IME 446 Metal Deformation Processes

Designation: Professional elective

Catalog Data: IME 446 (or MCE 446) Metal Deformation Processes (3) Study of the characteristics of metal flow under different loading conditions. Theories, capabilities, and limitations of a wide range of deformation processes applied to industrial metalworking. (Lec. 3) Prerequisites: 240 or 340 and CHE 333.

Course Materials:

Course notes will be supplied by the instructor. A reading list of texts in metalworking, metal deformation theory, and the mathematical theory of plasticity will be supplied for reference purposes.

Prerequisites by Topic:

1. Introductory metallurgy and dislocation theory course material.
2. First course in strength of materials with 2-dimensional stress/strain analysis.

Course Objectives:

Students completing this course will have achieved the following objectives:

Objective	Link to Curriculum Objective
1. An understanding of the mechanics of metal forming	7, 8
2. An understanding of the capabilities and limitations of metal forming processes	7, 8, 10
3. A theoretical basis in plasticity theory sufficient to explore the literature on metal deformation mechanics	2, 8

Topics:

1. Introduction – overview of metal deformation processes, classification as primary and secondary; hot and cold working, basic limitations of deformation processing.
2. Basic deformation principles – review of test data (cold working), magnitude of elastic strains, work hardening, ductility; volumetric strain in metals; instability in simple tension; empirical stress/strain relations; test procedures for hot working; empirical stress/strain-rate relations; design of parts/processes for available ductility.
3. Applications of basic principles – homogeneous and inhomogeneous deformation; plastic work; the redundant work factor; simple analyses of secondary forming processes; limitations of drawing and rolling processes; design and control of rolling mills.
4. Introduction to plasticity theory – analysis of stress and strain: biaxial stress systems,

3-dimensional stress systems, Mohr's circles representation, strain transformation equations, Mohr's circle for strain increments; criteria for yielding and plastic flow; isotropic hardening model; stress/strain increment relationships; representative and strain measures; plane strain and bulge testing of sheet metal.

5. Application of plasticity theory – bending under tension; radial drawing; biaxial instability and forming limits; effect of die friction on pressures and forces; slab analysis methods.
6. Introduction to slip-line field and bounding theorem.

Laboratory Assignment:

At least one laboratory exercise is used to illustrate the deformation principles.

Contribution to Professional Component:

Engineering Design: 1 credit or 33%
Engineering Science: 1.5 credits or 50%
Math/Basic Science: 0.5 credit or 17%

Course Outcomes:

Departmental Outcome	Indicator
A. An ability to solve engineering problems by applying knowledge of mathematics and basic science.	Homework Assignments, Tests
B. An ability to use modern computing tools and techniques to effectively solve industrial engineering problems	Specific Assignment and Laboratory Report
C. An ability to solve basic engineering problems in the areas of mechanics, materials, thermodynamics and electrical circuits.	Homework Assignments, Tests
D. An ability to solve complex engineering problems that combine aspects of mechanics, materials, thermodynamics and electrical circuits.	Homework Assignments, Tests
J. An understanding of common manufacturing processes and their applications.	Homework Assignments, Tests
K. An understanding of the relationship between product design characteristics and manufacturing efficiency and costs.	Homework Assignments, Tests
L. An in-depth knowledge in at least one area of interest related to industrial engineering.	Overall grade
O. An ability to effectively carry out engineering experiments and interpret associated data.	Laboratory Assignment and Report

Prepared by: Peter Dewhurst **Date:** August 2005