The University of Jordan
School of Engineering
Electrical Engineering Department
2nd Semester – A.Y. 2020/2021

Course: **Power Electronics – 0943461 (3 Cr. – Required Course)**

Instructor: Dr. Mohammed Haj-Ahmed
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Office Hours: Will be posted soon

Course website: http://elearning.ju.edu.jo/

Catalog description: Basic elements of power electronic systems. Applications of power electronics. Classification of power electronic controllers. Power semiconductor devices (PSD). Classification of PSD. V-I characteristics of the major PSD. Switching characteristics of PSD. Basic drive circuits of PSD. Line commutated converters. Single-phase half-wave rectifiers. Single-phase full-wave rectifier configuration. Three-phase half-wave and full-wave rectifiers. Single-phase and three-phase semi-converters. Inversion mode of operation. Performance characteristics of line commutated rectifiers. Introduction to AC switching controllers. Introduction to DC-to-DC converters. Introduction to DC-to-AC converters.

Prerequisites by course: **EE** **0903361** Electronics (II) (pre-requisite)

Prerequisites by topic: Students are assumed to have a background in the following topics:
- Electrical circuit analysis techniques.
- Electronics and semiconductor fundamentals.
- Fourier series, Fourier transform and signal analysis.

Textbook: **Power Electronics: Circuits, Devices & Applications by Muhammad H. Rashid, Pearson, 4th edition, 2013.**

References:

1. Power Electronics: Converters, Applications, and Design by Ned Mohan, Tore M. Undeland and William P. Robbins, Wiley, 3rd Edition, 2002.
2. Elements of Power Electronics by Philip Krein, 2nd edition, Oxford University Press, 2014.
3. Power Electronics: A First Course by Ned Mohan, 1st edition, Wiley, 2011.
4. Power Electronics by Daniel W Hart, 1st edition, McGraw-Hill Education, 2010.
5. Fundamentals of Power Electronics by Robert W. Erickson and Dragan Maksimovic, Springer, 2nd Edition, 2001.
6. A Hundred Solved Problems in Power Electronics by Euzeli C. dos Santos Jr. and Gregory Carlos, Independent Publishing, 1st Edition, 2015.
7. Principles of Electric Machines with Power Electronic Applications by Mohamed E. El-Hawary, Wiley-IEEE Press, 2nd edition, 2002.

8. Transformers and Inductors for Power Electronics: Theory, Design and Applications by W.G. Hurley and W.H. Wölfle, Wiley, 1st edition, 2013.

Schedule: 16 Weeks, 42 lectures (50 minutes each) plus exams.

Course goals: The overall objective is to introduce the student to the theme and merits of power electronics as a modern power conditioning tool. Several power semiconductor switching devices are introduced along with their trigerring and drive circuits. Waveform construction and rectification is addressed, along with the details of invereters, AC voltage regulators and DC choppers.

Course learning outcomes (CLO) and relation to ABET student outcomes (SO):

Upon successful completion of this course, a student will: **[SO]**

1. Understand the role of power electronics in power conditioning systems and applications, and realize their merits and drawbacks compared to conventional alternatives. **[4, 7]**
2. Be able to assess the waveforms quality factors of both AC and DC signals. **[1, 4]**
3. Be familiar with symbols, ratings, classifications and characteristics of power electronic switches, such as: diodes, power transistors, thyristors, etc. **[1]**
4. Be able to design and practically implement the triggering circuit of silicon-controlled rectifiers. **[1, 2]**
5. Understand the operation of single-phase and three-phase rectifiers under different loading conditions. And be able to calculate their performance parameters at both the load and supply sides. **[1]**
6. Be familiar with inverter circuits, AC voltage regulators, and DC choppers, their design and their control topologies. **[1, 2]**

Course topics:

Hrs

1. Introduction to Power Electronics: The concept of power electronics, applications, merits and drawbacks, and converter classifications. Power semiconductor switches: features, classifications and comparisons. AC & DC waveforms quality assessment. Examples. **8**
2. Silicon-Controlled Rectifiers (SCRs): Construction and two-transistor equivalent model of an SCR. Static and dynamic characteristics of SCR switches. Gate characteristics and triggering circuitry design of SCRs. **6**
3. Rectification Process and Rectifier Circuits: Single-phase half-wave and full-wave rectifiers (controlled & uncontrolled). Three-phase half-wave and full-wave rectifiers (controlled & uncontrolled). Single-phase and three-phase semi-controlled rectifiers. This includes power circuit configuration, triggering signals and conduction pattern, principle of operation, waveform construction, analysis and solution for resistive, inductive and highly-inductive loading conditions, performance evaluation both at load and supply sides. **18**
4. Introduction to DC-to-DC Converters (DC Choppers): Classification and basic power circuit configurations, control topologies and waveform construction, analysis and performance parameters of basic chopper circuits. **3**
5. Introduction to DC-to-AC Converters (Inverters): Basic power circuit configurations, control topologies and waveforms construction, analysis and performance parameters of basic inverter circuits. **4**

6. Introduction to AC-to-AC Converters (AC Voltage Regulators): AC semi-conductor switches, basic power circuit configuration, waveform construction and performance parameters. **3**

Ground rules: Attendance is required and highly encouraged. To that end, attendance will be taken every lecture. Eating and drinking are not allowed during class, and cell phones must be set to silent mode. All exams (including the final exam) should be considered cumulative. Exams are closed book. No scratch paper is allowed. You will be held responsible for all reading material assigned, even if it is not explicitly covered in lecture notes.

Assessment & grading policy:

Assignments	0%	Quizzes	0%
First Exam	20%	Projects	10%
Midterm Exam	30%	Lab Reports	0%
Final Exam	40%	Presentation	0%
		Total	**100%**

Last Revised: March 2021