POWER ELECTRONICS (ENGLISH)

Course Syllabus

Class Meeting: Tuesday Class 3-4 and Thursday Class 1-2 for lectures.
Friday Class 7-8 and 9-10 for seminars.
Refer to course schedule for details. Changes, if any, will be announced in advance.

Classroom: E. 330 East-1 Building for lectures
1206, 2203, 2204 & 2205 Center-2 Building for seminars

Instructors: LIU Jinjun, 82667870, jjliu@mail.xjtu.edu.cn
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Offices: W. East-2 Building (Department of Industrial Automation, School of E. E.)

TA Team: A team of graduate students coordinated by HUANG Zhiheng (18653606569, striver@stu.xjtu.edu.cn)

TA Offices: The Graduate Students' Hall, PEREC (No. 3 Building, iHarbor Campus)

Office Hours: TBD

Text Books: N. Mohan, T. M. Undeland, W. P. Robbins. Power electronics: converters, applications, and design. 3rd edition, John Wiley & Sons, New York, USA, 2003; Higher Education Press, Beijing, China, 2004
LIU Jinjun and WANG Zhaoan. *Power Electronics*, 6th edition, China Machine Press, Beijing, China, 2022 (in Chinese)

Website: **http://syxt.xjtu.edu.cn**, **pel-course.xjtu.edu.cn** (for backup and reference)

Lecture Notes: Both English and Chinese lecture notes are available on the course websites.

Objective: This is an introduction course to the Power Electronics discipline and is lectured in English. The objective is to develop understanding of power semiconductor devices and power conversion techniques for electric power processing and control. The typical power semiconductor devices include power diode, thyristor, Power MOSFET, and IGBT. Understanding of the basic physics of operation, major characteristics, driving and protection circuits of these devices is necessary. Understanding the topologies and operation principles of various power converters (including rectifiers, inverters, DC-DC converters, AC-AC converters, AC-DC-AC frequency changers, and switching power supplies etc.) and understanding basic Pulse Width Modulation techniques is the focus part of this course. Basic analysis and design for rectifier circuits, DC-DC converters, and inverters and basic understanding of soft-switching techniques are also required.

Grading:

Homework + Lab + quiz	20%
Seminars	30%
Final Exam	50%

Important Notice: Discussion of the course material and homework/seminar assignments with fellow students, teaching assistants, and instructor is encouraged, but the problem solutions must be student's individual work. Copying/sharing any part of the solutions from/with other students is not allowed.

XJTU Tentative Course Schedule

Course **Power Electronics (English)**

Instructors **LIU Jinjun, WEI Yuqi, LI Yitong, LIU Zeng, ZHANG Yan**

Week	Date	Form	Content
1	9.10	Lecture 1	**Introduction**
1	9.12	Lecture 2	**Power Electronics Devices** Introduction to Power Electronics Devices Power Diode
2	9.17	Holiday	
2	9.19	Lecture 3	Thyristor
3	9.24	Lecture 4	Typical Fully-Controllable Devices Other New Power Electronics Devices Power Integrated Circuits and Integrated Power Electronic Modules
3	*9.26*	*Lecture Void*	*Preparing for Seminar 1：Introduction and Power Electronics Devices*
4	9.29	Seminar 1	**Introduction and Power Electronics Devices** 1. Identify a power electronic equipment **2.** Understand power electronic devices by simulation
4	10.1	Holiday	
4	10.3	Holiday	
5	10.8	Lecture 5	**AC to DC Converters (Rectifiers)** Single-Phase Controlled Rectifier
5	10.10	Lecture 6	Three-Phase Controlled Rectifier
6	10.15	Lecture 7	Influence of Transformer Leakage Inductance to rectifier circuit Uncontrolled Rectifier with Filter Capacitor
6	10.17	Lecture 8	Input Harmonics and Power Factor of Rectifier circuit High Power Controlled Rectifier
7	10.22	Lecture 9	Inversion Mode Operation of Rectifier circuit Realization of Phase Control in Rectifier Circuits
7	*10.24*	*Lecture Void*	*Lab1 Three-Phase Full Bridge Rectifier*
8	*10.29*	*Lecture Void*	*Preparing for Seminar 2：AC to DC Converters*
8	10.31	Lecture 10	**DC to AC Converters (Inverters)** Commutations Voltage Source Inverter
8	11.1	Seminar 2	**AC to DC Converters (Rectifiers)** **1.** Understand three-phase rectifier by simulation **2.** Study uncontrolled bridge rectifier supplying RC load by simulation
9	11.5	Lecture 11	Current Source Inverter Connection of Multiple Inverters Multi-Level Inverter
9	*11.7*	*Lecture Void*	*Preparing for Seminar 3: DC to AC Converters*
9	11.8	Seminar 3	**DC to AC Converters (Inverters)** 1. Study an inverter consists of 2 H-bridges in series by simulation 2. Understand three-phase bridge Voltage-Source-Inverter by simulation
10	11.12	Lecture 12	**DC to DC Converters (Choppers and isolated DC-DC converters)** Basic DC to DC converters Composite DC to DC converters
10	11.14	Lecture 13	Isolated DC to DC converters
11	*11.19*	*Lecture Void*	*Lab2 DC to DC Converters* *Preparing for Seminar 4: DC to DC Converters*
11	11.21	Lecture 14	**Ac to AC Converters** Phase-Controlled AC Controller Other AC Controllers

Week	Date	Form	Content
11	11.22	Seminar 4	**DC to DC Converters (Choppers and isolated DC-DC converters)** 1. Understand Buck/Boost converter by simulation 2. Understand isolated DC-DC converter by simulation
12	11.26	Lecture 15	Cycloconverter Matrix Converter
12	*11.28*	*Lecture Void*	*Preparing for Seminar 5: AC to AC Converters*
12	11.29	Seminar 5	**AC to AC Converters** 1. Understand phase-controlled AC voltage controller by simulation 2. Understand AC voltage controller under chopping-control by simulation 3. Make comparison between the above two converters.
13	12.3	Lecture 16	**PWM Techniques** Basic Principle of PWM
13	12.5	Lecture 17	PWM Methods for Inverters PWM Methods with Feedback Control PWM Methods for Rectifiers
14	*12.10*	*Lecture Void*	*Lab4 Single-Phase AC-DC-AC Converter* *Preparing for Seminar 6: PWM Techniques*
14	12.12	Lecture 18	**Soft-Switching Techniques** Basic Concept of Soft-Switching Classification of Soft-Switching Techniques Typical Soft-Switching Circuits
14	12.13	Seminar 6	**PWM Techniques** 1. Understand three-phase PWM Voltage-Source-Inverter by simulation 2. Understand single-phase full bridge PWM Voltage-Source-Converter by simulation
15	*12.17*	*Lecture Void*	*Preparing for Seminar 7: Soft-Switching Techniques*
15	12.19	Lecture 19	**Applications of Power Electronics**
15	12.20	Seminar 7	**Soft-Switching Techniques** 1. Analyze power losses of hard-switching Buck converter by simulation 2. Understand quasi-resonant Buck converter and analyze power losses by simulation
16	12.24	Lecture 20	**Practical Application Issues of Power Semiconductor Devices** **Review and Summary**
16	*12.26*	*Lecture Void*	*Lab3 Half Bridge Switching-Mode Power Supply* *Preparing for Seminar 8: Applications of Power Electronics & Practical Application Issues*
16	12.27	Seminar 8	**Applications of Power Electronics** **Practical Application Issues of Power Semiconductor Devices** Conceptual design of a power electronic equipment for a specific application