

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	功能软材料 3D 打印 – 基础、工程与应用 3D Printing of Functional Soft Materials: Fundamentals, Engineering and Applications				
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	ME364				
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)	刘吉 机械与能源工程系 liuj9@sustech.edu.cn Liu Ji Department of Mechanical and Energy Engineering liuj9@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 (2 个助教，负责实验仪器操作部分的材料准备等)				
10.	选课人数限额(可不填) Maximum Enrolment (Optional)	N. A.				
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	44			学生课堂报告 4 课时	48

Credit Hours

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<p>12. 先修课程、其它学习要求 Pre-requisites or Other Academic Requirements</p>	<p>MSE001 材料科学与工程基础 Fundamentals of Materials Science and Engineering 或者 ME261 工程材料—科学、工艺与设计 Engineering Materials - Science, Processing and Design</p>
<p>13. 后续课程、其它学习规划 Courses for which this course is a pre-requisite</p>	
<p>14. 其它要求修读本课程的学系 Cross-listing Dept.</p>	

教学大纲及教学日历 SYLLABUS

15. 教学目标 **Course Objectives**

3D 打印是一种快速成形技术，它以数字模型文件为基础，通过逐层打印的方式来构造物体。3D 打印技术，涉及信息技术、材料科学、精密机械等多个方面，该技术已逐步投入到工业应用。而多学科交叉的软材料科学是材料学和工程学最为活跃的领域之一。本课程从介绍软材料的不同 3D 打印技术出发，阐述新型 3D 打印技术在功能软材料加工领域的应用。在回答“如何 3D 打印软材料”和“3D 打印软材料有什么用”的同时，阐述通过对软材料的设计和 3D 打印去解决生活中的关键问题。

The 3D printing process builds a three-dimensional object from a computer-aided design model, usually by successively adding material layer by layer. Currently, 3DP has been used as a key technology in a variety of areas, including information technology, material science, precision machinery, aerospace, biomedical engineering, and further applied in industrial manufacturing.

Soft materials are one of the most active fields in material science and engineering science. This course (3D Printing of Functional Soft Materials: Fundamentals, Engineering and Applications) will systematically introduce the basic principles for various 3D printing techniques for functional soft materials, as well as fundamentals behind the printing techniques of soft materials. In addition to lectures in classroom, laboratorial skills on 3D printing of functional soft materials will also be delivered.

Students are supposed to understand “what is soft material 3D printing for?” “how are soft materials 3D printing used?” by learning to solve those grand challenges in our society via the design and 3DP engineering of emerging soft materials.

16. 预达学习成果 **Learning Outcomes**

- 1) 能解释软材料的基本概念、原理、种类和应用；
 - 2) 能初步掌握各类软材料打印技术，并参与实验设计与实验室操作
 - 3) 能初步掌握特定应用领域，如生物医用、环境、信息和能源科学等，对软材料的特殊需求，以及为满足需求的软材料的 3D 打印加工；
 - 4) 初步具备对于 3D 打印软材料的某一前沿领域的调查研究、分析总结以及大胆评论的能力。
 - 5) 具有在讨论和团队作业中的合作能力。
- 注：以上结果可以通过小组讨论、课堂讨论、课后和课堂作业、实验室操作以及期中期末报告等环节测量。
- By the end of this course, the students will be able to
- 1) Explain the fundamental concepts, mechanism, catalogue and application of soft materials;
 - 2) Master the printing techniques for soft material engineering, participate the material design and laboratory 3DP machine operation;

3) Master the specific application of 3D printed soft materials, such as biomedical engineering, environmental, information and energy science, the requirement and solutions for soft materials printing;

4) Process the capability to do literature research on the application of 3D printed soft materials in a specific field, make summary and come with perspective insights;

5) Discuss within a team work with collaborative skills;

Note: all these outcomes will be evaluated during subgroup discussion, homework, laboratory equipment manipulation, mid-term and final-term assessment.

