ECE 411 – Power Electronics

Credits: 4, **Contact Hours:** Two 75 minute lecture sessions per week, one 160 minute laboratory session per week.

Coordinator: M. Krishnamurthy, Associate Professor of ECE

Textbook: Daniel W. Hart, Power Electronics, McGraw-Hill Education; 1st edition (January 22, 2010) ISBN-10: 0073380679

2019 Catalog Data: ECE 411: Power Electronics. Credit 4.
Power electronic circuits and switching devices such as power transistors, MOSFETs, SCRs, GTOs, IGBTs, and UJTs are studied. Their applications in AC/DC, DC/DC, DC/AC, and AC/AC converters as well as switching power supplies and UPS systems are explained. Simulation mini-projects and lab experiments emphasize power electronic circuit analysis, design, and control.

Prerequisites or co-requisites by topic: ECE 311

Enrollment: Senior Level Elective Course

Specific outcomes of instruction:
Given a complex electrical and computer engineering challenge (e.g., navigate a maze, follow a line, win "Mint Shuffle"), each student should be able to perform the following tasks by the end of the course.

1. Given a power semiconductor device such as power diodes, Thyristors, power transistors, power MOSFETs, Diac, Triac, GTOs, IGBTs, and UJTs, draw the *v-i* characteristics and analyze the switching behavior.
2. Given a power electronic circuit including power diodes and Thyristors, determine time intervals when the semiconductor devices are ON and OFF, draw the equivalent circuits for ON and OFF time intervals, analyze the circuit, and find RMS, average, harmonics, THD, and CF of the current and voltage signals.
3. Given a half-wave/full-wave controlled/uncontrolled single-phase AC/DC rectifier, find the voltage and current waveforms and analyze the equivalent circuits.
4. Given a half-wave/full-wave controlled/uncontrolled three-phase AC/DC rectifier, find the voltage and current waveforms and analyze the equivalent circuits.
5. Derive and apply the relevant equations of DC/DC converters: Buck, Boost, and Buck-Boost converters in continuous-conduction and discontinuous-conduction mode of operation.
6. Derive and apply the relevant equations of DC Switching Power Supplies: Flyback and Forward converters in continuous-conduction and discontinuous-conduction mode of operation.
7. Given a PWM/square-wave, single-phase/three-phase DC/AC inverter, find the voltage and current waveforms and analyze the equivalent circuits.
8. Derive and apply the relevant equations of single-phase and three-phase AC voltage controllers including power diodes and Thyristors.
9. Carry out an independent project using simulation tools, identifying context of the problem, approach chosen, projected timeline and tools used.
10. Develop a time-constrained presentation based on independent term project and present it to an audience. Highlight all lessons learned from the project and explain any deviations.

Relationship of ECE 411 specific outcomes of instruction to student outcomes:

	Student Outcomes	**Course Goals**
1	An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	1,2,3,4,5,6, 7, 8
2	An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	1,2,3,4,7,9
3	An ability to communicate effectively with a range of audiences	10
4	An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts	9
5	An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	1,2,3,4,5,6, 7, 8
6	An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	9, 10
7	An ability to acquire and apply new knowledge as needed, using appropriate learning strategies	9

Topics:

- Introduction to power electronics and Power semiconductor devices (2 weeks)
- Power computations and definitions, modeling, and simulations (1 week)
- Rectifiers: Half-wave uncontrolled and controlled, full-wave uncontrolled and controlled; three-phase uncontrolled and controlled rectifiers with and without filters (3 weeks)
- AC/AC Converters, AC voltage controllers (1 week)
- DC/DC converters: Buck, Boost and Buck-boost converters (2 weeks)
- DC power supplies: Flyback and Forward Converters (1 week)
- DC/AC inverters: Single-phase and three-phase converters (2 weeks)

Prepared by: M. Krishnamurthy **Date:** February 28, 2020