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**	**光伏发电技术 Photovoltaic Power Generation Technology**
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**	ME381
4.	**课程学分 Credit Value**	3
5.	**课程类别 Course Type**	专业选修课 Major Elective Courses
6.	**授课学期 Semester**	秋季 Fall
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）**	丘龙斌，机械与能源工程系，qiulb@sustech.edu.cn Longbin Qiu, Department of Mechanical and Energy Engineering, qiulb@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	48				48

12.	先修课程、其它学习要求 Pre-requisites or Other Academic Requirements	固体与半导体物理（ME272）
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

到 2030 年，必须从低碳能源中产生可持续发展所需的电力，以将大气中的二氧化碳浓度控制在当前科学共识认为“风险较低”的水平。开发低碳能源不仅代表了巨大的技术和工程挑战，而且在日益增长的能源市场中也带来了同样巨大的前景。

学生将学习太阳能电池将光转化为电能的原理，能量转换的效率极限及理论基础，制造太阳能电池的工艺，测试表征太阳能电池的性能，目前主流的技术，以及如何评价现有的和新兴太阳能电池技术的风险和潜力。我们将讲述当前的技术（单晶和多晶硅、CdTe、CIGS、CPV），以及新兴的技术（有机、仿生、有机/无机杂化钙钛矿，和基于纳米结构的太阳能电池）的潜力和缺点。动手实验室课程探索太阳能电池在实践中的工作原理。我们将学习如何提高太阳能电池的性能和降低成本，以及规模化应用的主要障碍——技术和经济。学生将应用这些知识来开发一个关于他们选择的太阳能相关主题的课堂项目。

By the year 2050, energy supply for sustainable development must be generated from low-carbon sources to cap atmospheric CO_2 concentrations at levels deemed "lower-risk" by the current scientific consensus. The necessity to develop low-carbon energy sources represents not only an awesome technological and engineering challenge, but also an equally large economic opportunity in a huge energy market.

Students will learn how solar cells convert light into electricity, how solar cells are manufactured, how solar cells are evaluated, what technologies are currently on the market, and how to evaluate the risk and potential of existing and emerging solar cell technologies. We examine the potential & drawbacks of currently manufactured technologies (single- and multicrystalline silicon, CdTe, CIGS, CPV), as well as pre-commercial technologies (organics, biomimetic, organic/inorganic hybrid, and nanostructure-based solar cells). Hands-on laboratory sessions explore how a solar cell works in practice. We will learn how to enhance solar cell performance and reduce cost, and the major hurdles–technological and economic–towards widespread adoption. Students will apply this knowledge towards developing a class project on the solar-related topic of their choosing.

16. 预达学习成果 Learning Outcomes

1. 描述光伏器件（和能量转换效率）的主要原理。
2. 熟悉目前主流的技术，并列出每种技术的优缺点，并设计成本模型。
3. 了解规模化应用光伏部署的主要限制，以及可能的采用的策略和技术。
4. 将上述内容应用于实际项目，评估技术、经济和社会方面之间的权衡。

1. Describe the principal phenomena governing the function (and conversion efficiency) of a PV device.
2. List currently commercialized technologies, and list strengths, weaknesses of each, and develop a cost model.
3. Identify limitations to terrawatt-scale deployment, and possible enabling strategies and technologies.
4. Apply the above to a real-world project, evaluating complex trade-offs between technology, economics, and social aspects.

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. 前言：太阳能技术框架。Class Introduction; Solar Technology Framework. (2 学时)
2. 太阳能及标准太阳光谱。The Solar Resource; "Standard Solar Spectra." (2 学时)
3. 光学调控：入射光吸收及光学损失。Light Management: Light Absorption and Optical Losses (2 学时)
4. 光生载流子激发过程。Charge Excitation. (2 学时)
5. 光生载流子：电荷分离过程 I。Charge Separation I. (2 学时)
6. 光生载流子：电荷分离过程 II。Charge Separation II. (2 学时)
7. 器件基础。Device Fundamentals. (2 学时)
8. 影响器件性能的材料性质。Materials Properties Affecting Performance (2 学时)
9. 电荷提取与收集过程。Charge Extraction and Collection. (2 学时)
10. 硅基太阳能电池 I。Silicon Solar Cells I. (2 学时)

项目问题定义（授课时间以外）。Define the problems for the course project (outside of normal class time).

11. 硅基太阳能电池 II。Silicon Solar Cells II. (2 学时)
12. 薄膜太阳能电池 I。Thin Film Solar Cells I. (2 学时)
13. 薄膜太阳能电池 II。Thin Film Solar Cells II. (2 学时)
14. 理论光电转换效率：细致平衡原理。Theoretical Photoelectric Efficiency Limits: Detailed Balance Limitation. (2 学时)

项目进展检查。Project progress check-in.

15. 光电转换效率模拟：等效电路。Simulation of Power Conversion Output: Equivalent Circuit. (2 学时)
16. 光电转换效率模拟：漂移扩散方程。Simulation of Power Conversion Output: Drift Diffusion Equation. (2 学时)
17. 新兴光伏技术。Emerging Technologies. (2 学时)

项目进展检查。Project progress check-in.

18. 光电能量转换效率损失的机制 I：体缺陷态密度。Troubleshooting Photoelectric Conversion Efficiency Losses: defect density of bulk. (2 学时)
19. 光电能量转换效率损失的机制 II：界面电荷复合。Troubleshooting Photoelectric Conversion Efficiency Losses: interfacial charge recombination. (2 学时)
20. 光伏系统建造与成本。Cost and Manufacturability. (2 学时)

项目进展检查。Project progress check-in.

21. 组件：结构与制造技术。Modules: Structures and Fabrication Techniques. (2 学时)
22. 组件，系统与可靠性分析。Modules, Systems, and Reliability. (2 学时)
23. 光伏价格，市场与补贴。Price, Markets, and Subsidies. (2 学时)
24. 期末项目汇报。Student Project Presentations. (2 学时)

合计：48 学时

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

《太阳电池基础与应用（第 2 版）》，朱美芳，熊绍珍，科学出版社 2014 年

PV education, https://www.pveducation.org/pvcdrom/welcome-to-pvcdrom/instructions

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		5		
课堂表现 Class Performance				
小测验 Quiz		25		

课程项目 **Projects**				
平时作业 **Assignments**		40		
期中考试 **Mid-Term Test**				
期末考试 **Final Exam**				
期末报告 **Final Presentation**		30		
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