DENSYS

DECENTRALISED SMART ENERGY SYSYEMS

Programme content

Rev. 1.0 - 15 Sep. 2019

Semester 1 (University of Lorraine) - Total 30 ECTS		
Module name	Content summary	Main learning outcomes
Harmonization 3 ECTS	• Basics of Fluid Mechanics, Thermodynamics, Heat & Mass transfers • The different operating modes of electric circuits. Transformers. Power calculations. Electromechanical power conversion principle	• Master the prerequisites for the advanced courses of the master • Master the conservation principles in Mechanical and Chemical Engineering • Understand the basics of Electric Circuits, Magnetic circuit and direct applications in power exchanges.
Energy conservation processes 9 ECTS	• Heat and fluid for energy • Chemical and electrochemical processes involved in energy • Electricity conversion and distribution	• Master the principles of energy conversion involving fluid and heat • Master the principles and processes of chemical and electrochemical energy transformation • Master mechanical energy conversion into electricity and grid interface
Key technologies of DES 9 ECTS	• Renewable energy sources • Energy storage • Interconversion of energy carrier processes	• Master the principles of the key renewable energy resources • Master the different ways of storing electrical and thermal energy • Master the different ways of interconversion processes between energy carriers • Be able to implement simplified dynamic models
Case based module 3 ECTS	• Bottom up study of a real life problem (for which several solutions exist) that include the key technologies of DES (RES, storage, carriers interconversion) • Supervised team work	• Explore a real-life case and design a usable model • Be capable to have in mind other systemic points: e.g. costs of the technologies, availability of the resources (material), recyclability, social acceptance, …
Language, culture	French	Initiation to the local language and cultural tips
Elective #1 6 ECTS	• Critical resources for energy and recyclability • Materials for energy conversion • Energy transition and territories • Economy for energy	2 courses over 4 (3ECTS/course)

Semester 2 (University of Lorraine) - Total 30 ECTS		
Module name	Content summary	Main learning outcomes
Smart and flexible energy management **12 ECTS**	• Sizing and optimizing a local energy network • Energy management strategy • Smart energy networks	• Be able to formulate and solve the optimization problem of the design of an energy network • Be able to implement an energy management strategy in both centralized and decentralized mode and related control/command issues • Be able to understand the basis and the specific needs of a communication network and the use of the information network to reach consensus in smart energy grids
Immersive week in University of Liège (Digitalization and Artificial intelligence)		
Challenge based module (First part) **6 ECTS**	• To discover solutions of an open problem and mobilize knowledge for practical applications (technological objects, systems, services). • To carry out a systemic analysis that takes into account economical, business and societal aspects. • Elective lectures (ac. to the challenge topic) • Supervised team work	• Be capable to propose solutions of an open real life problem • Be able to design technological solutions, size and optimize with a large range of criteria, design a smart energy management strategy. • Be able to take into account the non-technological issues: regulatory, territorial, social, political framework • Be able to develop a systemic approach of the design of an energy network
Breadth courses (mandatory) **6 ECTS**	• Project management • Sustainable collaborative interdisciplinary project management • System Engineering	
Elective #2 **6 ECTS**	• Co-simulation of processes • Social acceptance of energy projects • Scientific, social and human context in the elaboration of energy policies • Public awareness, education in energy transition • Life cycle analysis • Energy and environment: terminological issues	2 courses over 6 (3ECTS/course)
Summer session (1)		

