Transilvania University of Brașov, Romania

Study program: Advanced Electrical Systems (in English)

Faculty: Electrical Engineering and Computer Science
Study period: 2 years (master)

1st Year

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Numerical methods for advanced electrical systems analysis	SEA101	4	1		2	

Course description (Syllabus): Advanced notions of electromagnetic field computation; Finite difference method. Applications; Finite element method. Applications for some linear and non-linear problems. Advanced methods for circuits and networks computation; Methods for steady state regimes. Applications for the design of passive filters; Methods for dynamic regimes; Methods for signal processing; The Fourier analysis of harmonic signals.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Advanced systems for measuring, data acquisition and processing	SEA102	5	2		1	

Course description (Syllabus): General aspects of acquisition and processing of data. Data Acquisition systems functions. Fields of use. Recent trends. Technologies, platforms and standards. Circuits for signal conditioning Converting the signal output voltage of the electrical transduction; Adaptation-level signals; SAPD galvanic separation of the source signal; Analog signal filters; Analog signals pre-processing; Analog to digital signals conversion; Sampling of an analog signals. Sampling Circuit; Digital Signal processing .Encode analog signals; Analog-digital converters. Numerical processing systems ports: Parallel and serial ports of computers. The serial interface: RS family. The parallel interface: GPIB bus. Modular instrumentation: VXI, PXI. Dedicated interfaces: USB, Ethernet, CAN. Virtual instrumentation notions. Main Lab VIEW elements used for developing DAQ systems. Configuration of Wireless Acquisition Systems. Smart sensors and MEMS. Description of Wireless Sensor Networks. Interfaces, standards and network topologies.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Environmental policy and electromagnetic compatibility	SEA103	4	2		1	

Course description (Syllabus): EU Environmental policies; Principles underlying concept implementation SD (sustainable development); The European environmental policy instruments; Environmental indicators; National Level Indicators.; Organizing environmental information: Indictor types, environmental issues; Types of pollution due to electrical systems; Methods to reduce the environmental electromagnetic pollution; The interaction between the biological and electromagnetic environment.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Modern energy storage systems	SEA104	4	2		1	

Course description (Syllabus): Professional training of the Master Degree Students will be done by the theoretical and computer aided design level of knowledge regarding the electrical energy storage systems. Are estimated to obtain advanced competences in mathematical modelling, computer-aided design and dedicated software applications. Electrical Energy Storage Systems and energy markets; Parameters and mathematical models for batteries with Pb, Ni-Cd, NiMH, Na-S, Li; Superconducting Capacitors (Ultracapacitors); Fuel Cells; Vanadium Redox flow Batteries (VRB); Pumped – Hydroelectric Storage; Compressed Air Energy Storage; Flywheels; Superconducting Magnetic Energy Storage; Applications in Electrical Energy Transmission and Distribution.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Control of power electronic converters	SEA105	5	2		1	1

Course description (Syllabus): Introduction: types of electronic converters, efficiencies and losses, characteristics of power semiconductor devices, of electronic converters and electric machines, control techniques, specialized digital control circuits . Fundamentals of soft commutation: Switching semiconductor devices, hard commutation, analyzing soft commutations: ZCS, ZVS, ZVT commutations. Switching semiconductor devices: MOSFET and IGBT. Drive circuits. Voltage control drive circuits. Three phase inverters. Control techniques: Six step inverter, sinusoidal PWM, Space Vector PWM. Control of the induction machine: Model of the induction machine using the space vectors, control strategies of the induction machine: scalar and vector control. Scalar control: open loop, with speed sensor, sensorless control. Vector control: with speed sensor, sensorless, field orientation (stator, rotor and airgap) and direct torque control (DTC). Practical control schemes. Control of permanent magnet synchronous motor, control of permanent magnet DC brushless machine. Uninterruptable power supplies. Energy storage systems Current controllers: basic requirements and performance criterions, types of current controllers: linear current controllers: stationary PI, synchronous PI, state controllers, predictive and deadbeat; nonlinear current controllers: hysteresis, delta modulation , real time optimization, fuzzy logic and neural networks based. Structure of digital control systems of electronic converters: basics of electronic converters digital control, general purpose microprocessors and microcontrollers for electronic converters control, advanced microprocessors, ASIC circuits, examples.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Research practical stage SEA-1	SEA106	8				10

