ELEC4305 COURSE CATALOG INFO

Course Code : ELEC4305				**Course Name :** Power Electronics			
Semester	**Lecture (Le+T+L)**	**Local Credit**	**ECTS**	**Language**	**Category**	**Instructional Methods**	**Prerequisites**
7	(3+0+0)	3	5	English	Elective	Lecture	ELEC3301 OR ELEC3305
Course Content	Multi-disciplinary nature of power electronics. Power switches (diodes, thyristors, transistors, IGBT, MOSFET, etc.) and their characteristics. Basics of power electronic conversion: switching matrix, power converter definitions. Hard switching dc-dc converters, converters with isolation, voltage transfer characteristics, analysis, design, control. Soft switching and resonant converters, EMI issues. Basic hard switched dc-ac conversion and characteristics, sinusoidal PWM, multi-phase multi-level converters. Basic ac-dc conversion, fully controlled, half controlled, and uncontrolled rectifiers. Harmonics, power quality, filtering.						
Course Outcomes	**CO 1.** Employing the knowledge of circuit theory and fast semiconductor switches, understand the switching rules and develop circuit topologies that will provide useful energy conversion. Recognize the types of power electronic conversion and map them to real life energy system applications. **CO 2.** Apply the basic mathematical and engineering knowledge to power electronic conversion problems. **CO 3.** Perform the analysis of basic power electronic conversion systems. Discontinuous and continuous mode analysis, harmonic spectrum analysis, average model based analysis etc. **CO 4.** Utilizing advanced simulation software, investigate the performance of power converters, Evaluate the simulation data to assess the performance and the characteristics of the converters. Develop control model for the converters for the purpose of controlling them in the energy conversion applications such as power supplies, motor drives, renewable energy systems.						

COURSE PLAN	
W1	Introduction: applications, multidisciplinary nature of power electronics, fields of power electronics, etc. (Chapter 1 of Mohan) DC/DC, DC/AC, AC/AC conversion types
W2	Principles of Power Electronics: Switching rules, basic operating rules for switching circuits, volt-seconds rule, ampere-seconds rule, periodical solutions, the switching matrix, switch requirements, unidirectional and bidirectional switches, etc. (Chapter 1 and chapter 3 of Mohan)
W3	Power semiconductor overview, diodes, thyristors, power transistors, ideal and real switches, capability limits
W4	DC/DC Converters (Chapter 7) Basic converter topologies, Voltage input-output function derivations
W5	DC/DC Converters (Chapter 7) Converter behavior (continuous/discontinous operating modes)
W6	DC/DC Converters (Chapter 7) Full-bridge DC/DC converter, Unipolar/Bipolar Modulation, MIDTERM
W7	DC/DC converters (Chapter 10) SMPS: DC/DC converters with isolation (flyback, forward, isolated push-pull, half, full bridge converters)
W8	DC/DC converters (Chapter 10) Modelling and control of DC/DC converters: state-space averaging, voltage/current mode control, cascade control
W9	Hard/Soft Switching Concepts, Transistor Snubbers (Chapter 24,25,26, 27)
W10	DC/DC Converters (Chapter 9/27) Snubbers continued, Commutation techniques: Hard switching and soft switching, ZVS, ZCS, Resonant Converters (resonant load, quasi-resonant, resonant transition), other commutation techniques, MIDTERM

W11	DC/AC Converters (Inverters) (Chapter 8) Basics voltage source inverter, current source inverter, single phase half and full (H) bridge inverter
W12	DC/AC Converters (Inverters) (Chapter 8) H-bridge inverter analysis, modulation, sinusoidal PWM, harmonic spectrum, optimal PWM, phase displacement control
W13	DC/AC Converters (Inverters) (Chapter 8, handouts) Three phase voltage source inverters, basic topology, six step operating mode, scalar modulation, sinusoidal PWM, voltage linearity, harmonics spectrum, triplen harmonic injection PWM
W14	Rectifiers (Chapter 5,6 Mohan, 2,3 Lander): Rectifier principles, single switch, uncontrolled, semi controlled, multi-phase and multi-winding configurations, manalysis