Semester 3 (KTH) – Total 30 ECTS Specialization track ”Decentralized smart energy systems in a global energy system ”		
Module name	Content summary	Main learning outcomes - LO
Global energy markets and systems in transition 6 ECTS	• Function of energy systems with a strong focus on the relationship between the structure of the technical systems and their respective economical boundary conditions (pricing, market, etc.), as well as the function and transformation of energy markets.	• Be able to analyse the function and structure of the global energy system regarding energy type and industrial and political structure • Be able to analyse the function and price formation mechanisms of energy markets - globally as well as locally • Be able to assess the effect of climate changes on the transformation of the energy systems and energy markets
Energy Data, Balances and Projections 6ECTS	• Project based course (lectures delivered by local and external experts, practical via computer labs) • Exposure to energy data classification, collection and projections activities of the International Energy Agency (IEA), the UN Statistical Division (UN Stats) as well as the International Atomic Energy Agency.	• Be able to understand the links between human activities, the need for energy services • Be able to understand the mechanics of a national energy balance. • Master various methodologies used to project future energy demand. • Be able to apply relevant software tools and use the gathered data for future energy scenario assessment
Challenge based module - 6 ECTS	• Follow-up 2nd semester module- content is similar	• Follow-up 2nd semester module- LO are similar, and work will be oriented according to the specialization track
Language, culture	Swedish	Initiation to the local language and cultural tips
Breadth courses (mandatory) 6 ECTS	Theory and Methodology of Science for Energy Research	Master the theory and methodology of science to prepare for the development of their Master’s thesis
Elective 3 6 ECTS	• Renewable Energy Technology • Green Building - Concept, Design, Construction and Operation • Energy System Economics, Modelling and Indicators for Sustainable Energy Development	1 course over 3 (6 ECTS/course)
Challenge based module presentation		

Semester 3 (PoliTo) – 30 ECTS Specialization track "Energy-to-X: innovative pathways for energy storage"		
Module name	Content summary	Main learning outcomes
Polygeneration and advanced energy systems 6 ECTS	• Description, modelling, analysis of advanced energy systems based on the integration of power, thermo-chemical and electro-chemical processes for purposes of energy management and storage.	• Be able to design of complex energy systems based on thermo-chemical and electro-chemical processes • Be able to design of power-to-X processes • Be able to design of technologies and processes for CO2 recovery and re-utilization and poly-generation systems.
Smart electricity systems 6 ECTS	• Evolution of the electricity systems, with the on-going transition towards a growing utilization of electricity in many applications.	• Be able to use the correct terminology in addressing the problems concerning smart grid applications • Be able to interpret the problems concerning the introduction of distributed energy resources in the smart grids
Challenge based module - 6 ECTS	Follow-up 2nd semester module- content is similar	• Follow-up 2nd semester module- LO are similar
Language, culture	Italian	Initiation to the local language and cultural tips
Breath courses (mandatory) 6 ECTS	Digital humanities	• Be capable to understand the many aspects linked to sustainability and to use the knowledge provided, to analyse and define the characteristics of new technologies to produce goods and services oriented towards sustainability.
Elective 3 6 ECTS	• Models and scenarios for energy planning • Advanced materials for energy • Thermal design and optimization	1 courses over 3 (6 ECTS/course)
Challenge based module presentation		

Semester 3 (UPC) – 32 ECTS Specialization track ” Thermal Energy Engineering”		
Module name	Content summary	Main learning outcomes
Thermal equipment for heat and cold generation 5 ECTS	• Techniques for generating heat and cold. • Methodologies that allow the calculation and design of thermal systems using softwares	• Master advanced methods of numerical simulation analysis of items of equipment (incl. with phase change, transient). • Master the most advanced calculation methods of items of equipment generating heat and cold • Comprehensive analysis systems
Computational methods in thermal energy technology 5 ECTS	• Training in the numerical solution of the governing equations of fluid dynamics and heat and mass transfer.	• Master the basic mathematical formulations of fluid dynamics and heat and mass transfer phenomena. • Master the different numerical integration methodologies of the Navier-Stokes equations, the resolution of turbulent flows based on methods like RANS, LES and DNS.
Turbulence: phenomenology, simulation - 5 ECTS	• Phenomenology of turbulent flows • Statistical tools for turbulent flows • Basics of modelling turbulence	• Master basic knowledge of turbulence and its energy spectrum, statistical treatment of turbulent flows • Be able to model and solve turbulent flows
Challenge based module - 6 ECTS	• Follow-up 2nd semester module- content is similar	• Follow-up 2nd semester module- LO are similar, and work will be oriented according to the specialization track
Language, culture	Spanish	Initiation to the local language and cultural tips
Breadth courses (mandatory) 5 ECTS	Energy Resources	Be able to understand the need for energy and its relationship to sustainable human development, the transformations from an "energy source" to its use as "energy service". .
Elective 3 6 ECTS	• Intensification on Heat and Mass transfer • Heat Exchanges • Heat Engines and Combustion • Experimental measurement techniques	2 courses over 4 (3 ECTS/course)
Challenge based module presentation		