上海交通大学研究生专业课程信息收集表

Information Form for SJTU Graduate Profession Courses

<table>
<tr><th colspan="6">课程基本信息 Basic Information</th></tr>
<tr><td>*课程名称
Course Name</td><td colspan="5">（中文 Chinese）集成计算材料工程
（英文 English）Integrated Computational Materials Engineering</td></tr>
<tr><td>*学分
Credits</td><td>2</td><td>*学时
Teaching Hours</td><td colspan="3">32（1 学分=16 课时）</td></tr>
<tr><td>*开课学期
Semester</td><td>秋季学期 Fall</td><td>*是否跨学期
Cross-semester?</td><td>否 No</td><td colspan="2">跨 Spanning over 个学期 Semesters（含夏季学期）。</td></tr>
<tr><td>*课程类型
Course Type</td><td>专业前沿课 Program Frontier Course</td><td>*课程分类
Course Type</td><td colspan="3">全日制课程 For full-time students</td></tr>
<tr><td>*课程性质
Course Category</td><td>专业课 Specialized Course</td><td>课程层次
Targeting Students</td><td colspan="3">博士课程 Doctoral Level</td></tr>
<tr><td>*授课语言
Instruction Language</td><td>中文 Chinese</td><td>主要授课方式
Teaching Method</td><td colspan="3">课堂教学 In class teaching</td></tr>
<tr><td>*成绩类型
Grade</td><td>等第制 Letter grading</td><td>主要考核方式
Exam Method</td><td colspan="3">论文 Essay</td></tr>
<tr><td>*开课院系
School</td><td colspan="5">材料科学与工程学院 School of Materials Science and Engineering</td></tr>
<tr><td>所属学科
Subject</td><td colspan="5">材料科学与工程</td></tr>
<tr><td rowspan="2">负责教师
Person in charge</td><td>姓名 Name</td><td>工号 ID</td><td>单位 School</td><td colspan="2">联系方式 E-mail</td></tr>
<tr><td>顾剑锋</td><td></td><td>材料科学与工程学院</td><td colspan="2">gujf@sjtu.edu.cn</td></tr>
<tr><th colspan="6">课程扩展信息 Extended Information</th></tr>
<tr><td>*课程简介
(中文)
Course Description</td><td colspan="5">（分段概述课程定位、教学目标、主要教学内容、先修课程等；不少于 200 字。）
课程定位：本课程是面向材料科学与工程学科博士研究生的一门专业前沿选修课，主要讲述当前智能制造前沿的 ICME 技术，为开展博士学位论文的研究工作打下基础。
教学目标：针对典型热加工工艺，介绍 ICME 关键技术，掌握多尺度、多场耦合的工艺过程分析，以及宏-微观结合数值分析的基本框架，应用与材料研究中。
主要教学内容：本课程内容包括分三个部分。第一部分简要介绍 ICME 基本要素、概念、技术关键及国内外最新进展，突出强调其在智能制造中的地位和对提升高端制造的重要作用。第二部分针对铸造、锻造和热处理三种热加工工艺，分别介绍其中的传热、相变、力学等物理过程和数学模型，并重点讲授有限元数值模拟分析所需输入的材料参数、工艺参数、初始条件和边界条件等，使得学生在掌握各单个工艺数值模拟的研究方向和进展的同时，能够规范地进行典型热加工工艺过程的规范模拟和分析。第三部分首先介绍介观模拟方法（相场法和元胞自动机法）的基本原理和应用，跨尺度耦合的算法设计原理，力求学生掌握针对典型热加工工艺进行宏-微观结合数值分析的基本框架。其次介绍铸造/锻造、铸造/热处理、锻造/热处理工艺间传递的场量，重点突出数据接口设计和数据传递，力求学生掌握针对两个以上工艺的全流程模拟进行开发方案的设计。
先修课程：材料加工原理，有限元分析原理和方法，计算材料学</td></tr>
<tr><td>*课程简介
（English）
Course Description</td><td colspan="5">Course orientation: This course is a frontier elective course for PhD students in materials science and engineering. It mainly describes the ICME technology in the frontier of intelligent manufacturing, laying a foundation for further research of doctoral dissertation.
Teaching objectives: This course introduces the key technology of ICME for typical thermal processing technology, and helps master the process analysis of multi-scale and multi-field coupling, as well as the basic framework of macro-micro combined numerical analysis, and its application in materials research.</td></tr>
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	Main content: The first part briefly introduces the basic elements, concepts and key technologies of ICME, and the latest developments at home and abroad, highlighting its position in intelligent manufacturing and its important role in promoting high-end manufacturing. The second part introduces the physical process and mathematical model of heat transfer, phase transformation, mechanics during hot working process of casting, forging and heat treatment, respectively. The necessary inputs for FEM numerical simulation are emphasized, such as material parameters, process parameters, initial conditions and boundary conditions, etc. Students are expected to be familiar with research direction and progress of each individual process, and be able to perform simulation and analysis of typical hot working process correctly. The third part firstly introduces the basic principle and application of the mesoscopic simulation method (phase field method and the cellular automata method) and design principle of multi-scales coupling algorithm. The basic framework of macro- micro combined numerical analysis for typical thermal process should be mastered. Secondly, the transferred field variables between casting/forging, casting/heat treatment, forging/heat treatment are introduced, highlighting the data interface design and data transfer. Students are expected to master the design of the development plan for the whole process simulation of two or more processes. **Prerequisite courses:** Principles of Materials Processing, Finite Element Analysis (FEA)，Computational Materials Science.

