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）材料加工力学基础
（英文 English）Fundamental Mechanics in Materials Processing</td></tr>
<tr><td>*学分
Credits</td><td>3</td><td>*学时
Teaching Hours</td><td colspan="3">48（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>专业基础课 Program Core 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">硕博共用 All graduates</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">笔试 Written Exam</td></tr>
<tr><td>*开课院系
School</td><td colspan="5">050 材料科学与工程学院 School of Material Science and Engineering</td></tr>
<tr><td>所属学科
Subject</td><td colspan="5">材料科学与工程 Material Science and Engineering</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 colspan="2">单位 School</td><td>联系方式 E-mail</td></tr>
<tr><td>崔振山</td><td></td><td colspan="2">材料科学与工程学院</td><td>cuizs@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。）
1. 课程定位：塑性加工是产品制造的主要方法之一，包括锻造、冲压、轧制、挤压、拉拔等，其主要特征是固体坯料在力的作用下产生永久变形（即塑性变形）,从而形成所需要的形状，变形过程一般还能改进材料的力学性能。成形过程的变形分析是以塑性力学和材料科学为基础的，其分析结果是成形工艺设计和装备设计的理论依据。因此，材料加工力学基础是重要基础课程之一。
2. 教学目标：通过本课程的学习，使学生能够掌握塑性大变形的描述方法，材料变形的本构关系、屈服准则、硬化准则，掌握塑性变形的能量原理及其衍生出来的上限法和刚塑性有限元方法，熟悉工程问题的分析方法。
3. 主要教学内容：
（1）大变形过程的描述方法，应力和应变表述的特殊性以及各自要遵循的基本方程与边界条件。
（2）材料的本构关系与塑性变形流动规律，应变路径对材料屈服与强化的影响。
（3）塑性变形遵从的基本能量原理，基于能量原理的塑性变形分析方法，如上限法、刚塑性有限元法等。
（4）金属塑性变形的微观机制及其对产品力学性能的影响。
4. 先修课程：材料力学、材料加工原理</td></tr>
<tr><td>*课程简介
（English）
Course Description</td><td colspan="5">（须与中文一致，翻译请力求信达雅。）
1. Course orientation: Forming, including forging, stamping, rolling, extrusion, drawing and many other plastic processing, is the main method of product manufacturing. Its main feature is that the solid billet receives permanent deformation (i.e. plastic deformation) under the action of force, to form the desired shape. Besides that, deformation process can also improve the mechanical properties of materials. Deformation analysis of forming process is based on plasticity and material science. The analysis results are the theoretical basis for forming process design and equipment design. The course of “Fundamental Mechanics in Material Processing” is therefore a key course in study of materials engineering.</td></tr>
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2. Course goal: Through the study of this course, students can master the description method of large plastic deformation, the constitutive relation of material deformation, yield criterion and hardening law. Students can also master the energy principle of plastic deformation and the derived solution methods like upper bound method and rigid plastic finite element method, and gained the ability for analyzing engineering problems.

3. Main contents:
(1) Description method of large deformation; particularity of stress and strain definition; basic equations and boundary conditions for forming process.
(2) The constitutive relation of materials; deformation principle in plasticity; effect of strain path on yielding and strengthening of materials.
(3) Basic energy principle for plastic deformation; energy principle–based analysis methods for plastic deformation, including upper bound method, rigid-plastic finite element method and so on.
(4) Microscopic mechanism of metal plastic deformation and its effect on mechanical properties of products.

