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**	微加工与微系统 Microfabrication and Microsystems
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**	ME335
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**	春季学期 Spring Semester
7.	**授课语言** **Teaching Language**	英文 English
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）**	胡程志，助理教授，机械与能源工程系，Email: hucz@sustech.edu.cn Chengzhi Hu, Assistant Professor, Department of Mechanical and Energy Engineering, Email: hucz@sustech.edu.cn
9.	**实验员/助教、所属学系、联系方式** **Tutor/TA(s), Contact**	许鑫贵，助教，机械与能源工程系，Email：11849279@mail.sustech.edu.cn Xu Xingui, Department of Mechanical and Energy Engineering Email：11849279@mail.sustech.edu.cn
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	40	4	4		48

12. 先修课程、其它学习要求 Pre-requisites or Other Academic Requirements	CH101B General Chemistry B 化学原理 B PHY105B General Physics II B 大学物理 B(下)
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

微加工与微系统是机械与能源工程系本科生与研究生专业选修课。其他学科专业具备相应基础知识且有兴趣的学生可以选修。本课程的先修课程有化学原理 B 与大学物理 B(下)。
本课程的主要任务是通过各个教学环节及教学手段使学生掌握常用面向微机电系统，微机器人，微电子器件，微流体器件，芯片实验室，生物传感器等微系统工作原理，设计准则，加工工艺与方法。培养学生设计加工新型微传感器，微执行器，微系统的基本能力。为以后从事微器件与微系统等方向的工程技术工作、科学研究工作以及开拓新技术领域奠定基础。

Microfabrication and Microsystems is a major elective course for undergraduate and graduate students in the Department of Mechanical and Energy Engineering. Students from other majors who have appropriate basic knowledge and are interested can take courses. The prerequisite courses are General Chemistry B and General Physics B.

The objective of this course is to teach the working principles, design, and processing techniques of microsystems that are commonly used as micro-electromechanical systems, microrobots, microelectronic devices, microfluidic devices, lab-on-a-chips, biosensors, etc. Meanwhile, it is obligated to train students the basic capabilities in design and process of new microsensors, microactuators, and other microsystems. The course will also lay a foundation for future engineering, scientific research and development of new technologies in the direction of microdevices and microsystems.

16. 预达学习成果 Learning Outcomes

通过对本课程的学习，学生将学习微尺度物理效应，了解微系统常用材料并熟悉多种广泛用于微机器人，微流体器件，芯片实验室，生物传感器等微系统设计，制备工艺与方法。

After completing this course, students will understand several physical laws in microscale, the commonly used materials for microsystems, and will be familiar with the system design, processing techniques of several types of microsystems, such as microrobots, microfluidic devices, lab-on-a-chips and biosensors.

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.)

课程内容	教学要求	学时分配
绪论 • 介绍微系统及基本原理 • 微尺度控制 • 微系统应用 Introduction • Overview of microsystems and their working principles • Control issues at micro scale • Applications of microsystems	了解微系统、微感应器、微机器人的基本原理，以及在不同的微系统下的微流控技术 Understand the working principle of microsensors, microactuators, microrobots, and microfluidic control technology in various types of microsystem	2
微型化中的按比例缩小法则 • 按比例缩小法则简介 • 几何结构的按比例缩小 • 静电力中的缩比特性 • 电磁力的缩比特性 • 流体力学中的缩比特性 • 电学中的缩比特性 Scaling Laws • The scaling law of different physical parameters • The scaling characteristic in electrostatic force • The scaling characteristic of electromagnetic force • The scaling characteristic in fluid mechanics • The scaling characteristic in electricity	了解比例缩小法则，以及在不同领域的应用 Understand the scaling law and its application in different fields	2
微系统设计中的工程力学 • 微尺度静电力 • 范德华力 • 表面张力 • 不同微观力的微系统中的应用 Forces • Electrostatic forces at microscale • Van de Waals Force • Surface Tension • Forces at microscales and their engineering applications	了解微系统中存在的力，并学会分析微系统中的力 Understand the forces present in the microsystem and learn to analyze the forces present in the microsystem	2
磁场理论 • 磁耦 • 铁磁性 • 电磁公式 Magnetism • Magnetic Dipole • Ferromagnetism • The equations of electromagnetism	掌握磁场的基本理论。了解磁学中基本概念和麦克斯韦方程组 Understand the basic theory of magnetic field; Understand the basic concepts in magnetism Understand the Maxwell equations in Electromagnetism	2
磁力磁矩磁场 • 应力张量 • 能量各向异性 • 形状各向异性 • 永磁材料和软磁材料计算磁力磁矩方法 • 电磁场计算 Magnetic force, torque, and field • Stress tensor	掌握磁力,磁矩,磁场的相关理论 Understand relevant theories of magnetic force, magnetic torque and magnetic field 掌握工程电磁场设计准则 Understand the design principle for engineering electromagnetic fields	4

