course	5	7-point grading scale	Internal examination	Written exam	English
System Identification and Diagnosis (25E-SEE1-3)	Course	5	7-point grading scale	Internal examination	Oral exam	English
Test and Validation (N-EE-K3-21B)	Course	5	Passed/Not Passed	Internal examination	Oral exam based on a project	English

§ 19: ADDITIONAL INFORMATION

When writing a project report the following extent and format must be adhered to:

Maximum number of pages

The allowed maximum number of pages for a report is determined by semester and number of students in the project group, and is calculated using the following formula:

Max number of pages = fixed value + factor x ECTS x number of students

'ECTS' refers to the number of ECTS for the project module.

'Fixed value' is:

- 5 pages for mini projects
- 20 pages for 1st – 5th semester Bachelor studies
- 30 pages for Bachelor of Engineering internship report, Bachelor of Engineering project, and Bachelor of Science and case-based project report (traineeship)
- 30 pages for 1st – 4th semester Master of Science studies

'Factor' is:

- 0.8 for mini projects
- 1.0 for semester projects
- 1.2 for long Master of Science theses
- 1.5 for Bachelor of Science, Bachelor of Engineering, and Master of Science theses
- 1.5 for Bachelor of Engineering internship report and case-based project report (traineeship)

An example of calculating the maximum number of pages for a Bachelor of Science thesis by 4 students: 30 + 1.5 x 15 x 4 = 120 pages.

The number of pages is counted from the first content page, incl. appendix. Appendices are a compilation of material which is relevant for the project, but not part of the main focus and therefore does not belong inside the report; e.g. detailed description of test setups, additional experimental or model results, theoretical derivations, etc. Front page, title page, summary, table of contents, list of table and figures, nomenclature, and references, are not included in the page count. Enclosures are not included in the page count either. An enclosure is technical documentation which does not include significant portions of text composed by the students. It can be data sheets from instruments, print out of program code, diagrams, additional tables or figures compiling data without accompanying text, copy of communication with external contact etc. Additionally, blank pages prior to the beginning of a new chapter are not counted.

The character size should be minimum 11 pt.

Participation in PBL introductory course

All students, who have not participated in Aalborg University's PBL introductory course during their Bachelor's degree, must attend the introductory course "Problem-based Learning and Project Management". The introductory course must be approved before the student can participate in the project exam. For further information, please see the module description.

The current version of the study curriculum is published on the Aalborg University website for study curricula and the Study Board's website.

Additional information about semester descriptions is available in Moodle. Moodle provides study-related information, i.e. course descriptions, course literature, timetables and information about activities and events.

§ 20: COMMENCEMENT AND TRANSITIONAL RULES

The curriculum is approved by the dean and enters into force as of September 1, 2025.

The Study Board does not offer teaching after the previous curriculum from 2024 after the summer examination 2026.

The Study Board will offer examinations after the previous curriculum, if there are students who have used examination attempts in a module without passing. The number of examination attempts follows the rules in the Examination Order.

§ 21: AMENDMENTS TO THE CURRICULUM AND REGULATIONS