ME-CEE 327 Finite Element Methods in Mechanics Fall 2017

Instructors: **Professor Wing Kam Liu and Professor Mark Fleming of Caulfield Engineering**

Days and Times: Tu, Th 12:30pm-1:50pm, **Tech LR2**

Office hour: Professor Wing Kam Liu: Tu Th 11:15am-12:15pm, Fri 9-10am, Tech A327

TAs: Mon Wed 3:30pm-5:00pm, Tech A311 or by appointments

TAs and Computer Instructors: **Lead TA** Saeed Rahimi Aghdam SaeedRahimiAghdam2013@u.northwestern.edu

Joint TAs: 1/3 Mahsa Tajdari MahsaTajdari2021@u.northwestern.edu; 1/3 Dmitriy Olegovich Kats DmitriyKats2021@u.northwestern.edu; 1/3 Kevontrez Kyvon Jones KevontrezJones2021@u.northwestern.edu

4 Graders: Rahimi Aghdam, Mahsa Tajdari, Dmitriy Olegovich Kats, Kevontrez, Kyvon Jones

COURSE OBJECTIVES:

To learn the basic theory behind the finite element method (FEM), how to program the FEM using MATLAB, and how to use a general commercial FEM codes to write interface programs and solve practical engineering problems.

	Topics	Problems
Week 1 Sep 19 & 21	**Fish and Belytschko:** Ch. 2 (Sections 2.1-2.3): 1D problems, element stiffness matrix, assembly	**HW1:** 2.1, 2.2
Week 2 Sep 26 & 28	**Fish and Belytschko:** Ch. 3 (Sections 3.1-3.6): Strong and weak forms	**HW2:** 3.1, 3.2, 3.3, 3.7
Week 3 Oct 3 & 5	**Fish and Belytschko:** Ch. 4 (Sections 4.1-4.5): Element shape functions, Gauss quadrature **Fish and Belytschko:** Ch. 5 (Sections 5.1-5.2): FEM for 1D elasticity **Optional reading:** 1D elasticity, heat conduction, advection-diffusion	**HW3:** 3.10, 4.1, 5.17 (a, b) **Comp HW1:** 1D FEM in MATLAB part 1 (due Oct 19)
Week 4 Oct 10 & 12	**Fish and Belytschko:** Ch. 6: Strong and weak forms in 2D **Abaqus Tutorial 1 (Oct 13)** **Supplementary:** FEM for 2D & 3D problems with Laplace equation	**Comp HW2:** 2D Abaqus (due Oct 26)
Week 5 Oct 17 & 19	**Fish and Belytschko:** Ch. 7 (Sections 7.1-7.2): Shape functions in 2D **Supplementary:** Lagrangian polynomials and numerical integration **Optional reading**: Ch. 7 (Sections 7.3-7.8)	**HW4:** 5.16, 6.1, 7.1 **Need correction for 5.16**
Week 6 Oct 24 & 26	Review **Midterm**	
Week 7 Oct 31 & Nov 2	**Fish and Belytschko:** Ch. 4 (Section 4.6) Gauss quadrature **Supplementary reading:** Elasticity tensor notes, principle of virtual work in multiple dimensions **Recommended**: Ch. 9: Stress analysis in 2D	**Comp HW3 (assigned on Tues Oct 31):** 1D FEM in MATLAB part 2 (**due Nov 14**)
Week 8 Nov 7 & 9	**Abaqus Tutorial 2 (Nov 10)** Principle of Virtual Work	**Comp HW4 (assigned on Tues Nov 7):** 2D & 3D stress analysis in Abaqus (due Nov 21)
Week 9 Nov 14 & 16	**Advanced Topics:** Hyperelasticity (Nov 14) **Advanced Topics:** Viscoelasticity (Nov 16)	**Comp HW5**: Viscoelasticity in Abaqus (due Nov 30)
Week 10 Nov 21 Nov 23 no lecture (Thanksgiving)	**Advanced Topics:** Viscoelasticity (Nov 21)	
Week 11 Nov 28 & 30	**Hypermesh and LS-Dyna Tutorial (Nov 28)** Make-up lectures and review	
Week 12	**FINAL EXAM** – to be determined	

GRADING: Written homework 15% (due 1 week after assigned), computer assignments 35% (due 2 weeks after assigned), exams 50%. All homeworks will be assigned Thursday and due Thursday, except for Comp HW2, which will be assigned Tuesday Oct 11 and due Oct 25.

TEXTBOOKS: Required: J. Fish and T. Belytschko. *A first course in finite elements*. Wiley & Sons Ltd., West Sussex, UK, 2007.

Highly Recommended: T.J.R. Hughes, *The Finite Element Method: Linear Static and Dynamic Finite Element Analysis.* Dover Publications, Inc., Mineola, NY, 2000.