Course Syllabus

Course Information

Course Number/Section	BMEN4v95.002
Course Title	Undergraduate Topics in Biomedical Engineering: Finite Element Analysis in Biomedical Engineering
Term	Spring 2018
Days & Times	Tuesdays and Thursdays 10:00 am – 11:15 am
Location	ML1 1.106

Contact Information

Instructor Contact Information

Instructor	Clark Meyer, PhD
Office Phone	972-883-4175
Email Address	cam140130@utdallas.edu
Office Location	BSB 13.562
Office Hours	by appointment (suggest a time or range of times via email)

TA Contact Information

Teaching Assistant	Taek ("Tek") Kang
Email Address	taek.kang@utdallas.edu
Office Hours	TBA

Course Pre-requisites, Co-requisites, and/or Other Restrictions

Biomechanics and linear algebra – OR senior status and consent of instructor (provided by email to those seniors that have completed linear algebra but not biomechanics).

Course Description

Lecture course. The course will provide an introduction to the finite element method with an emphasis on applications in biomedical engineering. Traditionally rooted in structural engineering, finite element methods are used in simulating the mechanical response of the human body and medical devices. Theories will be reinforced through practical applications primarily using commercial simulation software. The course will also briefly cover methods of creating computational models from medical image sets.

Program Educational Objectives

Biomedical Engineering Bachelor's graduates are expected to attain the following Program Educational Objectives within a few years after graduation:

Careers that lead to leadership roles in biomedical engineering or related fields
or
Gain admission to graduate, professional, or health related programs.

Student Learning Objectives/Outcomes

1. Achieve an understanding of and ability to derive equations used in the finite element method; e.g. weak form, shape functions, constitutive relations (SO: a).
2. Learn to setup conditions for simulations of medical devices' mechanical performance using suitable assumptions (SO: e).
3. Learn to create and run simulations of medical devices' mechanical performance using commercial software (SO: k).

Textbooks and Materials

Primary text (required)

R. B. Dupaix, Becoming a Finite Element Analyst: A Design-Model-Verify Approach, 1st edition, Cognella, Inc., 2016. ISBN: 978-63189-959-1

Required Materials

Software (available online or free through the university):
FEbio – available from febio.org (not in ML1)
Abaqus – free student version available online (not in ML1)
Mimics – access to student version available in ML1 and through instructor
Matlab – access available in ML1, library, and through UTD
SolidWorks – access available in ML1 and library
COMSOL – access available in ML1

Additional Suggested Course Materials

Personal computer for using febio, abaqus, and mimics etc. off-campus
Suggested textbooks
B. J. MacDonald – Practical Stress Analysis with Finite Elements
K-J Bathe – Finite Element Procedures
J. N. Reddy – An Introduction to Nonlinear Finite Element Analysis: with applications to heat transfer, fluid mechanics, and solid mechanics
J. D. Humphrey – Cardiovascular Solid Mechanics: Cells, Tissues, and Organs

Assignments & Academic Calendar

(Topics, Reading Assignments, Due Dates, Exam Dates)

Homework will be assigned approximately weekly and submitted via elearning. Students should plan to spend time studying and reviewing material outside of class in addition to setting aside time necessary for completing homework. Familiarity with software will be achieved through assignments. A project in the second half of the course that will require substantial time outside of class.

Topics to be covered

1. Course Overview and Introduction
    a. Introduction to finite element methods and analysis
    b. Brief history of finite element methods

    c. Overview of current use in medical device applications
    d. Sample analysis example walkthrough (geometry, mesh, loads/BCs, load steps, solution, post-processing)
    e. Types of analyses (by dimensionality and purpose)
2. Mathematical and Continuum Mechanics Preliminaries
    a. Vectors, matrices, tensors (up to 4th order)
    b. Mechanical equilibrium, index notation
    c. Measures of stress, strain, displacement
    d. Material properties
    e. SI units, unit-free methods
3. Details of Theory
    a. Weak form
    b. Elements and nodes
        i. Element types
        ii. Shape functions
        iii. Gauss points
    c. Boundary conditions
        i. Fixed
        ii. Displacement
        iii. Symmetry
        iv. Contact
    d. Constitutive equations
    e. Solvers
4. Software Introduction
    a. FEbio, Abaqus, SolidWorks, COMSOL
    b. Limitations (contact, constitutive equations)
    c. Setting up and solving simple problems
    d. Convergence issues and resolving them
5. Image Segmentation
    a. Software
    b. Methods
    c. Pitfalls
    d. Case studies
6. FDA Guidance on Computational Modeling Reporting
7. FEA Software Revisited
    a. Using image derived parts
    b. Post-processing
    c. Verifying results
    d. Scripting
8. Additional Theory & Implementation Topics
    a. Explicit Solvers
    b. Shape memory materials
    c. Viscoelastic materials
    d. Goodman diagrams

Key Dates
Midterm Exam: March 1, 2018
Project Due: April 23, 2018
Final Exam: between May 1 and May 7, 2018, see coursebook.utdallas.edu for details

Grading Policy

Midterm: 20 %	Final: 30%	Homework: 20%
Quizzes: 15%	Project: 15%	

Letter Grade:

A+	> 97.00%	B-	82.99-80.00%	D+	69.99-67.00%
A	96.99-93.00%	C+	79.99-77.00%	D	66.99-63.00%
A-	92.99-90.00%	C	76.99-73.00%	D-	62.99-60.00%
B+	89.99-87.00%	C-	72.99-70.00%	F	< 60.00%
B	86.99-83.00%				

Course Policies

Make-up Exams
All students are expected to take the exams on the dates posted in the class schedule and as announced by the instructor. The final exam will be during the University's final exams period. Unavoidable conflicts must be communicated to the instructor ahead of time. Missing exams, quizzes, etc. without email notification in advance of the absence will result in a grade of zero for the assignment or test in all but situations due to emergency.

Late Work
No late work will be accepted without prior authorization.

Class Attendance
Class attendance is expected but will not be directly recorded. Failure to be present for a quiz (quizzes may not be announced ahead of time) or test will result in a zero for that activity. A make-up will not be offered if a student is unexpectedly absent for reasons other than an emergency.

Classroom Citizenship
Each student is expected to participate during lecture and associated discussion. Do not use phones during class.

UT Dallas Syllabus Policies and Procedures

The information contained in the following link constitutes the University's policies and procedures segment of the course syllabus.
Please go to http://go.utdallas.edu/syllabus-policies for these policies.

The descriptions and timelines contained in this syllabus are subject to change at the discretion of the Professor.