**T-867-GRID** **SMART-GRID AND SUSTAINABLE POWER SYSTEMS** **8 ECTS**

**Year of study:** First year MSc.
**Semester:** Spring.
**Level of course:** 5. Second cycle, intermediate.
**Type of course:** Core for MSc Electric Power Engineering, elective for other programs.
**Prerequisites:** None. **Other recommended prerequisites:** Basic knowledge of electric circuits, electric engineering fundamentals and power systems is highly recommended.
**Schedule:** Runs for 12 weeks- 6 teaching hours a week.
**Supervisor:** Mohamed Abdelfattah.
**Lecturer:** Mohamed Abdelfattah.

**Description:**
*The main goal of this course is to present the fundamentals of "Smart-Grids" with a focus on selected related topics. The course will include many lectures, presentations, and class discussions, on many topics that are related to smart grids technology, including:*

- Introduction to electric power systems.
- Types of energy resources.
- Types of electric power plants.
- Introduction to Smart-grids.
- Self-healing and virtual power plant (VPP) concepts
- Information and communications technologies (ICT) applications for Smart-grids
- Fundamentals of the smart-grids protection
- Smart-grids reliability
- Smart-grids automation
- Other selected topics, or case studies, on smart-grids, such as renewable energy and emerging technologies, high voltage direct current (HVDC) transmission, fluctuating renewable energy sources such as wind and solar, energy storage systems, microgrids, electric vehicles, intelligent computational methods, active distribution network, demand response, smart homes, buildings and cities.

**Learning outcome:**
*Knowledge:*
After successful completion of this course, the students should be able to:

- Know the basic components of the electric power systems.
- Understand how electrical energy is generated, transmitted, distributed, and consumed.
- Explain different energy resources and related types power plants.
- Be familiar with the fundamentals of smart-grids.
- Understand the role of smart-grids technologies in integrating renewables
- Understand the role of information and communications technologies (ICT) solutions on smart-grids including some selected topics such as wide area measurement systems (WAMS) and applications (PMU), Internet protocol (IP) and Internet-based applications, global positioning system (GPS) applications, multi-agent systems (MAS), geographic information system (GIS) applications, automatic meter reading (AMR), wireless and radio communication, power line carrier communication, optical fiber communication, Information and cyber security.

- Define the self-healing and virtual power plant (VPP) concepts.
- Learn the fundamentals of smart-grids protection and its role in self-healing function.
- Understand the importance of reliability and automation in distribution networks.
- Know more details about selected topics, or case studies, on smart-grids, such as renewable energy and emerging technologies, high voltage direct current (HVDC) transmission, fluctuating renewable energy sources such as wind and solar, energy storage systems, microgrids, electric vehicles, intelligent computational methods, active distribution network, demand response, smart homes, buildings and cities.

*Skills:*
After successful completion of this course, the students should be able to:

- Apply the concept of high voltage transmission in electric power systems for reducing the transmission losses and improving the voltage level at the receiving end.
- Apply the self-healing concept in distribution networks, based on the availability of advanced protection systems which is supported by smart switches with communication capabilities.
- Propose an outage management scenario for simple distribution networks, for fault detection, isolation and supply restoration.
- Calculate the reliability indices in distribution networks.
- Apply basic concepts of smart-grids technologies in different applications for electric power systems, using information and communications technologies (ICT) and renewable energy resources solutions.
- Write a technical background presentation and a research report that covers the current research work on individual selected topics, projects or case studies which related to smart-grids technologies.

*Competence:*
After successful completion of this course, the students should be able to:

- Estimate the transmission losses and voltage profile in real high voltage electric power systems.
- Integrate smart automatic switches with communication capabilities with advanced protection systems for developing the self-healing function in distribution networks.
- Apply an outage management scenario for simple distribution networks, for fault detection, isolation and supply restoration.
- Evaluate the performance and reliability level of a distribution network based on reliability indices values.
- Propose suitable smart-grids technologies as a solution for different realistic applications in electric power systems, based on the availability of information and communications technologies (ICT) and renewable energy resources solutions.
- Demonstrate a technical background presentation and a research report that covers the current research work on individual selected topics, projects or case studies which related to smart-grids technologies.

**Reading material:** No textbook. Lectures slides and notes. Selected recent articles, publications, and some chapters from recommended references. Selected topics presentations.
**Teaching and learning activities:** Lectures; for the presentation of the fundamentals. Class discussions; for thinking, brainstorming, and understanding. Group presentations; for supporting the knowledge exchange and teamwork skills. Individual assignments (projects); for the development of the self-learning and individual research and publication skills.
**Assessment methods:** Exam. Project, on selected topics, including a review presentation and a report on a research question or task.
*In order to pass this course, you need 60% or higher on the exam grade and 60% or higher on the total grade.*
**Language of instruction:** English.

***All course descriptions may be subject to change.*** Revised information on the course schedule, reading material, teaching and learning activities, and assessment methods will be introduced in the learning management system Canvas at the beginning of the semester.