



Faculty of Health, Science and Technology  
Electrical Engineering

# Syllabus

## Smart renewable energy electrical grids

<b>Course Code:</b>	ELAD22
<b>Course Title:</b>	Smart renewable energy electrical grids <i>Smarta elnät för förnybar energi</i>
<b>Credits:</b>	7.5
<b>Degree Level:</b>	Master's level
<b>Progressive Specialisation:</b>	Second cycle, has only first-cycle course/s as entry requirements (A1N)

**Major Field of Study:**  
ETA (Electrical Engineering)

### Course Approval

The syllabus was approved by the Faculty of Health, Science and Technology 2022-10-17, and is valid from the Autumn semester 2023 at Karlstad University.

### Prerequisites

30 ECTS credits of programme courses in Mathematics completed at the Master level (Engineering), and registered for programme courses worth 150 ECTS credits in Industrial Engineering and Management, Computer Engineering, or Energy and Environmental Engineering at the Master level (Engineering), plus upper secondary level Swedish 3 or Swedish as a second language 3 and English 6, or equivalent.

### Learning Outcomes

The aim of the course is for students to acquire knowledge about technology used to integrate renewable energy in smart electrical grids.

Upon completion of the course, students should be able to:

- describe different technologies used in smart electrical grids,
- explain the role of the smart electrical grid for integration of renewable energy,

- describe how distributed energy resources are used to design a smart electrical grid,
- analyse the principles and functionality of smart electrical grids, and
- give an account of and perform calculations on smart renewable energy management and system operation.

### **Content**

- Electrical grid structure: Traditional structure of electrical power grids, electrical energy production, transmission and distribution grids, and electricity consumers, industrial electrical grids, commercial electrical grids, and electrical grids for housing, ICT and grid calculation, plus SCADA.
- Smart electrical grids and renewable energy: Infrastructure for measuring, data management, and data communication, distributed energy resources, flexibility and consumption response, smart applications, energy storage, electric vehicles and charging infrastructure, renewable energy for heat, and hydrogen gas, micro-grids, AI and IoT, edge and cloud computing, plus blockchain.
- Control and handling of electrical power: Power flows, operating principles in different time scales, energy optimisation, and market implementation.
- Ethical and social aspects of smart electrical grids.

### **Reading List**

See separate document.

### **Examination**

Assessment is based on a written exam, oral and written presentations, and documented participation in laboratory sessions.

If students have a decision from Karlstad University entitling them to Targeted Study Support due to a documented disability, the examiner has the right to give such students an adapted examination or to examine them in a different manner.

### **Grades**

One of the grades Distinction (VG), Pass (G), or Fail (U) is awarded in the examination of the course. For students in Engineering programmes, one of the grades 5 (Pass with Distinction), 4 (Pass with Some Distinction), 3 (Pass), or U (Fail) is awarded in the examination of the course.

### **Quality Assurance**

Follow-up relating to learning conditions and goal-fulfilment takes place both during and upon completion of the course in order to ensure continuous improvement. Course evaluation is partly based on student views and experiences obtained in accordance with current regulations and partly on other data and documentation. Students will be informed of the result of the evaluation and of any measures to be taken.

### **Course Certificate**

A course certificate will be provided upon request.

### **Additional information**

The local regulations for studies at the Bachelor and Master levels at Karlstad University stipulate the obligations and rights of students and staff.