• Anisotropy energies • Shape anisotropy • Magnetic force and torque for permanent magnet and soft magnet		
液体 • 纳维-斯托克斯方程 • 雷诺数 • 菲克扩散定律 Liquid • Navier-Stokes equation • Reynolds numbers • Fick's law	掌握液体中的纳维-斯托克斯方程，及微流体扩散对流的理论，了解不同雷诺数下流体运动特性 Understand the navier-stokes equation in liquid Understand the theory of microfluid diffusion and convection Understand the fluidic dynamics for different Reynold Number fluid.	2
用于微系统的材料 • 有源衬底材料 • 硅的化合物 • 砷化镓 • 石英 • 聚合物 Materials for microsystems • Active substrate material, • silicon compound • gallium arsenide • quartz • polymer	掌握微系统中使用的材料，以及材料的性质和应用 Understand the materials used in Microsystems, their properties and applications	4
微系统加工工艺 • 光刻 • 离子注入 • 扩散 • 氧化 • 化学气相沉积 • 物理气相沉积 • 外延沉积 • 腐蚀 Microfabrication • Lithography • ion implantation • diffusion • oxidation • chemical vapor deposition • physical vapor deposition • epitaxial deposition • corrosion	掌握微系统的多种加工工艺方法 Learn the multiple processing and fabrication methods of microsystem	8
微加工与微系统课程回顾 中期报告 Review of previous lectures on microfabrication and microsystems Mid Report	总结前期微加工与微系统课程 中期报告 Review of previous lectures on microfabrication and microsystems Mid Report	2
观察设备 • X 射线衍射 • 扫描电子显微镜 • 透射电子显微镜 Observation Tools • XRD • SEM • TEM	掌握多种材料的微尺度观测方法 Understand several observation methods of materials at micro scale	4
微系统仿生学设计 • 生物界微尺度运动 • 鞭毛运动 • 绒毛运动	了解多种微生物运动方法 Understand the motion principles for several microorganism	2

Biomimetics for Microsystems • Motion at microscale in nature • Motion by Flagella • Motion by cilia		
新型微纳米机器人设计，制备，与应用 • 自驱动微纳米机器人 • 外部驱动微纳米机器人 Microrobotics • self-driven micro-/nano- robots • externally driven micro-/nano-robots	了解微纳米机器人的设计制备工艺及应用 Understand the design process and application of micro-/nanorobot	4
实验室训练 Lab Training	了解微加工环境，几种常用微加工设备培训（光刻机等） Familiar with environment for microfabrication, Training on several microfabrication equipment, such as mask aligner.	2
新型微流体器件设计，制备，与应用 • 微流体控制 • 微流体驱动 • 细胞微流控芯片 • 线虫微流控芯片 Microfluidic chips • Microfluidic control • microfluidic drive • cell microfluidic chip • nematode microfluidic chip	掌握微流体器件的设计及制备工艺及其在生物医疗领域应用 Understand microfluidic device design and fabrication process, and their applications on biological and biomedical field	4
新型微传感器与微执行器设计，制备，与应用 • 压力传感器 • 应变传感器 • 陀螺仪 • 磁致伸缩 • 电致伸缩 • 形状记忆合金 • 水凝胶 Microsensors and Microactuators • Force sensor • strain sensor • gyroscope • magnetostrictive material • electrostrictive materials • shape memory alloy • smart hydrogel	掌握微传感器与微执行器的设计与制备方法 Design and preparation of microsensor and microactuator	2
学生微系统设计项目终期汇报 Final report from students working a microsystem project	对微加工、微系统有新的理解，对存在的问题有自己的解决思路和方法 Have a new understanding of microfabrication and microsystem, and have their own solutions to existing problems	2

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

南方科技大学 SOUTHERN UNIVERSITY OF SCIENCE AND TECHNOLOGY

Tai-Ran Hsu，MEMS and Microsystems: Design，Manufacture and Nanoscale Engineering，Second Edition

John Wiley & Sons 2008

Marc J. Madou，Fundamentals of Microfabrication and Nanotechnology，2011 CRC Press

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		10%		
课堂表现 Class Performance				
小测验 Quiz		10%		
课程项目 Projects		30%		
平时作业 Assignments				
期中考试 Mid-Term Test				
期末考试 Final Exam				
期末报告 Final Presentation		50%		
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