Appendix 6
Degree programme-specific appendix for the degree programme
“Digitalised Energy Systems”

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- Unofficial Version -

This is an unofficial English translation, based on the German “ Studiengangsspezifische Anlage für den Studiengang „Digitalised Energy Systems“ (Anlage zur „Prüfungsordnung für die Fachmasterstudiengänge des Departments für Informatik der Fakultät II – Informatik, Wirtschaft- und Rechtswissenschaften an der Carl von Ossietzky Universität Oldenburg“).

The German document published in "Amtliche Mitteilungen der Carl von Ossietzky Universität Oldenburg" is the legally binding one.

(1) Supplement to Section 2: Learning outcomes

Special learning outcomes of the Master’s degree programme
One of the greatest technological and societal challenges is the so-called energy revolution. The main challenge for reliable, economically viable and environmentally responsible energy supply resides in the efficient, secure and reliable digitalisation of a technical system for integrating a large number of fluctuating generators, consumers, storage facilities and grid components that are difficult to forecast into a technically stable and financially viable overall system. The energy system is considered to be critical infrastructure. This infrastructure is the lifeline of modern societies; when it fails or is compromised, this results in lasting supply bottlenecks, considerable disruption to public safety and other dramatic repercussions.

The Master’s degree programme “Digitalised Energy Systems” provides in-depth academic study that enables graduates to tackle these challenges head on. To be admitted to this programme, students must have completed a Bachelor’s degree in Computing Science, Business Informatics, Electrical Engineering or any relevant previous degree programme in Information Technology with predominantly technical and information technology components. At first glance, future electrical energy systems - so-called smart grids - are about the communication-based interconnection of relevant (operating) units (generators, consumers, grid operating equipment, etc.) to optimise and monitor these components to achieve efficient and reliable system operation, whereby an increasing number of decentralised, regenerative generators (especially photovoltaics, wind energy and biomass) must now be integrated. However, the overall challenge is much greater because only an integrated consideration of all influencing factors, such as user acceptance, CO2 emissions, sector coupling or security of this socio-technical and cyber-physical system in the interplay between economic efficiency, reliability and environmental sustainability can bring about practical solutions that pay sufficient heed to the complex interdependencies. The subject area of digitalisation in particular plays a major role and requires advanced skills.

Skills
Graduates of this degree programme have a clear understanding of the fundamentals, principles and methods of Computing Science and its applications in digitalised energy systems as well as a particular insight into the methods, problems and findings from the latest research in energy information systems. They can assess methods for developing and analysing the required system intelligence and select and apply them appropriately to solve problems. They have in-depth knowledge of algorithms for adaptive control as well as regulation and continuous dynamic optimisation of the complex and very extensive (European) power supply system, as well as the creation of overall system competence and orchestration. To this end, graduates are particularly proficient in managing complexity through decomposition and abstraction, identifying and focussing on generalisable principles, and finding decoupling points for effective governance and the avoidance of bottlenecks.

*) There may be interim provisions for this version of the regulations, which may also affect you during the course of your degree programme. For more information, please read the official version of the regulations/amendments (Section II) in the official notices at: https://uol.de/en/official-announcements

Graduates are able to evaluate theories and methods, process models, tools and systems according to scientific criteria and use them to solve practical problems in the energy industry. They have expert knowledge about the design, specification, implementation, optimisation and validation, as well as operation and further development of complex energy information systems for communication (measurement, control and regulation) and automation and are able to apply and manage the application of such systems. They have learned how to design new algorithms in this field of application, and how to implement them based on information and communication technologies and assess their characteristics. They have expert knowledge of current methods of development of complex software solutions, especially in a team.
They are able to work responsibly and conscientiously and are aware of the social impact of informatics in this safety-critical field of application.

Graduates of this degree programme have also learned how to work as part of a group as well as present their own or others' results convincingly. They are well prepared to take on leadership roles in teams and at companies.

In addition to the skills acquired in a previous Bachelor's degree programme, graduates of the Master's degree programme "Digitalised Energy Systems" also have the following skills:

Subject matter skills
Graduates can...

