

## 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.	<b>课程名称 Course Title</b>	增材制造与设计 Additive Manufacturing and Design
2.	<b>授课院系 Originating Department</b>	机械与能源工程系 Department of Mechanical and Energy Engineering
3.	<b>课程编号 Course Code</b>	ME462
4.	<b>课程学分 Credit Value</b>	3
5.	<b>课程类别 Course Type</b>	专业选修课 Major Elective Courses
6.	<b>授课学期 Semester</b>	秋季 Fall
7.	<b>授课语言 Teaching Language</b>	中英双语 English & Chinese
8.	<b>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 &amp; Contact (For team teaching, please list all instructors)</b>	白家鸣 机械与能源工程系 baijm@sustech.edu.cn Jiaming Bai Department of Mechanical and Energy Engineering
9.	<b>实验员/助教、所属学系、联系方式 Tutor/TA(s), Contact</b>	待公布 To be announced
10.	<b>选课人数限额(可不填) Maximum Enrolment (Optional)</b>	

11. 授课方式 Delivery Method	讲授	习题/辅导/讨论	实验/实习	其它(请具体注明)	总学时
	Lectures	Tutorials	Lab/Practical	Other (Please specify)	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	ME302 机械制造基础 Fundamentals of Manufacturing
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

介绍增材制造及设计的概念及相关技术，教学目标主要包括：

1. 各种增材制造标准工艺的基础和前沿发展，及增材制造在各工业领域的应用和案例研究：汽车，航空航天，医疗，消费品等。
2. 增材制造的设计理念，技术和分析方法，包括拓扑优化设计及仿真模拟的应用。
3. 课程完成后，学生能够充分了解及应用最前沿的增材制造技术，材料选择，设计和优化及其应用领域。

This module will introduce and develop the concepts and techniques for Additive Manufacturing. The module will emphasise on:

1. The fundamentals and cutting-edge development of the various ASTM Additive Manufacturing technologies and will highlight applications and case studies from the Additive Manufacturing industries in the following areas: Automotive, Aerospace, Medical, Consumer goods, etc.
2. The advanced design concepts, techniques and analysis methodologies like design topology optimisation and simulation on their design prior to additive manufacturing.
3. Upon completion, participants should be able to apply the execution of concept and skills acquired in the areas of Additive Manufacturing, material selection, design and optimisation and their applications.

#### 16. 预达学习成果 Learning Outcomes

本课程介绍各种增材制造标准工艺的基础和前沿发展，讲解增材制造的设计理念，技术和分析方法，让学生能够充分了解及应用最前沿的增材制造技术，材料选择，设计和优化及其应用领域，同时培养学生能够熟悉问题定义、科学研究、分工协作等能力。

The fundamentals and cutting-edge development of the various ASTM Additive Manufacturing technologies and will highlight applications and case studies from the Additive Manufacturing industries. The advanced design concepts, techniques and analysis methodologies like design topology optimisation and simulation on their design prior to additive manufacturing. Upon completion, participants should be able to apply the execution of concept and skills acquired in the areas of Additive Manufacturing, material selection, design and optimisation and their applications.