Course description (Syllabus): Practical stage research carried out in university or in private companies on a subject specific to the SEA master domain. The research topics are focused on the following areas: Electrical machines and drives; Static converters; Monitoring and prediction of electrical systems operation; Systems for production, distribution and transport of electrical energy; Renewable energy; Energy storage and recovery; Electromagnetic compatibility and power quality; Materials and sensors.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
CAD for electrical systems	SEA107	5	1		2	

Course description (Syllabus): Optimizing the electrical systems using SCILAB; Matrix Operations; Programming; 2D and 3D Graphs; Numerical analysis and optimisation; Interfacing SCILAB with other programming languages; Modelling and simulation; Electrical engineering applications.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Dynamic modelling of electrical systems	SEA108	5	1		1	1

Course description (Syllabus): System models; Steps in modelling the dynamics of a system; Models classifications; Common model types; Models for the prime movers in classical power plants; Models for the synchronous generator: electromechanical model, electromagnetic model, per unit equations, simplified electromagnetic models; Modelling of

the excitation systems for the SG;; Models for the electric energy transport and distribution networks; The induction machine d-q model; The model of an autonomous induction generator; Model types for power converters; Voltage-source converter model; Dynamic regimes modelling in electrical systems; Dynamic models of hybrid electrical vehicles (EVs) and hybrid supply system for EVs; Doubly-fed induction generator system dynamic model; PV systems and energy storage systems models; Models for autonomous micro-grids.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Advanced optimization methods for electrical systems	SEA109	5	2			1

Course description (Syllabus): The course objective is to provide students with a basic understanding of optimization problems, regarding formulation, analytic and computational tools for their solutions, and applications in electrical engineering areas.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Smart electrical microgrids	SEA110	5	2		1	1

Course description (Syllabus): The general discipline objective consists in training the skills in the domain of smart electrical grids, microgrids with renewable energy sources and distributed generation systems. The course content covers the following main issues: main distributed energy resources; concept of smart grid and microgrid; interfacing renewable energy sources; power quality issues in a microgrid; voltage and frequency control in microgrids; protections in a microgrid.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Ethics and academic integrity	SEA111	2	1			

Course description (Syllabus): The course objective is to provide students with basic knowledge about ethics and academic integrity in the scientific activity.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Research practical stage SEA-2	SEA112	8				12

Course description (Syllabus): Practical stage research carried out in university or in private companies on a subject specific to the SEA master domain. The research topics are focused on the following areas: Electrical machines and drives; Static converters; Monitoring and prediction of electrical systems operation; Systems for production, distribution and transport of electrical energy; Renewable energy; Energy storage and recovery; Electromagnetic compatibility and power quality; Materials and sensors.

2nd Year

Optional study package 1

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Hydro power energy conversion systems	SEA201	5	2		1	

Course description (Syllabus): The importance of hydroelectricity in the renewable energy sources area; Micro hydro power plants; Definition of micro hydro power plants (MHPPs); MHPPs situation in Romania; Green certificates for MHPPs; Hydro electric potential categories; MHPP base technology; Types of accumulation; MHPP power calculation; Hydraulic turbines; Electrical generators; Electro-mechanical equipment development; Auxiliary equipment; Autonomous MHPPs; The opportunity of using the induction generator: parameters control, single-phase operation; MHPPs integration into the system; Automatic control and monitoring; Operation optimization (SCADA systems); Pumped storage – MHPP level.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Testing to electromagnetic disturbances	SEA202	5	2		1	

Course description (Syllabus): Disturbances in electromagnetic environment. Evolution of regulations regarding the conducted disturbances testing. Particularities of the immunity standard EN61000. CISPR regulation; CEM comportment of the system for data transmission. Differential and common mode of connection. Disturbance processes in data transmission systems: reflections, propagation, errors; Equipment immunity to electrostatic discharges: description of phenomena, testing procedures, modelling and simulation, mitigation techniques; Immunity to radiofrequency electromagnetic disturbances; Simulation of the disturbances produced by a real electric network: burst, surge, harmonics and inter-harmonics, unbalance; Equipment immunity testing to harmonics, flicker and voltage variation; Reduction of conducted disturbances: methods and tools.