- name and identify the principles of Computing Science and transfer this knowledge to current developments in the energy industry,
- link these principles with physical and systems engineering fundamentals of electrical engineering
- differentiate and contrast in more detail one sub-area of Energy Information Systems in which they have specialised,
- identify and evaluate the techniques and methods that are applicable in their specialist area as well as their limitations,
- develop solutions for complex and novel, potentially vaguely defined or unusual tasks in the area of Energy Information Systems and evaluate such proposals according to the state of the art,
- identify, structure and solve problems including in new or nascent areas of their discipline,
- apply state-of-the-art and innovative methods in the investigation and solution of problems, drawing on other disciplines where appropriate,
- correlate knowledge from different disciplines and apply these synergies in complex situations,
- develop complex energy information systems, processes and data models,
- recognise the limitations of the current state of knowledge and current technology and contribute to the further scientific and technology development of Energy Information Systems,
- discuss current developments in Energy Information Systems and assess their relevance to specific tasks and the development of digitalised energy systems in general.

Methodological skills
Graduates can...

- identify, formalise and investigate problems appropriately using suitable formal methods,
- develop and assess one or more solutions,
- evaluate tools, technologies and methods and apply them in a nuanced manner,
- investigate problems using technical and scientific literature, write an article in line with scientific criteria and present their results in an academic presentation,
- plan time schedules as well as material and human resources,
- apply project management techniques,
- creatively develop new and original approaches and methods,
- reflect on problems including in new or nascent areas of their discipline and apply computing science methods for investigation and solutions.

Social skills
Graduates can...

- integrate their abilities into team processes,
- recognise the achievements of others,

- take on board criticism of their own actions,
- respect the decisions reached in a team,
- speak with and write to users and experts convincingly,
- identify subtasks and assume responsibility for them.

Personal skills
Graduates can...
- take on leadership roles in a team,
- follow further developments in Computing Science in general and in their specialised area of Energy Information Systems with a critical eye,
- carry out innovative activities in their professional field successfully and independently,
- recognise the limits of their skills and expand them in a targeted manner,
- reflect on their self-image and actions from a professional, methodological, social and societal point of view,
- develop and reflect on their own theories on independently established hypotheses,
- work independently in their professional field.

(2) Supplement to Section 5: Duration, scope and structure of the academic programme, credit points, part-time study

2.1 Structure and scope of the academic programme
The Master's degree programme "Digitalised Energy Systems" has a standard period of study of four semesters (two academic years). The modules are delivered exclusively in English.
The degree programme is divided into the areas of
- "Fundamental Competences" with a workload of 54 credit points, which teaches basic skills in Computing Science and Automation and Electrical Engineering in the sub-areas of "Automation and Electrical Engineering" and "Computer Science and Energy Informatics",
- "Foundations of Digitalised Energy Systems" with a workload of 36 credit points, which aims to teach skills and knowledge in the future field of digitalised energy systems in the sub-areas of "Digitalised Energy System Automation, Control and Optimisation" and "Digitalised Energy System Design and Assessment" and reflects on the various domain-specific application perspectives as well as current research topics in the third sub-area "Innovation Topics and Smart Grids", and
- the Master's thesis module (30 credit points).

The type and number of classes/lectures, credit points and type and number of module examinations are stipulated in Appendix 2 to these Master's examination regulations.

2.2 Modules
Area of "Fundamental Competencies"
The area of "Fundamental Competencies" (54 credit points) consists of the sub-areas
- "Automation and Electrical Engineering" (with a workload of 27 credit points, Table 2.2.1), and
- "Computer Science and Energy Informatics" (with a workload of 27 credit points, Table 2.2.2)

Table 2.2.1: Modules in the sub-area "Automation and Electrical Engineering"

Module code	Module name	Module type	Credit points
inf5100	Digital Technology on Energy Markets	Compulsory	6
inf5102	Power System Components, Networks, Operation	Compulsory	6
inf5124	Research Project Digitalised Energy Systems	Compulsory	15
Total			**27 ECTS**

It is also possible to work on a topic in the module "inf5124 Research Project Digitalised Energy Systems" whilst studying abroad. If this is the case, the topics must be agreed prior to studying abroad with the module coordinator and it is compulsory to attend course guidance sessions. The examination component is evaluated at the University of Oldenburg by lecturers of the Master's degree programme Digitalised Energy Systems.

Table 2.2.2: Modules in the sub-area: "Computer Science and Energy Informatics"
In addition to the compulsory module inf5110, two of the elective modules from the following table must be taken.