#### 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
<p>增材制造概述 Overview of Additive Manufacturing</p> <ul style="list-style-type: none"> <li>- What is additive manufacturing</li> <li>- Why use the term additive manufacturing</li> <li>- The benefits of AM</li> <li>- Current trends and implications of AM</li> <li>- Distinction between AM and CNC machining</li> <li>- Generalized AM process chain</li> <li>- Industry impact and applications</li> </ul>	<ul style="list-style-type: none"> <li>- Understand the definition of AM.</li> <li>- Understand the current trends and implications of AM.</li> <li>- Understand the industry impact and applications of AM.</li> </ul>	2
<p>增材制造标准工艺 (I) ASTM AM Processes (I)</p> <ul style="list-style-type: none"> <li>- Vat photo-polymerization               <ul style="list-style-type: none"> <li>• Photopolymerisation materials;</li> <li>• Optics;</li> <li>• Machine Hardware;</li> <li>• Applications</li> </ul> </li> <li>- Powder bed fusion process               <ul style="list-style-type: none"> <li>• Materials</li> <li>• Powder Fusion Mechanisms</li> <li>• Process parameters and Modelling</li> <li>• Applications</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>- Understand the background of stereolithography and selective laser sintering.</li> <li>- Understand the process and application of stereolithography and selective laser sintering.</li> </ul>	4
<p>增材制造标准工艺 (II) ASTM AM Processes (II)</p> <ul style="list-style-type: none"> <li>- Materials Extrusion               <ul style="list-style-type: none"> <li>• Basic principles</li> <li>• Hardware</li> <li>• Materials</li> <li>• Other materials extrusion technologies</li> </ul> </li> <li>- Materials jetting               <ul style="list-style-type: none"> <li>• Continuous and drop-on-demand jetting</li> <li>• Thermal and piezoelectric actuation</li> <li>• Jetting materials</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>- Understand the background of materials extrusion and materials jetting.</li> <li>- Understand the type of materials of materials extrusion and materials jetting.</li> <li>- Understand the other materials extrusion technologies.</li> <li>- Understand the continuous and drop-on-demand jetting methods.</li> </ul>	4
<p>增材制造标准工艺 (III) ASTM AM Process (III)</p> <ul style="list-style-type: none"> <li>- Binder jetting               <ul style="list-style-type: none"> <li>• Working principles</li> <li>• Materials</li> <li>• Process benefits and drawbacks</li> </ul> </li> <li>- Directed energy deposition               <ul style="list-style-type: none"> <li>• DED process description</li> <li>• Material delivery systems</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Understand the process of Binder Jetting.</li> <li>• Understand the importance of the infiltration step in the Binder Jetting process.</li> <li>• Know the different beam energy sources and feedstock types.</li> <li>• Know the advantages and disadvantages of the direct energy deposition process.</li> </ul>	6



<ul style="list-style-type: none"> <li>• Typical materials and microstructure</li> <li>- Sheet lamination processes</li> <li>• Background and working principal</li> <li>• Laminated object manufacture</li> <li>• Ultrasonic additive manufacturing</li> </ul>	<ul style="list-style-type: none"> <li>• Understand the applications for the direct energy deposition process.</li> <li>• Understand the process of laminated object manufacture and ultrasonic additive manufacturing.</li> </ul>	
<p>增材制造的数据处理链 Data processing chain in AM</p> <ul style="list-style-type: none"> <li>- Data processing chain</li> <li>- STL files</li> <li>- Build Orientation</li> <li>- Support structures</li> </ul>	<ul style="list-style-type: none"> <li>• Understand the Data processing chain in 3D printing.</li> <li>• Understand the issues need to be aware of during the modeling process.</li> </ul>	2
<p>增材制造设计 Design for Additive Manufacturing</p> <ul style="list-style-type: none"> <li>- The fundamental of hardware assembly design</li> <li>- Dimensional accuracy of AM parts</li> <li>- Designing enclosures</li> <li>- Common design features</li> </ul>	<ul style="list-style-type: none"> <li>- Understand the fundamental of hardware assembly design.</li> <li>- Understand the common design features.</li> </ul>	4
<p>3D 扫描技术 3D Scanning</p> <ul style="list-style-type: none"> <li>- 3D scanning process overview</li> <li>- Scanning process</li> <li>- Scan data preparation</li> <li>- Scan data to CAD data</li> <li>- Non-contact, contact and volumetric scanning techniques</li> <li>- 3D scanning Applications</li> </ul>	<ul style="list-style-type: none"> <li>- Understand the technical principle of 3D Scanning.</li> <li>- Understand the Non-contact, contact and volumetric scanning techniques.</li> </ul>	2
<p>逆向工程 Reverse Engineering</p> <ul style="list-style-type: none"> <li>- The fundamental of reverse engineering</li> <li>- Why RE</li> <li>- The applications of reverse engineering</li> <li>- RE with 3D printing – Case study</li> <li>- Reverse modelling strategies</li> <li>- Geomagics Design X</li> </ul>	<ul style="list-style-type: none"> <li>- Understand the fundamental of reverse engineering.</li> <li>- Understand the applications of reverse engineering.</li> </ul>	4

