

Theory of Plasticity – ME734

January 2025

- Objectives:**
1. To learn concepts of classical theory of metal plasticity, and
 2. To learn to apply the theory of plasticity to solve idealized boundary value problems related to (i) plastic deformation of structural components and (ii) sheet metal forming processes.

Instructor: Dr. M. K. Jain (Off. JHE 326G ext. 27841, E-mail: jainmk@mcmaster.ca)

Lecture Period: Tu, Th, 4 PM-6 PM (first class: Thursday, September 3)

Lecture Room: JHE323

Teaching Method: In-class lectures

Course web site: <http://avenue.mcmaster.ca> (to be set up in the coming weeks)

Evaluation:

Weekly or biweekly assignments (5 all together):	30%
Individual Term Project:	40%
Final Examination:	30%

- Textbooks:**
1. Elastic and Inelastic Stress Analysis by Irving H. Shames and Francis A. Cazzarelli (Second edition) - Mainly Chapter 8 of the book (and some material from the earlier chapters may be covered).
 2. Mechanics of Sheet Metal Forming by Marciniak, Duncan and Hu (Second edition)

Reference Books:

1. Plasticity – Theory and application by A. Mendelson
2. Plasticity for Mechanical Engineers by Johnson and Mellor
3. Metal forming by W. H. Hosford and R. M. Cadell
4. Fundamentals of Metal Forming by R. H. Wagoner and J-L. Chenot

Lecture #	Lecture Topics
1 (parts 1 & 2):	Introduction to plasticity, 1-D plasticity and viscoplasticity
2 (parts 1 & 2):	3D non-hardening plasticity, isotropic yielding, Mises and Tresca yield criteria in 2D and 3D
3 (parts 1 & 2):	Drucker’s postulate, concepts of normality and convexity of the yield surface, Levy-Mises flow rule and Prandtl- Reuss equations
4 (parts 1 & 2):	Strain hardening, isotropic hardening, kinematic hardening, proportional loading, hypothesis of universal stress-strain curve and equivalent plastic work, rate dependent 3D models with and without strain hardening.
5 (parts 1 & 2):	An overview of various sheet metal forming processes
6 (parts 1 & 2):	Plastic instability and flow localization at large strains, forming limits
7 (parts 1 & 2):	Plastic anisotropy and anisotropic yield criteria for sheet metal forming
8 (parts 1 & 2):	Simplified analysis of axisymmetric sheet forming processes, hole expansion, deep drawing, nosing and flaring of tube and flange analysis in deep drawing, stretching over hemispherical punch.
9 (parts 1 & 2):	Mechanics of elastic-plastic bending (including small radius bending) of sheet materials

There will be 18 lectures in all (inclusive of two parts, for each of the 9 lectures) of about 2-hour duration with a 15 minute break after the first hour or so. The individual term project will be based on a detailed analysis of a published research paper (a different paper for each student) that involves aspects of theory of plasticity and its application to a specific problem. The paper will be selected by Dr. Jain for each student based on the above course content, and in keeping with the research interests of the student, whenever possible.

Final examination will be in-person in a classroom setting. It will be of 8-hour duration based on the lecture material, in-class example problems covered in the class, and assignment problems.

Policy Reminders:

Senate and Faculty of Engineering require all course outlines to include the following reminders:

“The Faculty of Engineering is concerned with ensuring an environment that is free of all adverse discrimination. If there is a problem, that can not be solved by discussion among the persons concerned, individuals are reminded that they should contact the Department Chair, the Sexual Harassment Officer or the Human Rights Consultant, as soon as possible.”

“Students are reminded that they should read and comply with the Statement on Academic Ethics and the Senate Resolution on Academic Dishonesty as found in the Senate Policy Statements distributed at registration and available in the Senate Office.”

"Academic dishonesty consists of misrepresentation by deception or by other fraudulent means and can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university”.

It is your responsibility to understand what constitutes academic dishonesty. For information on the various kinds of academic dishonesty please refer to the Academic Integrity Policy from May, 2022, located at

<http://www.mcmaster.ca/policy/Students-AcademicStudies/AcademicIntegrity.pdf>

The following illustrates only three forms of academic dishonesty:

1. Plagiarism, e.g. the submission of work that is not one's own or for which other credit has been obtained.
2. Improper collaboration in group work.
3. Copying or using unauthorized aids in tests and examinations.