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. 软材料 3D 打印概论 (4 学时) Introduction to Soft Materials 3D Printing (4 credit hours)
 - 1.1 软材料的概念 Introduction to Soft Materials
 - 1.2 传统软材料加工手段 Traditional Processing Technology of Soft Materials
 - 1.3 3D 打印优势 Advantages of 3D Printing Technologies
 - 1.4 3D 打印发展史 Brief History of 3D Printing
2. 软材料的化学性质(4 课时) Chemical Aspects of Soft Materials (4 credit hours)
 - 2.1 高分子的合成方法 Traditional Polymerization Methods
 - 2.2 功能高分子化学 Chemical Properties of Functional Polymers
3. 软材料的物理性质(4 课时) Physical Aspects of Soft Materials (4 credit hours)
 - 3.1 高分子链结构 Polymer Chain Structures
 - 3.2 高分子链动力学 Polymer Chain Dynamics
4. 熔融沉积制造(4 课时) Fusion Deposition Manufacturing (4 credit hours)
 - 4.1 熔融沉积制造原理 Processing Mechanism of FDM
 - 4.2 高分子相变与熔融态 Polymer Phase Change and Melting
 - 4.3 仪器操作与教学 (1 课时) Equipment Demonstration
5. 墨水直写打印(4 课时) Direct Ink Writing (4 credit hours)
 - 5.1 墨水直写打印原理 Processing Mechanism of DIW
 - 5.2 高分子溶液 Polymer Solution
 - 5.3 剪切变稀 Shear Thinning
 - 5.4 动态网络 Dynamic Network
 - 5.5 仪器操作与教学 (1 课时) Equipment Demonstration
6. 喷墨打印(4 课时) Inkjet Printing (4 credit hours)
 - 6.1 喷墨打印原理 Processing Mechanism of Inkjet Printing
 - 6.2 实验室操作与教学 (1 课时) Laboratory Demonstration
7. 中期报告(4 课时) Mid-term Report (4 credit hours)
8. 光固化式打印(4 课时) Stereolithography (4 credit hours)
 - 8.1 光固化式打印原理 Processing Mechanism of SLT

- 8.2 仪器操作与教学 (1 课时) Equipment Demonstration
- 9. 数字光处理式打印(4 课时) Digital Light Processing (4 credit hours)
 - 9.1 数字光处理式打印原理 Processing Mechanism of DLP
 - 9.2 仪器操作与教学 (1 课时) Equipment Demonstration
- 10. 功能软材料 3D 技术(4 课时) Functional 3D Printing of Soft Materials (4 credit hours)
 - 10.1 多材料打印 Multiple Material Printing
 - 10.2 高速打印 High Speed Printing
 - 10.3 4D 打印 4D Printing
 - 10.4 生物打印 Bioprinting
- 11. 3D 打印功能软材料应用(4 课时) Applications of 3D-Printed Functional Soft Materials (4 credit hours)
 - 11.1 生物医用与组织工程 Biomedical and Tissue Engineering
 - 11.2 柔性电子 Flexible Electronics
 - 11.3 软体机器人 Soft Robotics
 - 11.4 航空航天 Aerospace
 - 11.5 储能 Energy Storage
- 12. 期末报告(4 课时) Final Term Report (4 credit hours)

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

教材/Textbook

Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, Gibson Ian, Rosen David and Stucker Brent, Springer, 2010.

其它参考资料/Supplementary Readings

1. Printing on Polymers Fundamentals and Applications, Joanna Izdebska, Elsevier, 2016
2. 3D printing of soft robotic systems, R. F. Shepherd, Nature Reviews Materials, 3,84-100(2018)
3. Direct ink writing of 3D functional materials. Jennifer Lewis, Advanced Functional Materials 16 (2006): 2193-2204.
4. Inkjet printing-process and its applications. Madhusudan Singh, Advanced Materials 22 (2010): 673-685.
5. A review on stereolithography and its applications in biomedical engineering. Dirk W. Grijpma, Biomaterials 31 (2010): 6121-6130.
6. Additive manufacturing of biologically-inspired materials. Studart, André R. Chemical Society Review, 45.(2016): 359-376.
7. Principles of Polymer Chemistry, Paul J. Flory, 1962.
8. Michael Rubinstein, Ralph H. Colby. Polymer Physics (2003).

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		20		
课堂表现 Class		10		

Performance				
小测验 Quiz				
课程项目 Projects				
平时作业 Assignments		30		
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)	3D 打印机仪器操作与 教学 Equipment Demonstration	10		

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

机械与能源工程系教学委员会

