Transilvania University of Braşov, Romania

Study program: Advanced Electrical Systems

Faculty of 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 electrical systems analysis	SEA101	6	1		2	

Course description (Syllabus): Advanced notions of electromagnetic field computation (6 hrs): Finite difference method. Applications; Finit element method. Applications for some linear and non-linear problems. Advanced methods for circuits and networks computation (4 hrs); Methods for steady state regimes. Applications for the design of passive filters; Methods for dynamic regimes; Methods for signal processing (2 hrs); The Fourier analysis of harmonic signals. Applications for some specific signals Methods for obtaining the best solution of a project based on some specific criteria (2 hrs) Modelling and optimizing a problem by considering both the technical and economical aspects. Applications on a power distribution network.

Course title	Code	No. of credits	Number of hours per week			
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Measuring, data acquisition and processing systems	SEA102	6	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 preprocessing; 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			
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Electric energy quality monitoring	SEA103	6	1		1	1

Course description (Syllabus): Power Quality - Problems and Solutions; Advanced techniques for Quality of Electrical Energy Monitoring ; Voltage variation – Classifications, statistical estimation, indexes; Voltage Dips and Short Supply Interruptions; Distortion Regime – Sources, Effects, Regulations, in Nonsinusoidal Regime; Frequency Variation – Electrical Energy Quality Indicators; Techniques of Monitoring the Electrical Energy Quality Indicators, Statistical methods of analysis, Techniques of aggregation.

Course title	Code	No. of credits	Number of hours per week			
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Dynamic models for energy conversion	SEA104	6	1		1	1

Course description (Syllabus): Initial value problems for equations in differential-algebraic form. Algorithms of mixing numerical integration methods and elimination methods for solving differential-algebraic equations. The physical orthogonal axis model of electric machines. The differential and algebraic equations of the generalized orthogonal axis mathematical model of synchronous machine and induction machine, respectively. The „flux linkages-currents" algebraic correlations. Ways of selecting the state variables with a view to offline and online assessment, respectively. The winding flux linkage state-space model. The winding current state-space model. Class of mixed current-flux state-space models. Incorporating the effects of main flux path saturation. Dynamic (differential) inductances. Interconnected systems. Energy control center. Functions of the energy management systems. Development of high-order predictor methods for online contingency analysis.

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Electrical power converter's control	SEA105	6	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 technics,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 technics: Six step inverter, sinusoidal PWM, Space Vector PWM. Control of the induction machine: Model of the induction machine using the space vestors,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 modullation , 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**
CAD for electrical systems	SEA106	6	1		2	

Course description (Syllabus): Optimizing the electrical equipment using SCILAB: SCILAB data types; Matrix Operations; Programming; 2D and 3D Graphs; Interfacing C or Fortran programs with SCILAB; Applications in electrical domain.

Course title	**Code**	**No. of credits**	**Number of hours per week**			
			course	**seminar**	**laboratory**	**project**
Electrical energy storage systems	SEA107	6	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 modeling , 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**
Testing to conducted electromagnetic disturbances	SEA108	6	1		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, modeling and simulation, mitigation techniques; Immunity to radiofrequency electromagnetic disturbances; Simulation of the disturbances produced by a real electric network: burst, surge, harmonics and interharmonics, unbalance; Equipment immunity testing to harmonics, flicker and voltage variation; Reduction of conducted disturbances: methods and tools.

Course title	**Code**	**No. of credits**	**Number of hours per week**			
			course	**seminar**	**laboratory**	**project**
Energy stability analysis and management	SEA109	6	2		1	1

Course description (Syllabus): Basic concepts regarding the stability of power systems; Modeling the component elements of the power system: sincron generator, three phase transformers, electric lines; Stability of sincron generator to small disturbances; Transition stability of sincron generator connected to infinite power network; Voltage stability and voltage instability: Factors that contribute to voltage collapse; Load characteristics of the radial transmission systems; Establishing the load characteristics for a simple radial transmission system; Stability criteria: $d\Delta Q/dU$; dE/dU; dQG/dQL; Frequency stability and regulation; Balancing in the power system; primary and secondary power control; Stability in dispersed generation systems at distribution level; Energy management applying to electric systems.

Course title	**Code**	**No. of credits**	**Number of hours per week**			
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Smart electrical grids	SEA110	6	2		1	1

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

2nd YEAR

Course title	**Code**	**No. of credits**	**Number of hours per week**			
			course	**seminar**	**laboratory**	**project**
CAD/CAE in power electronics	SEA201	6	1		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, modeling and simulations of power electronics converters.

The course content covers the following main issues: Design and modeling aspects of the main DC-DC power electronics converters; Modeling and design of power semiconductors; Modeling and design of thermal circuits for power electronic converters; Snubber circuits for power semiconductors. Gate drive circuits and protection systems for power electronic converters;

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Micro hydroelectric power plants	SEA202	6	2		1	

Course description (Syllabus): Introduction; The importance of hydroelectricity in the renewable energy sources area; Micro hydro power plant; Definition of micro hydro power plants (MHPP). MHPP situation in Romania. Green certificates for MHPP. Hydro electric potential categories; MHPP base technology; Types of accumulation. MHPP power calculation. Hydraulic turbines. Electrical generators. Electro-mechanical equipment development. Auxiliary equipment; Autonomous MHPP; The opportunity of using the induction generator. Parameters control. Single-phase operation; MHPP 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			
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Wind power plants	SEA203	6	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.

Course title	Code	No. of credits	Number of hours per week			
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Electronic interfaces for power systems	SEA204	6	1		1	1

Course description (Syllabus): RES based Distributed Power Generating Systems . PV Interfaces Wind System Interfaces Other Distributed Generators: Microturbines; ICE based generators; Fuel Cells**;** Control structures of power electronics for DPGS**;** Grid supporting converters**;** HDVC Power Transmission systems

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Solar power plants and hybrid energy systems	SEA205	6	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; Lead-Acid Battery 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
Research practical stage and dissertation	SEA206	6	10 weeks. X 16 hours = 160 hours

Course description (Syllabus): Module A: Electric machines and drives;Module B: Electrical convertors; Module C: Monitoring and prediction in operation of electrical systems; Module D: Systems for production, transport and distribution of electrical energy; Module E: Storrage and recovery the energy; Module F: Electromagnetic compatibility and energy quality; Module G: Materials and senzors; The research stage is organized in Research Institute of the Unoversity and in others reaearch institution in which the object of research in in compliance with the modules subjects.