COURSE NOTES

Instructor in Charge	**Ronaldo I. Borja** Y2E2, Room 277C Tel. (650)723-3664 email: borja@stanford.edu Office Hours: 1:30–2:30 pm, MW
Course Assistant	**Julia T. Camargo** email: jcamargo@stanford.edu **Yitao Gao** email: yitaogao@stanford.edu
References	**The Finite Element Method (FEM)** By T.J.R. Hughes **Computational Poromechanics (CP)** By R.I. Borja

Notes:

1. The course deals with problems of fluid conduction (first half) and solid deformation (second half) solved with the finite element method. The intent of the course is to demonstrate how the finite element method can be used to solve many types of engineering problems. A second course offered in spring, CEE 314, will focus on coupled fluid conduction/solid deformation processes.

2. There will be problem sets and two computing assignments that will make use of the software ANSYS. Programming skills in Matlab, C++, or similar languages are needed for some of the homework.

3. There will be a midterm examination and a take-home final examination. Weighting for the final grade is as follows: Homework = 30%; Midterm Examination = 30%; Final Examination = 40%.

4. The class website is: `http://web.stanford.edu/~borja`

COURSE SYLLABUS

Week 1	Gauss theorem · volume integral · Lagrangian and Eulerian descriptions · material time derivatives • *CP 2.1–2.5, App 2.1, 2.2*
2	Mass conservation equation · volume fraction · fluid flow • *Lecture Notes* Formulation of one-dimensional BVP for fluid conduction • *FEM 1.1–1.3*
3	Strong and weak forms · Galerkin approximation · matrix form · piecewise linear approximations · element point of view • *FEM 1.4–1.11*
4	Formulation of 2D & 3D BVP for fluid conduction · generalized Darcy's law Data processing arrays: ID, IEN, and LM • *FEM 2.1–2.6*
5	Basic shape functions: triangular and bilinear quad element • *FEM 3.1–3.4* Numerical integration · assembly operations • *FEM 3.8*
6	Momentum conservation · generalized Hooke's law • *CP 2.5, App 2.3* **Midterm Examination: Friday, February 14**
7	Strong and weak forms for linear elastostatics · Galerkin approximation · matrix form • *FEM 2.7–2.9*
8	Strain-displacement matrix $\boldsymbol{B}$ · elastic stress-strain matrix $\boldsymbol{C}$ · numerical integration • *FEM 3.8*
9	Isoparametric elements: triangular, quadrilateral, tetrahedral, hexahedral Element stiffness · assembly operations • *FEM 3.1–3.8*
10	Residual form of finite element equations • *Rest of FEM Chapter 3* **Take-Home Final Examination**