Syllabus of Course ME-CEE 426-1

Advanced Finite Element Methods I

Room – Searle 3220 (unless otherwise notified)

Tue/Thu – 3:30-4:50pm

Mark Fleming (Office L497)
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<table>
<thead>
<tr>
<th>DAY/DATE</th>
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| 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.
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 is committed to providing the most accessible learning environment as possible for students with disabilities. Should you anticipate or experience disability-related barriers in the academic setting, please contact AccessibleNU to move forward with the university's established accommodation process (e: accessiblenu@northwestern.edu; p: 847-467-5530). If you already have established accommodations with AccessibleNU, please let me know as soon as possible, preferably within the first two weeks of the term, so we can work together to implement your disability accommodations. Disability information, including academic accommodations, is confidential under the Family Educational Rights and Privacy Act.

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 breached.

Students in this course are required to comply with the policies found in the booklet, "Academic Integrity at Northwestern University: A Basic Guide". All papers submitted for credit in this course must be submitted electronically unless otherwise instructed by the professor. Your written work may be tested for plagiarized content. For details regarding academic integrity at Northwestern or to download the guide, visit: https://www.northwestern.edu/provost/policies/academic-integrity/index.html

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

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Northwestern University is committed to supporting the wellness of our students. Student Affairs has multiple resources to support student wellness and mental health. If you are feeling distressed or overwhelmed, please reach out for help. Students can access confidential resources through the Counseling and Psychological Services (CAPS), Religious and Spiritual Life (RSL) and the Center for Awareness, Response and Education (CARE). Additional information on all of the resources mentioned above can be found here: https://www.northwestern.edu/counseling/
https://www.northwestern.edu/religious-life/ https://www.northwestern.edu/care/

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.