MSE 597 Deformation Processing Spring 2025

Lecture: MWF 1:30 ARMS 3115

Instructor: Prof. Kevin Trumble

Description: This course is in the series of general, microstructure-based materials processing courses: MSE 536 Solidification, MSE 512 Powder and MSE 548 Deposition Processing. The main application of deformation processing is to metals, based on their characteristic formability via mechanisms of crystal plasticity, with associated benefits and limitation of work hardening. Major processes covered include (bulk) forging, drawing, rolling, extrusion; (sheet) bending, stretching, deep drawing and shearing; and cutting processes (e.g., machining). The focus is on the interaction between shaping and properties through microstructure development in plastic deformation, including preferred orientation and associated anisotropy. Constraints of commercial practice are emphasized. The approach is extended to selected non-metallic materials and deformation mechanisms that historically have been treated separately.

Objectives: Students will learn to: 1. Quantitatively analyze the main deformation processing operations in terms of the governing mechanics and deformation mechanisms; 2. Recognize the capabilities and limitations of deformation processing for producing specific shapes and microstructures (properties); 3. Specify, optimize and design deformation processes; 4. Identify deformation processing defects and their origins; and 5. Assess the research literature on deformation processing.

Prerequisites: Graduate standing; Undergraduates: MSE 382 and either MSE 330 or 367.

Textbook: G. Dieter, Mechanical Metallurgy, 3rd Ed., 1986, McGraw-Hill (ISBN: 0070168938); 1986 Paperback (ISBN: 0071001786); 1989 Paperback, aka "Metric" 3rd Ed. (ISBN: 0071004068); 1986 Paperback reissued in 2013 as International (Indian) edition (ISBN: 1259064794). Other books recommended.

Exams: Two in-class midterms (mid Feb and early April) and a comprehensive final exam.

Grading: Homework, ~5 sets (10%); a recorded oral presentation on a selected course topic of student interest (15%); two midterms (20% each); and a final exam (35%).

Main Topics

Review of stress and strain, multi-axial elastic and plastic deformation
Yield criteria and flow rules
Work hardening, plastic instability, and strain-rate sensitivity
Uniform energy, slab and upper bound analyses of bulk deformation
Slip-line fields and other descriptions of deformation zones
Bulk forming operations: forging, rolling, drawing, extrusion, etc.
Formability and microstructure development
Texture development mechanisms and assessment, plastic anisotropy
Sheet forming operations: shearing, bending, stretching, deep drawing (cupping), etc.
Non-metallic materials applications and related topics

Feel free to contact Prof. Trumble for more information.