4. Prerequisite courses: Mechanics of Materials; Materials Processing Principles.

*教学大纲
(中文)
Syllabus

（建议列表形式，各列内容：章节、主要内容、课时数、教学方式等）

章节	主要内容	课时数	教学方式
第一章 绪论	塑性理论要解决的问题、发展过程；张量与求和约定；塑性力学的基本方程与简单问题的求解方法；金属塑性变形的微观机制。	3	课堂教学
第二章 大变形的几何学描述	L 变量与 E 变量；变形梯度与变形张量；Green 应变张量与 Almansi 应变张量；极分解定理与共旋应变；对数应变；无限小应变及其物理意义、变形率与应变率、应变张量的主值与分解。	6	课堂教学
第三章 应力描述	E 应力张量及其平衡方程；L 应力张量与 K 应力张量；L 应力、K 应力与 E 应力间的变换关系；E 应力的不变量与主应力，应力球张量与偏张量。	3	课堂教学
第四章 弹性与塑性本构关系	拉伸与压缩应力应变曲线，弹性应力应变关系，各向同性材料的屈服准则；塑性变形增量理论与全量理论；Drucker 公设与加卸载判据；大变形下的应力计算。	9	课堂教学
第五章 板料成形中的各向异性流动与强化	板料成形的力学特点；Hill 屈服准则与流动方程；Barlat 屈服准则与流动方程；板料的塑性强化模型。	3	课堂教学
第六章 上限原理及其应用	基本能量原理；应力间断和速度间断；上限原理与下限原理；基于刚性块流动模式的上限解法；基于连续速度场的上限解法；连续速度场和流函数法在挤压变形中的应用；工程问题的求解方法。	12	课堂教学
第七章 刚塑性有限元	有限元法的基本思路；刚塑性变分原理；离散化与单元速度场；单元内应变率和体积应变率；基于罚函数法的刚塑性有限元法；刚粘塑性有限元；基于 Lagrange 乘子法的刚塑性有限元；初始速度场假设与摩擦边界的处理。	12	课堂教学

*教学大纲

（须与中文一致，翻译请力求信达雅。）

（English）Syllabus	Chapter	Main contents	Hours	Teaching manner
	Chapter 1 Introduction	Plasticity related application fields and development; tensor and its summation convention; basic equations of plasticity and solution methods for simple problems; microscopic mechanism of plastic deformation of metals.	3	Class teaching
	Chapter 2 Geometrical description of large deformation	Lagrangian variables and Eulerian variables; deformation gradient and deformation tensor; Green strain and Almansi strain; polar decomposition and co-rotational strain; Logarithmic strain; infinitesimal strain and its physical meaning; rate of deformation; strain rate; principal value and decomposition of strain tensor.	6	Class teaching
	Chapter 3 Description of stress	Eulerian stress tensor and its equilibrium equation; Lagrangian stress tensor and Kirchhoff stress tensor; transformation between Lagrangian stress, Kirchhoff stress and Eulerian stress; mean volumetric stress tensor and stress deviator tensor.	3	Class teaching
	Chapter 4 Constitutive relations	Stress-strain curves in tensile and compressive tests; stress-strain relations in elasticity; yielding criteria for isotropic materials; incremental and total theory of plasticity; Drucker postulate and loading / unloading criterion; stress calculation method for large deformations.	9	Class teaching
	Chapter 5 Anisotropic flow and hardening of sheet metal	Mechanics characteristic of sheet metal forming; Hill's yielding criterion and flow equations; Barlat's yielding criterion and flow equations; hardening model of sheet metal.	3	Class teaching
	Chapter 6 Upper bound theorem and its application	Basic energy principle; discontinuity of stress and velocity; upper bound and lower bound theorem; upper bound solution based on rigid sliding blocks; upper bound solution based on continuous velocity fields; applications of continuous velocity fields and stream functions in analysis of extrusions; solutions of engineering problems.	12	Class teaching
	Chapter 7 Rigid-plastic finite element method	The basic idea of finite element method; variational principle for rigid-plastic deformation; discretization and element velocity fields; strain rate and volumetric strain rate in element; rigid-plastic finite element based on penalty function method; rigid-viscous plastic finite element method; rigid-plastic finite element method based on Lagrangian multiplier method; assumption of initial velocity field and handling of friction boundary.	12	Class teaching
*课程要求（中文）Requirements	（课程考核方式、考核标准等；不少于 50 字） 课程考核采取平时成绩、大作业、期末考试三种方式的结合，“平时成绩+大作业”占 30%，期末闭卷考试占 70%			
*课程要求（English）Requirements	（须与中文一致，翻译请力求信达雅。） The course assessment adopts the combination of three ways: usual score, projects and final exam. "Usual score + project" accounts for 30%, and the final exam accounts for 70%.			
*课程资源（中文）Resources	（教材、教参、网站资料等。） “塑性加工中的大变形力学”讲义，崔振山编著。			
*课程资源（English）Resources	（须与中文一致，请力求信达雅。） Plasticity for Large Deformation in Materials Forming, teaching materials by Prof. Cui Zhenshan			

备注 Note	