Syllabus of Course ME-CEE 426-II **Advanced Finite Element Methods II**
Room LG66 Wing Kam Liu, A326, w-liu@northwestern.edu
Tue/Thu – 9:30-10:50am Miguel Bessa, A315, mbessa@u.northwestern.edu
John Moore, A311, johnmoore2016@u.northwestern.edu
Patrick Lea, A315, patrick.lea@u.northwestern.edu

DAY/DATE	SUBJECT
	Chapter 7. Arbitrary Lagrangian Eulerian formulations (ALE)
Thu 4/4	Introduction to ALE (7.1). ALE continuum mechanics (7.2).
Tue 4/9	ALE governing equations and its weak form (7.3 thru 7.5).
Thu 4/11	Introduction to Petrov-Galerkin method (7.6).
Tue 4/16	Petrov-Galerkin formulation of momentum equation (7.7).
	Project #1a: Advection-diffusion problem (due in 2 weeks)
	Project #1b: ABAQUS ALE simulation (due in 2 weeks)
	Introduction to Micromechanics & RVE simulations
Thu 4/18	Overview on the analytical treatment of micromechanical problems: Eshelby problem.
Tue 4/23	Micromechanical FEA using RVEs.
	Project #3: RVE simulation of bimaterial unit cell (due in 2 weeks)
	Chapter 11. Extended Finite Element method (XFEM)
Thu 4/25	Conventional methods of modeling fracture. Introduction to XFEM: level set function, partition of unity property, and enrichment functions.
Tue 4/30	Modeling cracks using XFEM.
Thu 5/2	Implementation details of XFEM in 1D.
Tue 5/7	Modeling bimaterial interfaces with XFEM.
	Project #2: XFEM 1D code for weak discontinuities (due in 2 weeks)
Thu 5/9	XFEM in multi-dimensions.
	Chapter 12. Introduction to Multiresolution Continuum Theory (MCT)
Tue 5/14	Introduction to generalized mechanics.
Thu 5/19	Micromorphic theory.
Tue 5/21	MCT as a generalization of the micromorphic theory.
Thu 5/23	Finite element implementation of MCT.
Tue 5/28	Overview on the development of constitutive laws for MCT.
	Project #4: Multiresolution 1D code (due in 2 weeks)
	Chapter 13. Crystal Plasticity
Thu 5/30	Crystal plasticity fundamentals. Connections between mechanics and material science.
Tue 6/4	Basics of dislocation theory, crystallography and hardening laws.
Thu 6/6	Numerical implementation of crystal plasticity.

Prerequisites: ME/CEE-426-1 (Adv FEM I). Prior knowledge on FEA tool (ABAQUS) is desired but not necessary.

Text Book: Belytschko T, Liu WK, Moran B, Elkhodary K, Nonlinear Finite Element for Continua and Structures, John Wiley & Sons LTD, 2nd Edition 2013. New Chapters were added to the previous edition (Chapters 11, 12 and 13).

Projects: MATLAB & ABAQUS projects. Projects are due 2 weeks after day assigned.

Office Hours: Prof. W.K. Liu – Any time whenever present and not busy, or by appointment. Miguel Bessa – Wed. 2-4pm, or by appointment. John Moore – Mon. 9-10am, or by appointment. Patrick Lea – by appointment.

Grading: Class participation 10%. Projects 90%.