Syllabus of Course ME-CEE 426-1 **Advanced Finite Element Methods I**

Room – Searle 3220 (unless otherwise notified**)** Mark Fleming (Office L497)
Tue/Thu – 3:30-4:50pm Mark.Fleming@Northwestern.edu

DAY/DATE	SUBJECT
Thu 1/5	**Chapter 1. Introduction** Nonlinearity in mechanics
Tue 1/10	**Chapter 2. Total and Updated Lagrangian finite elements** Total Lagrangian (2.1 thru 2.5).
Thu 1/12	Updated Lagrangian (2.6 thru 2.8). Numerical integration. Shape functions Summary (2.13)
Tue 1/17	Intro to solution methods (2.12) and programming
Thu 1/19	**Chapter 3. Continuum mechanics for engineering analysis** Deformation and motion (3.1, 3.2). Strain measures (3.3). Stress measures (3.4).
Tue 1/24	Governing equations (3.5). Lagrangian governing equations (3.6). Polar decomposition and frame invariance (3.7).
Thu 1/26	**Chapter 5. Constitutive material models** Stress-strain curve (5.1, 5.2). Elasticity (5.3).
Tue 1/31	Hyperelasticity (5.4).
Thu 2/2	1D plasticity (5.5), Stress update algorithms (5.9)
Tue 2/7	Multiaxial plasticity (5.6) and J2 plasticity
Thu 2/9	Review session
Tue 2/14	**Midterm**
Thu 2/16	Computer lab / applications class
Tue 2/21	**Chapter 6. Solution methods and stability** Explicit methods (6.1, 6.2).
Thu 2/23	Stability and continuation methods (6.5). Numerical stability (6.6).
Tue 2/28	Implicit time integration (6.3). Linearization (6.4).
Thu 3/2	Computational fracture and damage mechanics
Tue 3/7	**Chapter 11**. XFEM for modeling fracture parameters
Thu 3/9	Final project presentations or poster session
Wed 3/15	Final project reports due by 9 pm

Prerequisites: ME/CEE 327 or equivalent.
Text Book: Ted Belytschko, Wing Kam Liu, Brian Moran (2014). Nonlinear Finite Elements for Continua and Structures. *John Wiley & Sons, Ltd.* [2014 edition]
Computer Labs: MATLAB/Python project and Abaqus/LS-Dyna/Ansys FEA projects
Homework: Due 1 week after day assigned. Computer assignment due 2 weeks after day assigned. Abaqus assignment due 3 weeks after day assigned.
Office Hours: Mark Fleming –Th. 2:30-3:30pm; or by appointment
Grading: Homework 25%. Computer labs 25%, Midterm 25%, Final project 25%

Northwestern University information

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This class or portions of this class will be recorded by the instructor for educational purposes (only Zoom lectures will be recorded). Portions of the course that contain images, questions, or commentary/discussion by students will be edited out of any recordings that are saved beyond the current term.

Academic Integrity: Engineers are required to adhere to the highest professional responsibility and ethics. Hence, Academic Integrity is strictly enforced in this course. A grade of F may be assigned to the course if Academic Integrity is bleached.

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https://www.mccormick.northwestern.edu/students/academic-integrity.html

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Exceptions to class modality: Class sessions for this course will occur in person. Individual students will not be granted permission to attend remotely except as the result of an Americans with Disabilities Act (ADA) accommodation as determined by AccessibleNU.