课程详述

COURSE SPECIFICATION

以下课程信息可能根据实际授课需要或在课程检讨之后产生变动。如对课程有任何疑问，请联系授课教师。

The course information as follows may be subject to change, either during the session because of unforeseen circumstances, or following review of the course at the end of the session. Queries about the course should be directed to the course instructor.

1.	**课程名称 Course Title**	**储能科学基础** **Fundamentals of Energy Storage Science**
2.	**授课院系** **Originating Department**	机械与能源工程系 Department of Mechanical and Energy Engineering
3.	**课程编号** **Course Code**	ME377
4.	**课程学分 Credit Value**	3
5.	**课程类别** **Course Type**	专业核心课 Major Core Courses
6.	**授课学期** **Semester**	春季 Spring
7.	**授课语言** **Teaching Language**	中英双语 English & Chinese
8.	**授课教师、所属学系、联系方式（如属团队授课，请列明其他授课教师）** **Instructor(s), Affiliation& Contact** **（For team teaching, please list all instructors）**	李文甲，助理教授，机械与能源工程系 Email：liwj@sustech.edu.cn Li Wenjia, Assistant Professor, Department of Mechanical and Energy Engineering, Email：liwj@sustech.edu.cn
9.	**实验员/助教、所属学系、联系方式** **Tutor/TA(s), Contact**	待公布 To be announced
10.	**选课人数限额(可不填)** **Maximum Enrolment（Optional）**	

11. 授课方式 Delivery Method	讲授 Lectures	习题/辅导/讨论 Tutorials	实验/实习 Lab/Practical	其它(请具体注明) Other（Please specify）	总学时 Total
学时数 Credit Hours	44		4		48

12. 先修课程、其它学习要求 Pre-requisites or Other Academic Requirements	ME304 能源工程基础或 ME273 能源科学基础 ME304 Fundamentals of Energy Engineering or ME273 Introduction to Energy Science
13. 后续课程、其它学习规划 Courses for which this course is a pre-requisite	
14. 其它要求修读本课程的学系 Cross-listing Dept.	

教学大纲及教学日历 SYLLABUS

15. 教学目标 Course Objectives

本课程旨在为学生提供基本的能源储存知识和各类储能技术的最新发展现状，使他们能够理解不同类型的储能原理和技术，掌握如电池、电解池、超级电容器、压缩空气储能等常见储能系统的工作原理和应用领域，以及如何评估和选择适当的储能解决方案。此外，课程还强调储能技术对可再生能源集成和能源可持续性的重要性，培养学生的实际问题解决能力，并激发他们对可再生能源存储与转换技术的兴趣和意识。

This course aims to provide students with fundamental knowledge of energy storage and the latest developments in various energy storage technologies. It enables them to understand different types of energy storage principles and technologies, grasp the working principles and application areas of common energy storage systems such as batteries, electrochemical cells, supercapacitors, and compressed air energy storage, as well as learn how to evaluate and select appropriate energy storage solutions. Furthermore, the course emphasizes the importance of energy storage technologies in renewable energy integration and energy sustainability, fostering students' practical problem-solving skills and igniting their interest and awareness in renewable energy storage and conversion technologies.

16. 预达学习成果 Learning Outcomes

1. 理解并掌握能源存储和转换过程中的基本原理；
2. 熟悉不同储能系统的基本过程以及关键技术；
3. 熟悉储能系统的最近研究进展；
4. 了解储能系统集成，管理和应用；
5. 了解储能系统的未来发展方向和能源互联网

1. Understand and master the fundamental principles of energy storage and conversion processes.
2. Familiarize with the basic processes and key technologies of various energy storage systems.
3. Acquire knowledge of recent research developments in energy storage systems.
4. Understand the integration, management, and application of energy storage systems.
5. Gain insight into the future directions of energy storage systems and the concept of the energy internet.

17. 课程内容及教学日历 （如授课语言以英文为主，则课程内容介绍可以用英文；如团队教学或模块教学，教学日历须注明主讲人）
Course Contents (in Parts/Chapters/Sections/Weeks. Please notify name of instructor for course section(s), if this is a team teaching or module course.)

1. 储能科学绪论（6 学时）

- 国际能源结构及碳中和政策
- 国内外可再生能源利用现状
- 储能的基本概念及原理
- 储能对可再生能源高效利用的意义
- 储能系统的基本分类
- 储能系统的基本分析方法

1. Introduction to energy storage technology (6 credit hours)

- International energy structure and carbon neutral policy
- Current situation of renewable energy utilization at home and abroad
- Basic concept and principle of energy storage
- Significance of energy storage for efficient utilization of renewable energy
- Basic classification of energy storage system
- Basic analysis method of energy storage system

2. 机械储能（4 学时）

- 机械储能基本概念和原理
- 气体介质的压缩空气储能
- 液体介质的抽水蓄能
- 固体介质的飞轮储能

2. Mechanical Energy Storage (4 credit hours)

- Basic concepts and principles of mechanical energy storage
- Compressed air energy storage with gaseous medium
- Pumped hydro energy storage with liquid medium
- Flywheel energy storage with solid medium

