Syrian Arab Republic

Higher Institute for Applied Sciences and Technology

HIAST

Course Specification Document

Title	Power Electronics

Credits	4.5 ECTS

Aims	This course aims to enable the student to analyze and understand the operation of the electrical power drive and power converter and to sensibilize him to the design stage by studying the effect of every element on the quality of the output under variable loads and their impact on the power network.

Intended learning outcomes

On successful completion of this course, the student will be able to:

- Master the methodology of analyzing nonlinear power converters.
- Understand the mutual effect between consecutive power circuits and how to analyze them independently.
- Understand and calculate the effect of different topology on the electrical network.
- Know the critical operating conditions and their impact on the design process.
- Always ensure design and hardware measurements coherence.
- Apply multi-level modeling to approach the physical realization.
- Use power measurement devices effectively.
- Create a reliable design.
- Draw the equivalent circuit for each stage and carefully and accurately label and direct all variables.

Syllabus

- **Introduction (a review of the basic concepts):** Instantaneous and average electrical power, power factor of linear and nonlinear loads, dissipation in power components, equation of thermal diffusion, approximate methods for solving thermal propagation, thermal-electrical equivalence, application to thermal propagation from a power device.
- **Uncontrollable AC-DC converters:** Diode modeling and methodology for studying nonlinear circuits, case study with inductive load and back emf, application of the methodology to full bridge rectifier with inductive loads & back emf, case with a smoothing capacitor, grid current and pf. three-phase rectifier, linear voltage regulators and their impact on the rectification stage.
- **Thyristors and synchronous rectification:** Thyristor static characteristics, dynamics limitation, thyristors family, gate drive methods, forced turn-off, basic rectifier circuits using the steady-state analysis methodology, full and mixed three-phase bridges, complementary thyristor bridges to drive a dc motor in 4-quadrants.

- **Switching DC-DC converters:** Fundamental topology with transformer (forward and flyback converters in continuous and discontinuous conduction) and without transformer (analysis of buck/boost converter in CC and DC), output ripple and influence of input and output capacitors.
- **DC-AC converter**: Basic topologies, analysis of full bridge topology, sine PWM modulation, current waveform, output filter and harmonies.
- **Switching devices characteristics and driving circuits:** Revision of diodes and transistors families, how to read technical datasheets and compare devices, switching on and off timing of transistor, some driving circuits for bjt, mosfet and igbt, switching loose calculation.
- **Dynamic modeling of choppers:** Quasi-model using average technique, exact model using state analysis, application to buck converter, controller design.