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| * Course Name | Chinese | | | |
| | English Fundamental Mechanics in Materials Processing | | | |
| * Credits | 3 | * Teaching Hours | 48 1 =16 | |
| * Semester | Fall | * | , ㅋ r | |
| | | | For full-time students | |
| * Course Category | Specialized Course | Targeting Students | All graduates | |
| * Grade | Letter grading | Exam Method | Written Exam | |
| * School | 050 School of Material Science and Engineering | | | |
| Subject | Material Science and Engineering | | | |
| Person in charge | Name | ID | School | E-mail |
| | | | | cuizs@sjtu.edu.cn |
| * ( ) Course Description | 200<br>1.<br>,<br>2.<br>3.<br>1<br>2<br>3<br>4<br>4. | | | |
| * English Course Description | 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. | | | |

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.

* ( ) Syllabus

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| | L E Green Almansi | 6 | |
| | E L K L K E E | 3 | |
| | Drucker | 9 | |
| | Hill Barlat | 3 | |
| | | 12 | |
| | Lagrange | 12 | |

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| 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 |
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| * Requirements | 50 “ + ” 30% 70% | | | |
| * English Requirements | 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%. | | | |
| * Resources | “ ” | | | |
| * English Resources | Plasticity for Large Deformation in Materials Forming, teaching materials by Prof. Cui Zhenshan | | | |

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| Note | |