3. 电磁储能（2 学时）：

- 超级电容器的基本概念、储能原理及应用
- 超导电-磁储能系统的基本概念及原理

3. Electrical Energy Storage (2 credit hours)

- Basic concepts, storage principles, and applications of super capacitors
- Basic concepts and principles of superconducting magnetic energy storage systems

4. 电化学储能（10 学时）

- 电化学储能的基本概念和原理
- 储能电池的基本结构及分类
- 传统储能电池（铅酸电池、镍铬/镍氢电池、纽扣电池）
- 锂离子电池
- 液流电池
- 金属空气电池
- 新型电燃料储能技术（E-Fuel）
- 其他新型电化学储能技术（钠硫电池）
- 传统电池与新型电池在储能领域应用的技术比对

4. Electrochemical Energy Storage(10 credit hours)

- Basic concepts and principles of electrochemical energy storage
- Basic structure and classification of energy storage battery
- Traditional energy storage battery (lead-acid battery, nickel chromium/nickel hydrogen battery, button battery)
- Lithium ion battery
- Flow battery
- Metal air battery
- New electric fuel energy storage technology (e-fuel)
- Other new electrochemical energy storage technologies (sodium sulfur battery)
- Technical comparison between traditional battery and new battery in energy storage field

5. 燃料储能（10 学时）

- 燃料储能基本概念和原理
- 燃料储能化学物质分类
- 氢储能（电解水制氢、光电催化制氢、太阳能热化学燃料合成、燃料电池）
- 二氧化碳还原制燃料技术（光催化二氧化碳还原、电催化二氧化碳还原）
- 固氮与合成氨技术
- 其他新型燃料储能技术介绍

5. Fuel Energy Storage (10 credit hours)

- Basic concepts and principles of fuel energy storage
- Classification of fuel energy storage chemicals
- Hydrogen energy storage (hydrogen production by electrolysis of water, hydrogen production by photocatalysis, solar thermochemical fuel synthesis, fuel cell)
- Carbon dioxide reduction to fuel technology (photocatalytic carbon dioxide reduction, electrocatalytic carbon dioxide reduction)

- Nitrogen fixation and ammonia synthesis technology
- Introduction of other new fuel energy storage technologies

6. 热能储能（6 学时）

- 热能储能的基本概念及原理
- 热能存储的方式和技术
- 常见的储热储冷技术及应用（建筑冷热负荷）

6. Thermal Energy Storage(6 credit hours)

- Basic concept and principle of thermal energy storage
- Ways and technologies of thermal energy storage
- Common heat and cold storage technology and application (building cooling and heating load)

7.储能系统管理集成与比较分析（4 学时）

- 储能系统与现有电网集成技术
- 储能系统的成本-效率分析
- 储能系统的应用与全生命周期分析

7. Energy Storage System Management, Integration, and Comparative Analysis (4 credit hours)

- Integration in the electricity sector
- Cost efficiency analysis of energy storage system
- Application and life cycle analysis of energy storage system

8. 储能技术未来发展方向和能源互联网（2 学时）

- 储能技术未来发展方向及展望
- 能源互联网

8. Future development of energy storage technology and energy Internet (2 credit hours)

- Future development of energy storage technology
- Energy Internet

9.课程演示实验（4 学时）

演示实验 1：电解水制氢示范实验 （2 学时）

演示实验 2：液流电池示范实验 （2 学时）

9. Course demonstration experiment (4 credit hours)

Demonstration Experiment 1: demonstration experiment of hydrogen production from electrolytic water (2 credit hours)

Demonstration Experiment 2: flow battery demonstration experiment (2 credit hours)

18. 教材及其它参考资料 Textbook and Supplementary Readings

[1] Michael Sterner, Ingo Stadler, Handbook of Energy Storage: Demand, Technologies, Integration, Springer, 2019, ISBN: 978-3-662-55503-3

[2] Robert A. Huggins, Energy Storage Fundamentals, Materials and Applications, 2nd edition, Springer, 2015, ISBN: 978-3-319-21238-8

[2] 郭韵. 储能原理与技术[M]. 哈尔滨工业大学出版社, 2022.

[3] 梅生伟. 储能技术[M], 机械工业出版社, 2022.

课程评估 ASSESSMENT

19.

评估形式 Type of Assessment	评估时间 Time	占考试总成绩百分比 % of final score	违纪处罚 Penalty	备注 Notes
出勤 Attendance	每次课程开始 Beginning of each class	15%		
课堂表现 Class Performance				
小测验 Quiz	随堂 In class quiz	15%		
课程项目 Projects				
平时作业 Assignments				
期中考试 Mid-Term Test				
期末考试 Final Exam	学期末 End of course	70%		
期末报告 Final Presentation				
其它（可根据需要改写以上评估方式） Others (The above may be modified as necessary)				

20. 记分方式 GRADING SYSTEM

☑ A. 十三级等级制 **Letter Grading**
☐ B. 二级记分制（通过/不通过） **Pass/Fail Grading**

课程审批 REVIEW AND APPROVAL

21. 本课程设置已经过以下责任人/委员会审议通过
This Course has been approved by the following person or committee of authority