Textbook: N. Mohan, T. M. Undeland, W.P. Robbins, **Power Electronics,** John Wiley Publishing Co., 2003. (Media Enhanced Third Edition (International))

Supplementary: **Textbooks:**
P. T. Krein, **Elements of Power Electronics**, Oxford University Press, 1998.
J.G. Kassakian, M.F. Schlecht, G.C. Verghese, **Principles of Power Electronics**, Addison Wesley, 1992.
R.W. Erickson and D. Maksimovic, **Fundamentals of Power Electronics**, Kluwer, 2001.
B. J. Baliga, **Power Semiconductor Devices**, PWM Publishing Co., 1996.
Cyril W. Lander, **Power Electronics**, McGraw-Hill, 1993, Third Edition.
Abraham I. Pressman, **Switching Power Supply Design**, 1998.

COURSE ASSESMENT AND ECTS WORK LOAD			
Type of Work	**Count**	**ECTS WORK LOAD**	
		Time (Hour)(Including prep. time)	**Work Load**
Attendance	14	3	42
Final Exam	1	20	20
Quizzes		10	10
Term project			
Reports			
Seminar			
Assignments			
Presentation			
Midterms		20	20
Project			
Laboratory			
Tutorial			
Other(Self study, Paper reviews)		30	30
		Total work load	122
		ECTS Credit (Load/25)	5

PROGRAM OUTCOMES - COURSE OUTCOMES RELATIONS		
PO	**Program Outcomes**	**CO**
1	**1.1.** Adequate knowledge in fundamentals of mathematics (algebra, differential equations, integrals, probability etc), science (physics, chemistry, biology etc.) and computer science (programming and simulation);	
	1.2. ability to use theoretical and applied knowledge in these areas in complex engineering problems.	1,2
2	**2.1.** Ability to identify, formulate, and solve complex engineering problems;	3,4
	2.2. ability to select and apply proper analysis and modeling methods for this purpose.	3,4
3	**3.1.** Ability to design and integrate components of a complex system or process, as they relate to Electrical and Electronics Engineering discipline, under realistic constraints	

	and conditions, in such a way as to meet desired requirements;	
	3.2. ability to apply modern design methods.	
4	**4.1.** Ability to devise, select, and use techniques and tools needed for analyzing and solving complex problems encountered in engineering practice;	
	4.2. ability to employ information technologies effectively.	
5	**5.1.** Ability to design experiments,	
	5.2. ability to conduct experiments, gather, analyze and interpret data.	
6	**6.1.** Ability to work in intra-disciplinary teams;	
	6.2. ability to work in multi-disciplinary teams;	
	6.3. ability to take individual responsibilities.	
7	**7.1.** Ability to effectively communicate via written and oral means;	
	7.2. knowledge of at least one foreign language;	
	7.3. ability to write effective reports and comprehend written reports;	
	7.4. ability to write design and manufacturing reports	
	7.5. ability to present effectively,	
	7.6. ability to give and follow clear instructions.	
8	**8.1.** Recognition of the need for lifelong learning;	
	8.2. ability to access information, to follow developments in science and technology, and to continue to educate him/herself.	
9	**9.1.** Consciousness to behave according to ethical principles, and about professional and ethical responsibility;	
	9.2. knowledge on standards used in engineering practice.	
10	**10.1.** Knowledge about business life practices such as project management, risk management, and change management;	
	10.2. awareness in entrepreneurship, innovation;	
	10.3. knowledge about sustainable development.	
11	**11.1.** Knowledge about the global and social effects of engineering practices on health, environment, and safety, and contemporary issues of the century reflected into the field of engineering;	
	11.2. awareness of the legal consequences of engineering solutions.	

Revison Date	**Prepared by**	**Approved by**
1.9.2021	Prof. Dr. Ahmet Masum Hava	Prof.Dr. Ahmet Aksen