*教学大纲 (中文) Syllabus	章节	主要内容	课学时	教学方式
	第一章 ICME概论	第一节ICME基本概念和发展历程 第二节ICME在材料和热加工领域的应用	2	课堂讲述
	第二章 液态成形过程数值模拟	第一节传热的基本原理与解析 第二节流动与凝固的基本原理与解析 第三节铸造模拟与工程应用	4	课堂讲述
	第三章 塑性成形过程数值模拟	第一节锻造成形的有限元计算原理 第二节集成锻造计算技术 第三节典型成形模拟案例	4	课堂讲述
	第四章 热处理过程数值模拟	第一节热处理过程中的多场耦合模型 第二节热处理工艺过程数值模拟原理及实现 第三节模拟参数及其测试 第四节热处理模拟的发展方向、趋势及典型案例	6	课堂讲述
	第五章 多尺度耦合模拟原理与技术	第一节介观尺度模拟——相场法 第二节介观尺度模拟——元胞自动机法 第三节跨尺度耦合原理与实施方法	10	课堂讲述
	第六章 多工艺衔接的全流程模拟技术	第一节热加工全流程模拟中的数据接口设计和数据传递 第二节ICME在热加工全流程模拟典型应用	6	课堂讲述

*教学大纲 （English） Syllabus	Chapter	Content	Hours	Format
	Chapter 1 Introduction of ICME	Section 1, Basic concept and history of ICME Section 2, Application of ICME in the field of materials thermal processing	2	lecture
	Chapter 2 Numerical simulation of liquid forming process	Section 1, Basic principle and analysis of heat transfer Section 2, Basic principle and analysis of flow and solidification Section 3, Casting simulation and	4	lecture

		engineering application		
	Chapter 3 Numerical simulation of plastic forming process	Section 1, Finite element calculation principle of forging forming Section 2, Integrated forging computing technology Section 3, Typical forming simulation cases	4	lecture
	Chapter 4 Numerical simulation of heat treatment process	Section 1, Multi-field coupling model in heat treatment process Section 2, Numerical simulation principle and realization of heat treatment process Section 3, Simulation parameters and their tests Section 4, Development direction, trend and typical cases of heat treatment simulation	6	lecture
	Chapter 5 Principle and technology of multi-scale coupling simulation	Section 1,Mesoscopic scale simulation -- phase field method Section 2, Mesoscopic scale simulation -- cellular automata method Section 3, Cross-scale coupling principle and implementation method	10	lecture
	Chapter 6 The whole process simulation technology of multi-process connection	Section 1, Data interface design and data transfer in the whole process simulation of thermal machining Section 2, Typical application of ICME in the whole process of thermal processing	6	lecture
*课程要求（中文）Requirements	（课程考核方式、考核标准等；不少于 50 字） 1. 基于授课内容进行扩展性阅读和知识整理，在本学期内完成 1 个读书报告(3000 字以上)； 2. 在课程结束前学生进行课堂的 PPT 演讲和汇报，不少于 15 分钟。 最终根据学生在读书报告、演讲报告的综合表现给予期末成绩。			
*课程要求（English）Requirements	1. A reading report (3000 words at least in Chinese character) related to the knowledge of the lectures should be submitted; 2. A PPT presentation is required at least 15 minutes for each student by the end of this course. A comprehensive performance review will be released based on above items.			
*课程资源（中文）Resources	（教材、教参、网站资料等。） **教材** 无 **主要的参考资料(学生任选一本)：** 1. Integrated Computational Materials Engineering (ICME): Implementing ICME in the Aerospace, Automotive, and Maritime Industries, The Minerals, Metals & Materials Society (TMS), 2013 2. 钢热加工数值模拟手册，顾剑锋译，机械工业出版社，2016 3. 塑性有限元法及其在金属成形中的应用，陈如欣，胡忠民编，重庆大学出版社，1989； 4. Multiscale Methods—Bridging the Scales in Science and Engineering, Edited by JACOB FISH, Oxford University Press, 2010. 5. Modeling materials: continuum, atomistic, and multiscale techniques, Ellad B. Tadmor, Ronald E. Miller. Cambridge University Press, 2011. 另外，每章将推荐经典的研究文献至少三篇，要求学生从阅读原文着手体会科学思想的发展过程。			
*课程资源（English）Resources	**Text Book:** No **Main References:** 1. Integrated Computational Materials Engineering (ICME): Implementing ICME in the Aerospace, Automotive, and Maritime Industries, The Minerals, Metals & Materials Society (TMS), 2013 2. Handbook of Thermal Processing of Steels, Translated by Jianfeng GU, China Machine Press，2016			

	3. Plastic finite element method and its application in metal forming. Eds. Ruxing CHEN, Zhongming HU, Chongqing University Press，1989； 4. Multiscale Methods—Bridging the Scales in Science and Engineering, Edited by JACOB FISH, Oxford University Press, 2010. 5. Modeling materials: continuum, atomistic, and multiscale techniques, Ellad B. Tadmor, Ronald E. Miller. Cambridge University Press, 2011. In addition, At least three classical papers will be provided for each chapter during the lecture.
备注 Note	