

## 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>	先进复合材料原理与应用 Fundamental and Applications of Advanced Composite Materials
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>	ME363
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>	春季 Spring
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	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

复合材料可以定义为两种或两种以上材料复合成一种其性能超过这些材料单独使用时的材料。本课程将介绍先进复合材料的基础概念，工艺及应用，教学目标主要包括：

- 复合材料的定义及分类，各种复合材料的基本性能及设计原理；
- 不同增强体和基体类型的复合材料的微观结构特性和物理性能，制造工艺和应用领域；了解复合材料中的界面效应，包括界面结构和特性，以及对复合材料产生的性能影响；
- 课程完成后，学生能够充分了解及应用复合材料的设计原理，结构-性能关系，优化制备工艺。

This module will introduce and develop the concepts and techniques for Advanced Composite Materials. The module will emphasise on:

- The definition, classification, basic properties and design principles and applications of various types of composite materials, especially for polymer matrix composites (PMCs).
- The microstructural characteristics, physical properties, manufacturing processes and application areas of different kinds of reinforcements and matrix materials, participants should acknowledge the definition and interfacial effect of the interface in the composite materials, including interfacial structures, characteristics and the effects on the properties of composites.
- Upon completion, participants should be able to apply the execution of concept and skills acquired in the areas of Advanced Composite Materials, design principles, microstructure-property correlations in the composites and the optimization of the preparation processes.

#### 16. 预达学习成果 Learning Outcomes

- 熟悉复合材料的定义，分类，基本性能和设计原则。
- 熟悉各类增强材料和基体材料的分类，微观结构特征，物理性质，制造工艺和应用领域。
- 熟悉复合材料界面的定义和界面效应。
- 了解界面结构和特性，以及它们对复合材料性能的影响。
- 熟悉聚合物/金属/陶瓷基复合材料的微观结构特征 - 物理性质，制备方法和应用领域。
- 了解复合材料中的微观力学和宏观力学。
- 熟悉不同类型复合材料的重要应用。

- Be familiar with the definition, classification, basic properties, and design principles of composite material.
- Obtain the knowledge classification, microstructural characteristics, physical properties, fabrication strategies and application fields of the various types of reinforcements and matrix materials.
- Familiar with the definition and interfacial effect of the interface in the composites.
- Understand the interfacial structures and characteristics, and their effects on the properties of composites.
- Be familiar with the microstructural characteristics-physical properties, fabrication methods and application fields of the polymer/metal/ceramics matrix composites.
- Understand the micromechanics and macromechanics in the composites.
- Be familiar the important applications for different types of composites.

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
先进复合材料概述 Overview of Advanced Composite Materials (ACM): <ul style="list-style-type: none"> <li>• What is ACM; Classification of ACM; Characteristics of ACM; Industry impact applications;</li> <li>• Current situation and prospects</li> </ul>	<ul style="list-style-type: none"> <li>• Understand the definition, classification, characteristics of ACM.</li> <li>• Understand the application and importance of ACM in industry.</li> </ul>	4
先进复合材料分类 ACM classification: <ul style="list-style-type: none"> <li>• Reinforcement: Fiberglass; Carbon/Boron fiber; Ceramic fiber; Aramid fiber</li> <li>• Matrix: polymer; Metal; Ceramics; Carbon/Carbon</li> </ul>	<ul style="list-style-type: none"> <li>• Understand the various types of reinforcement and matrix materials.</li> <li>• Understand the microstructure characteristics, physical properties, manufacturing process and application field of reinforcement and matrix materials.</li> </ul>	4
聚合物基复合材料 Polymer Matrix Composites: <ul style="list-style-type: none"> <li>• Reinforcement: Fiberglass; Carbon fibers; High modulus organic fibers; Other reinforced fibers</li> <li>• Matrix: Basic properties; Resin matrix for composites; High performance resin matrix; Resin matrix for corrosion-resistant composites</li> <li>• Polymeric interface: Formation and function mechanism; Failure mechanism; Surface treatment of fibers; Interfacial properties of PMCs</li> </ul>	<ul style="list-style-type: none"> <li>• Understand the definition, classification of Polymer Matrix Composites.</li> <li>• Understand the special properties of thermoplastic matrix: low density &amp; high elasticity, thermal performance, chemical corrosion resistance, electrical properties etc.</li> <li>• Understand the structure design of polymer matrix composites.</li> </ul>	4
聚合物基复合材料工艺 Polymer Matrix Composites Processing	<ul style="list-style-type: none"> <li>• Understand the manufacturing methods of thermosetting and thermoplastic composites.</li> </ul>	4