Module code	Module name	Module type	Credit points
inf5110	Practical Course (Energy Informatics)	Compulsory	15
inf5104	Fundamentals of Game Theory in Energy Systems	Elective	6
inf5106	Optimal and Model-Predictive Control	Elective	6
inf514	Simulation-based Smart Grid Engineering and Assessment	Elective	6
Total			**27 ECTS**

Area of "Foundations of Digitalised Energy Systems"
The area of "Foundations of Digitalised Energy Systems" (36 credit points) is made up of the three sub-areas:

- Digitalised Energy System Automation, Control and Optimisation (with a workload of 18 credit points, Table 2.2.3),
- Digitalised Energy System Design and Assessment (with a workload of 12 credit points, Table 2.2.4) and
- Innovation Topics and Smart Grids (with a workload of 6 credit points, Table 2.2.5).

The sub-area of "Digitalised Energy System Automation, Control and Optimisation" introduces students to issues relating to the operational management, control and regulation of digitalised energy systems. The skills acquired here are further strengthened in the two other sub-areas "Digitalised Energy System Design and Assessment" and "Innovation Topics and Smart Grids" and considered from the perspective of current developments and research topics. Students must take modules from all three sub-areas according to the following specifications.

Table 2.2.3: Digitalised Energy System Automation, Control and Optimisation
Students must choose at least one of the modules inf5109 and inf341. In total, students must take three modules with a workload of 6 credit points each.

Module code	Module name	Module type	Credit points
inf341	Robust Control and State Estimation in Digitalised Energy Systems	Elective	6
inf5112	Digitalised Energy System Modeling and Control	Elective	6
inf5114	Digitalised Energy System Requirements Engineering	Elective	6
Inf5118	Decentralised Nonlinear Model-Based Control in Digitalised Energy Systems	Elective	6
inf516	Distributed Operation in Digitalised Energy Systems	Elective	6
inf579	Special Topics in 'Digitalised Energy Systems' I	Elective	6
inf581	Special Topics in 'Digitalised Energy Systems' II	Elective	6
inf584	Special Topics in 'Energy Informatics' I	Elective	6
inf585	Special Topics in 'Energy Informatics' II	Elective	6
Total			**18 ECTS**

Table 2.2.4: Digitalised Energy System Design and Assessment
Students must take two of the modules from Table 2.2.4.

Module code	Module name	Module type	Credit points
inf340	Uncertainty Modeling for Control in Digitalised Energy Systems	Elective	6
Inf5120	Digitalised Energy System Co-Simulation	Elective	6
inf5122	Learning-Based Control in Digitalised Energy Systems	Elective	6
Total			**12 ECTS**

Table 2.2.5: Innovation Topics and Smart Grids
Students must take two of the modules from Table 2.2.5.

Module code	Module name	Module type	Credit points
Inf5126	Digitalised Energy System Cyber-Resilience	Elective	3
inf5128	AI in Energy Systems	Elective	3
inf5130	Socio-technical Energy Systems	Elective	3
inf586	Current Topics in 'Energy Informatics' I	Elective	3
inf587	Current Topics in 'Energy Informatics' II	Elective	3
inf591	Current Topics in 'Digitalised Energy Systems'	Elective	3
Total			**6 ECTS**

2.3 Master's thesis module
Table 2.3.1: Master's thesis module

Module code	Module name	ECTS credit points
mam	Master Thesis Module Digitalised Energy Systems	30

2.4. Part-time study
It is possible to follow the programme on a part-time basis (cf. Section 4.4. MPO).

(3) Supplement to Section 15 Resits of module examinations and the Master's thesis, free attempt
Students may only resit an examination that they have failed or have been deemed to fail in the module inf5124 Research Project once.

(4) Supplement to Section 20 Admission to the Master's thesis
Students may only be admitted to the Master's thesis module if, at the time of the admission decision, any missing skills that were the subject of an incidental provision based on Section 2.1 and/or Section 2.2 of the regulations governing access and admission to the consecutive Master's degree programme "Digitalised Energy Systems" (M.Sc.) of School II - School of Computing Science, Business Administration, Economics, and Law at the University of Oldenburg have been established.

(5) Supplement to Section 21 Master's thesis module
As a rule, the Master's thesis is to be written in English. With the consent of both the first and second assessor, the Master's thesis may be written in German.