

ME 531- Inelastic Design Methods

CRN: 37489

Class Hours: MW, 1-3 pm, LUMEB 1047

Instructor: Prof. Huseyin Sehitoglu, Office Hours -Open (Rm 3052 LUMEB)

Website: <http://html.mechse.illinois.edu/classes/> (Class notes, handouts and HW will be on this site).

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Class notes will not follow any particular text.

Recommended Textbooks:

- (1) Strengthening Mechanisms in Crystal Plasticity, A.S.Argon, online UIUC
<http://www.oxfordscholarship.com.proxy2.library.illinois.edu/view/10.1093/acprof:oso/9780198516002.001.0001/acprof-9780198516002>
- (2) Mechanics of Solid Materials, R. Asaro, V.Lubarda, Online Library UIUC
<https://www-cambridge-org.proxy2.library.illinois.edu/core/books/mechanics-of-solids-and-materials/BA29D281AB4356A7CAFB2D938FBA0632>
- (3) Fatigue of Materials, S. Suresh, Cambridge, 1991
- (4) Physics of Creep, F.Nabarro, CRC Press, 1995
- (5) T. Mura, Micromechanics of Defects in Solids, Nijhoff, 1982, 1991, <https://link-springer-com.proxy2.library.illinois.edu/book/10.1007%2F978-94-011-9306-1>
- (6) WARP 3D Open Source Code-downloadable from <http://www.warp3d.net/> . Intro lecture is available under downloads as well as the manual
- (7) LAMMPS Open Source Code, <http://lammps.sandia.gov> for molecular dynamics

We will make references to the above text and others during course coverage.

Outline

1. Fundamentals of Deformation- Micro- to Macro- Transition, rate- temperature-pressure effects, Non-Schmid Effects
2. Overview of Plasticity, Constitutive Modeling
3. Solution of Deformation Fields under Thermo-mechanical Loading (application to tension-torsion, contact loading)
4. Contact Mechanics Plasticity
5. Gurson Plasticity
6. Introduction to Molecular Dynamics, LAMMPS Open Source Code, Visualization of Slip and Deformation
7. Introduction to Micro-mechanics, Dislocation Mechanics, Peierls -Nabarro, Kink pairs
8. Latent Hardening
9. Finite Strain Plasticity, Crystal Plasticity, WARP3D Open Source Code
10. WARP3D-Cyclic Const Models
11. Cohesive Models, Hydrogen Plasticity
12. Irwin Model, Dugdale Model, HRR Fields
7. Fundamentals of Fatigue, and Design Concepts
8. Fundamentals of Fracture and Creep, and Design Concepts

Grade:

- 25% Homework
- 20% Midterm
- 30% Final
- 25% Project

Classical Textbooks on Plasticity

- W. Prager (1959), An Introduction to Plasticity, Addison-Wesley, Reading, Mass.
R. Hill (1950), The Mathematical Theory of Plasticity, Clarendon Press, Oxford
L.M. Kachanov (1974), Fundamentals of the Theory of Plasticity, Mir Publishers,
A. Mendelson (1983), Plasticity: Theory and Application, Robert Krieger, (reprint)

Other Textbooks on Plasticity

- J. Chakrabarty (1987), Theory of Plasticity, McGraw Hill
A. Khan, S. Huang (1995), Continuum Theory of Plasticity

Historical Works on Plastic Deformation

- H. Tresca (1864), Sur l'écoulement des corps solides soumis de fortes pression, Compt. Rend., 59, 754
G.I. Taylor, C.F. Elam (1923) The distortion of an Aluminum Crystal During a Tensile Test, Proc. R. Soc. London, A102, 603-667.
Von Mises, R. (1928) Mechanik der Plastischen Formänderung von Kristallen, Z. Agnew. Math. Mech, 8, 161-185
A. H. Cottrell (1953) Dislocations and Plastic Flow in Crystals, Oxford University Press, London