<ul style="list-style-type: none"> <li>● Moulding techniques: Hand lay-up molding; Bag moulding; Filament winding; Pultrusion; Compression molding; Resin transfer molding; Fiber reinforced thermoplastic polymer molding (FRTP); Injection molding; Mould and auxiliary materials</li> <li>● Solidification process</li> </ul>	<ul style="list-style-type: none"> <li>● Understand the preparation process of prepreg of fiber reinforced thermoplastic polymer.</li> <li>● Understand the application prospect of fiber reinforced thermoplastic polymer.</li> </ul>	
<p>聚合物基复合材料性能 Properties of PMCs</p> <ul style="list-style-type: none"> <li>● Basic mechanical properties: Tensile properties; Compressive properties; Shear properties; Bending properties of composites</li> <li>● Other mechanical properties: Impact, fatigue, creep deformation, environmental influence and rupture of composites</li> <li>● The high frequency dielectric property of composite material and radar cover</li> </ul>	<ul style="list-style-type: none"> <li>● Understand the classification of PMCs according to the arrangement of fibers, from the perspective of mechanics.</li> <li>● Understand the mechanical properties and mechanical anisotropy of PMCs.</li> <li>● Understand the tensile properties, compression and shear properties of unidirectional fiber composites.</li> <li>● Understand the high frequency dielectric property of composite material and radar cover.</li> </ul>	4
<p>聚合物基复合材料的其他性能 Other Properties of PMCs</p> <ul style="list-style-type: none"> <li>● Thermophysical properties; Heat resistance; Chemical resistance; Abrasive resistance; Flame resistance</li> </ul>	<ul style="list-style-type: none"> <li>● Understand the thermal, electrical, chemical, optical or other properties of PMCs.</li> </ul>	4
<p>金属基复合材料 Metal Matrix Composites (MMCs)</p> <ul style="list-style-type: none"> <li>● Development; Classification; Characteristics;</li> <li>● Matrix: Selection Principle; Category;</li> <li>● Manufacturing Methods: Solid-state method; Liquid method; In-situ composite technique;</li> <li>● Interface: Interfacial structure and reaction; Impact on the properties of MMCs; Interface optimization; Properties and application</li> </ul>	<ul style="list-style-type: none"> <li>● Understand the classification and matrix material selection of metal matrix composites.</li> <li>● Understand the main manufacturing methods and scope of application of metal matrix composites.</li> <li>● Understand the process of diffusion bonding and deformation pressure processing.</li> <li>● Understand the performance requirements for metal matrix composites in different work environments.</li> </ul>	4
<p>陶瓷基复合材料 Ceramic Matrix Composites (CMCs)</p> <ul style="list-style-type: none"> <li>● Whisker reinforced ceramics: Mechanism; Influence factors; Preparation techniques; Properties and application</li> </ul>	<ul style="list-style-type: none"> <li>● Understand the mechanism, influence factors, preparation techniques, properties of whisker reinforced ceramics and fiber reinforced ceramic matrix composites.</li> <li>● Understand the design and applications of</li> </ul>	4

<ul style="list-style-type: none"> <li>● Fiber reinforced CMCs: Mechanical properties and reinforcement mechanism; Preparation techniques; Interface control</li> <li>● Bionic structure CMCs: Design and preparation</li> </ul>	ceramic matrix composites.	
<p>碳/碳复合材料 Carbon/Carbon Composites</p> <ul style="list-style-type: none"> <li>● Development and characteristics; Preparation process; Computer simulation; Mechanical properties; Thermophysical properties; Biocompatibility</li> </ul>	<ul style="list-style-type: none"> <li>● Understand the chemical, physical and mechanical properties of Carbon/Carbon Composites.</li> </ul>	2
<p>航空航天领域的复合材料应用 Composites for Aerospace Application</p> <ul style="list-style-type: none"> <li>● Shielding and stealth composites; Magnetic induction composites; Photosensitive composite materials; Thermal and mechanical composites; Sound and wave absorbing composites</li> </ul>	<ul style="list-style-type: none"> <li>● Understand the application prospects and development of composite materials in the aerospace field.</li> </ul>	4
<p>电学和电子领域的复合材料应用 Composites for Electric and Electronic Application</p> <ul style="list-style-type: none"> <li>● Electrical contact composites; Conductive composites; Piezoelectric composites; Superconductive composites</li> </ul>	<ul style="list-style-type: none"> <li>● Understand the application prospects and development of composite materials in the electric and electronic field.</li> </ul>	4
<p>新型复合材料应用 Application of Advanced Composite Materials</p> <ul style="list-style-type: none"> <li>● Nanocomposite materials; Intelligent composites; Smart composites; Gradient composites; Biocomposites; Special functional composites</li> </ul>	<ul style="list-style-type: none"> <li>● Understand the definition, classification of new advanced composite materials.</li> <li>● Understand the application and superiority of new advanced composite materials.</li> </ul>	6

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

教材:

- Composite Materials: Science and Engineering, Krishan Kumar Chawla, Springer, 2013

参考资料:

- 复合材料, 尹洪峰, 魏剑, 2010, 冶金工业出版社
- 聚合物基复合材料设计与加工, 梁基照, 2011, 机械工业出版社
- 先进复合材料的制造工艺, Flake C. Campbell, 2016, 上海交通大学出版社

**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		40		
平时作业 Assignments		50		
期中考试 Mid-Term Test				
期末考试 Final Exam				
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)				

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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

