McMaster University
Department of Mechanical Engineering

Course Outline: ME 705, 2026
**Advanced Finite Element Analysis**

**Instructor:** ▪ Dr. Peidong Wu, x20092, peidong@mcmaster.ca

**Content:** Central to the course is to solve nonlinear problems in solid mechanics with finite element method. It starts with the kinematics of large deformations, together with relevant continuum mechanics. We then go on to describe implementations of plasticity models in to finite element software. Throughout the course, we describe the general, multiaxial form of the theory but uniquely, wherever possible, reduce the equations to their simplest, uniaxial form to develop understanding of the general theory and we hope physical insight. The course bridges the gap between senior undergraduate/graduate materials on engineering mechanics and existing advanced finite element software. It introduces a range of engineering applications, including assessment of damage and failure, prediction of deformation localization and necking.

**Lecture Schedule**: Lecture Notes and Tutorial Instructions will be posted on Avenue to Learn

**Lectures:** Time: Mondays 2:00 PM – 5:00 PM
Place: JHE 323
(Start on January 12, 2026)

**Textbook**: ▪ F. Dunne & N. Petrinic: "Introduction to Computational Plasticity"
(Oxford University Press; ISBN: 978-0-19-856826-1)
▪ Lecture Notes

**References**: ▪ Y.C. Fung: "A First Course In Continuum Mechanics"
▪ A.J.M. Spencer: "Continuum Mechanics"

| **Grading Scheme**: | | |
|---|---|---|
| | Project 1 | 20% |
| | Project 2 | 35% |
| | Project 3 | 45% |

**Projects:**
Three projects are intended to give students practical experience in applying theories and a commercial finite element package to analyze problems in mechanics of engineering materials.

**COURSE TOPICS:**

Introduction
- What are finite elements and why do we need them?

Some Observations of Plastic Deformation
- Tensile Test
- Work hardening
- Necking

Tensor Analysis

Continuum Plasticity
- Yield Criterion
- Isotropic Hardening
- Kinematic Hardening
- Strain Rate-Sensitivity (Viscoplasticity and Creep)

Kinematics of Large Deformations and Continuum Mechanics
- Strain and Stress Measures at Large Deformations
- Deformation Gradient, Velocity Gradient
- Strain Rate and Continuum Spin
- Objective Stress Rate

Use of ANSYS or ABAQUS

Special Topics
- Gurson Damage Model

## POLICY NOTICE

**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, specifically Appendix 3, located at**

**http://www.mcmaster.ca/senate/academic/ac_integrity.htm**

**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.** (Assignments must be one's own work. Submission of any part of an assignment copied from someone else constitutes plagiarism.)
**2. Improper collaboration in group work.** (Assignments and projects in this course represent individual work and therefore must be done entirely by each student. It is appropriate to work in pairs/groups to learn how to solve the problems, but it is unacceptable for individuals in a group to share/copy solutions.)
**3. Copying or using unauthorized aids in tests and examinations.**