<p>虚拟设计与仿真模拟 Virtual design and simulation concept</p> <ul style="list-style-type: none"> <li>- Unique capabilities of AM</li> <li>- Shape/functional/material complexity</li> <li>- Generative design</li> <li>- Topology optimisation</li> <li>- Lattice optimisation</li> <li>- Cellular structure</li> <li>- End-to-end design process for AM</li> </ul>	<ul style="list-style-type: none"> <li>- Understand the shape/functional/material complexity.</li> <li>- Understand the application of virtual design and simulation concept in additive manufacturing.</li> </ul>	2
<p>增材制造过程模拟及预测 AM process simulation and prediction</p> <ul style="list-style-type: none"> <li>- Challenges of current AM</li> <li>- Reasons for AM process simulation</li> <li>- Process simulation and validation</li> <li>- AM process advantages</li> <li>- Case study</li> </ul>	<ul style="list-style-type: none"> <li>- Understand the Challenges of current AM.</li> <li>- Understand the methods of process simulation and validation.</li> </ul>	4
<p>知识产权及标准 AM IP and Standards</p> <ul style="list-style-type: none"> <li>- Intellectual property</li> <li>- The trend of AM patents</li> <li>- ISO and ASTM standards for AM</li> </ul>	<ul style="list-style-type: none"> <li>- Understand the definition of intellectual property.</li> <li>- Understand the importance of intellectual property.</li> </ul>	2
<p>增材制造商业模式及成本 Costing and Business Models for AM</p> <ul style="list-style-type: none"> <li>- AM cost Drivers</li> <li>- Cost comparison of different manufacturing methods</li> <li>- AM cost model</li> </ul>	<ul style="list-style-type: none"> <li>- Understand the cost comparison of different manufacturing methods.</li> <li>- Understand the drivers and model of AM cost.</li> </ul>	2
<p>快速模具制造 Rapid Tooling</p> <ul style="list-style-type: none"> <li>- Direct AM production of injection moulding inserts</li> <li>- Investment casting</li> <li>- Typical applications</li> </ul>	<ul style="list-style-type: none"> <li>- Understand the AM for rapid tooling.</li> </ul>	2
<p>医疗领域的增材制造 AM for Medical</p> <ul style="list-style-type: none"> <li>- The use of AM to support medical applications</li> <li>- Software support for medical applications</li> <li>- Limitations of AM for medical applications</li> <li>- Further development of medical AM applications</li> </ul>	<ul style="list-style-type: none"> <li>- Understand the typical AM applications for medical.</li> <li>- Understand the further development of AM for medical.</li> </ul>	2
<p>增材制造工业应用 Industrial Aspects of AM</p>	<ul style="list-style-type: none"> <li>- Understand the aerospace, automotive industrial aspects of AM.</li> </ul>	2

- AM for aerospace application - AM for automotive application - AM for archaeological application		
增材制造实验 AM Experiments - Experiments of fused deposition modelling - Experiments of stereolithography - Experiments of binder jetting	- Ability to work with team members or to complete experiments individually.	4
Lectures slots could be swapped around * Possible invited lecturer		

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

- Gibson, Ian, Rosen, David, Stucker, Brent, Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, ISBN 978-1-4939-2113-3
- Chee Kai Chua, Kah Fai Leong, 3D Printing and Additive Manufacturing : Principles and Applications, World Scientific Publishing Company, ISBN-10: 9814571407.
- Tom Page, Design for Additive Manufacturing: Guidelines for cost effective manufacturing, ISBN-10 384732294X
- Ulrich, K.T., Eppinger, S.D., Product Design and Development, 4th Edition, McGraw Hill, 2008

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				
课程项目 Projects				
平时作业 Assignments		70		
期中考试 Mid-Term Test				
期末考试 Final Exam				
期末报告 Final Presentation		20		
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**

机械与能源工程系教学委员会