Optional study package 2

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
CAD/CAE in power electronics	SEA203	5	2		1	1

Course description (Syllabus): The general discipline objective consists in providing the required skills of knowing and utilization of specific CAD/CAE software for analysis, calculus, modelling and simulations of power electronics converters. The course content covers the following main issues: Design and modelling aspects of the main DC-DC power electronics converters; Modelling and design of power semiconductors; Modelling and design of thermal circuits for power electronic converters; Snubber circuits for power semiconductors; Gate drive circuits and protection systems for power electronic converters;

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Modern optimization solutions of electrical systems	SEA204	5	2		1	1

Course description (Syllabus): Modern optimization solutions of electrical motors; Modern optimization solutions in transport; Modern optimization solutions for lighting; Domestic Appliances and Building Services; Information and Communication Technology Devices; Market Strategies and Basic Political Conditions; Energy Saving Potentials Assessment.

Optional study package 3

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Digital systems for power quality monitoring	SEA205	5	2		1	

Course description (Syllabus): The course is an introduction to modern digital monitoring systems and automated data acquisition based on the latest IT technologies, which can be applied to automated industrial processes or development of new smart devices to be connected through the Internet of Things.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Wind energy conversion systems	SEA206	5	2			1

Course description (Syllabus): Introduction: Historical development and current status of wind power, wind power in power systems. Wind energy conversion system: drive torque and rotor power, turbines, hub and turbine design, rotor blade geometry, power control by turbine manipulation, mechanical drive trains. Generators and power electronics for wind turbines: constraints and demands on the generators, energy converter system, induction generators, synchronous generators: construction, operational ranges, design aspects, power converter elements: rectifiers and inverters, frequency converters, soft starter and capacitor bank. The transfer of the electrical energy to the supply grid: power conditioning and grid connection, grid protection, grid effects, resonance effects in the grid during normal operation, remedial measures against grid effects and grid resonance, grid control and protection, grid connection rules. Control and supervision of wind turbines: system requirements and operating modes, isolated operation of wind turbines, grid operation of wind turbines, control concepts, controller design, management system, monitoring and safety system. Power quality standards for wind turbines. Power quality measurements. The value of wind power: the value of a power plant, the value of wind power, the market value of wind power. Future concepts: wind power and voltage control, wind power in areas with limited transmission capacity, benefits of active management of distribution systems, transmission systems for offshore wind farms, hydrogen as a means of transporting and balancing wind power production. Dynamic modelling of wind turbines for power system studies.

Optional study package 4

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Solar power plants and hybrid energy systems	SEA207	5	2		1	1

Course description (Syllabus): Solar Technologies; Physics of PV Cell; PV Inverters; MPPT;PV, Batteries and Charge Controllers; Sizing a PV system; PV System Control; Grid requirements for PV generators; Grid connected PV plants; Case Studies; Storage for PV Stand-Alone Systems; Hybrid power systems; RES based Hybrid systems; SmartGrids and Distributed networks.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Computer-aided instrumentation	SEA208	5	2		1	1

Course description (Syllabus): Virtual Instrument concept and data acquisition; LabVIEW basics; connecting equipment in LabVIEW via various communication ports and protocols and building virtual instruments; application oriented course (e.g. building a virtual instrument in LabVIEW based on Arduino).

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Research practical stage SEA-3	SEA209	10				12

Course description (Syllabus): Practical stage research carried out in university or in private companies on a subject specific to the SEA master domain. The research topics are focused on: Electrical machines and drives; Static

converters; Monitoring and prediction of electrical systems operation; Systems for production, distribution and transport of electrical energy; Renewable energy; Energy storage and recovery; Electromagnetic compatibility and power quality; Materials and sensors.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Research practical stage SEA-4	SEA210	10				12

Course description (Syllabus): Practical stage research carried out in university or in private companies on a subject specific to the SEA master domain. The research topics are focused on: Electrical machines and drives; Static converters; Monitoring and prediction of electrical systems operation; Systems for production, distribution and transport of electrical energy; Renewable energy; Energy storage and recovery; Electromagnetic compatibility and power quality; Materials and sensors.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Practical stage for dissertation thesis preparation	SEA211	10				12

Course description (Syllabus): Practical stage research carried out in university or in private companies on a subject specific to the SEA master domain. The research topics are focused on: Electrical machines and drives; Static converters; Monitoring and prediction of electrical systems operation; Systems for production, distribution and transport of electrical energy; Renewable energy; Energy storage and recovery; Electromagnetic compatibility and power quality; Materials and sensors.

Course title	Code	No. of credits	Number of hours per week			
			course	seminar	laboratory	project
Dissertation thesis preparation	SEA212	10				2

Course description (Syllabus): Students guidance activities carried out by the coordinators for elaboration of dissertation theses.