Course Information

Course Code	5670464
Course Section	1
Course Title	STATIC POWER CONVERSION II
Course Credit	3
Course ECTS	5.0
Course Catalog Description	Introduction to forced commutated circuits, analysis, classification of techniques. Centretap inverter. Voltage-fed inverters; waveshaping; PWM, stepped and square-waveforms, voltage regulation, harmonics. Current-fed inverters; analysis, effect of SCR turn-off time on voltage waveform, overlap. DC-DC switching converters; time-ratio control, effect of loading, parameter optimization. Device failure mechanisms. Thermal considerations, maximum ratings, protection of switching elements. Series and parallel operation of switching elements.
Prerequisites	Students must complete one of the following sets to take this course.

Set	Prerequisites
1	5670463

Schedule	Tuesday , 14:40 - 16:30, - Thursday , 15:40 - 16:30, -

Instructor Information

Name/Title	Assist.Prof.Dr OZAN KEYSAN
Office Address	C-113
Email	keysan@metu.edu.tr
Personal Website	http://keysan.me
Office Phone	
Office Hours	Wednesday 15:40-16:30

Course Objectives

Students will be able to comprehend basic dc-dc converter topologies and their operating characteristics. Students will be able to comprehend the need for and the utilization of isolated dc-dc converter topologies and their operating characteristics. Students will be able to comprehend basic dc-ac converter topologies and their operating characteristics, harmonic characteristics.

Course Learning Outcomes

Determine the basic dc-dc converter topologies, obtain their pwm waveforms and derive their voltage transfer characteristics. Determine continuous and discontinuous operation modes and their conditions. Size filter components for mode of operation.

Determine the basic isolation requirements and derive the isolated converter topologies from the basic topologies and derive their voltage transfer characteristics. Determine continuous and discontinuous operation modes and their conditions. Size the isolation transformers and filter components for given mode of operation.

Characterize the inverter output voltage waveforms, calculate the fundamental component and for square wave mode of operation, evaluate the distortion. Characterize the inverter output voltage waveforms for pwm mode of operation, investigate the harmonic spectrum. Extend the concept from single to three-phase applications and evaluate the control and power flow issues.

Program Outcomes Matrix

Undergraduate

		Level of Contribution			
	Program Outcomes	**0**	**1**	**2**	**3**
1	Foundations: understanding of and ability to apply fundamental science and engineering of permanent value (ABET Criteria 3a, 3b, 3e and 3k)			X	
2	Breadth: familiarity with the diverse areas of Electrical and Electronics Engineering (ABET Criteria 3a, 3b)				X
3	Depth: ability to apply in depth knowledge of one or more specializations within the diverse fields of Electrical and Electronics Engineering (ABET Criteria 3a, 3b, 3c, 3e)			X	
4	Design: ability to participate in creative, synthetic, integrative activities of EE design (ABET Criteria 3c and 3e)			X	
5	Life-long learning: desire and ability to keep learning throughout life (ABET Criteria 3i)				X
6	Communication skills: ability to express ideas persuasively, in written and oral form (ABET Criteria 3g)				X
7	Social skills: ability to work with others, in professional and social settings (ABET Criteria 3d)				X
8	Global view: appreciation of diversity in the world and in intellectual areas (ABET Criteria 3h and 3j)			X	
9	Professional ethics: ability to recognize and appreciate importance of ethical standards in professional work (ABET criteria 3f)				X

0: No Contribution **1:** Little Contribution **2:** Partial Contribution **3:** Full Contribution

Instructional Methods

- *Lectures*
- Computer Simulations
- Hardware Project
- *In class examples*

Tentative Weekly Outline

Week	Topic	Relevant Reading	Assignments
1	Introduction to forced commutated circuits, Gate Turn-Off devices, DC/DC, DC/AC, AC/AC conversion, review of basic power electronics concepts	Chapter 1-4 Mohan	
2	Gate Turn Off Power Semiconductors (Chapter 21-22) Power Transistors: BJT, MOSFET, IGBT, IGCT, Switching pole, hard switching v-i trajectories	Mohan	
3	DC/DC Converters (Chapter 7) Basic converter topologies, Voltage input-output function derivations	Chapter 7	HW1
4	DC/DC Converters (Chapter 7) Converter behavior (continuous/discontinous operating modes)	(Chapter 7)	HW1

Week	Topic	Relevant Reading	Assignments
5	DC/DC Converters (Chapter 7) Converter behavior (continuous/discontinous operating modes)	(Chapter 7)	HW1
6	DC/DC Converters (Chapter 7) Full-bridge DC/DC converter, Unipolar/Bipolar Modulation	(Chapter 7)	HW2
7	DC/DC converters (Chapter 10) SMPS: DC/DC converters with isolation (flyback, forward, isolated push-pull, half, full bridge converters)	(Chapter 10)	HW3
8	DC/DC converters (Chapter 10) Modelling and control of DC/DC converters: state-space averaging, voltage/current mode control, cascade control (H-bridge converter controlled DC motor drive)	(Chapter 10)	HW3
9	DC/AC Converters (Inverters) (Chapter 8) Basics voltage source inverter, current source inverter, single phase half and full (H) bridge inverter	(Chapter 8)	HW4
10	DC/AC Converters (Inverters) (Chapter 8) H-bridge inverter analysis, modulation, sinusoidal PWM, harmonic spectrum, optimal PWM, phase displacement control	(Chapter 8)	HW4
11	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	(Chapter 8, handouts)	HW5
12	DC/AC Converters (Inverters) (Chapter 8, 11, 18, handouts) Space vector modulation, switching pattern optimization, optimal PWM, PWM rectifier, single switch boost PFC rectifier, inverter and rectifier applications, industrial inverter drives, UPS systems, control of inverters.	(Chapter 8, 11, 18, handouts)	HW5
13	Hard/Soft Switching Concepts, Transistor Snubbers (Chapter 24,25,26, 27)	(Chapter 24,25,26, 27)	HW6
14	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	(Chapter 9/27)	HW6

Course Textbook(s)

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

Course Material(s) and Reading(s)

Material(s)

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.

Reading(s)

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.

Supplementary Readings / Resources / E-Resources

Resources

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.
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Abraham I. Pressman, **Switching Power Supply Design**, 1998.

Assessment of Student Learning

Assessment	Dates or deadlines
Midterm and Final Exams	
Homework assignment evaluations	
Term project evaluation	

Course Grading

Deliverable	Grade Points
Midterm Exam I	20
Final Exam	30
Homework Assignments	25
Course Project	20
In Class Activities	5
Total	100

Course Policies

Class Attendance

Active participation is encouraged, and there will be a few pop-quizes

Late Submission of Assignments

No late submissions, and all projects will be submitted through Github.com and ODTUClass

Information for Students with Disabilities

To obtain disability related academic adjustments and/or auxiliary aids, students with disabilities must contact the course instructor and the ODTÜ Disability Support Office as soon as possible. If you need any accommodation for this course because of your disabling condition, please contact me. For detailed information, please visit the website of Disability Support Office: http://engelsiz.metu.edu.tr/

Academic Honesty

The METU Honour Code is as follows: *"Every member of METU community adopts the following honour code as one of the core principles of academic life and strives to develop an academic environment where continuous adherence to this code is promoted. The members of the METU community are reliable, responsible and honourable people who embrace only the success and recognition they deserve, and act with integrity in their use, evaluation and presentation of facts, data and documents."*