

Course Syllabus

Course Information

<i>Course Number/Section</i>	BMEN 4V95.001
<i>Course Title</i>	Undergraduate Topics in Biomedical Engineering: Finite Element Analysis in Biomedical Engineering
<i>Term</i>	Fall 2015
<i>Days & Times</i>	Mondays and Wednesdays 11:30am-12:45pm
<i>Location</i>	ECSS 4.417

Instructor Contact Information

<i>Instructor</i>	Clark Meyer, PhD
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<i>Office Location</i>	SPN 2.222
<i>Office Hours</i>	by appointment (suggest a time via email)

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

BMEN 3301 (Biomechanics) and ENGR 2300 (Applied linear algebra for engineers) – OR consent of instructor (provided by email).

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.

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).

Required Textbooks and Materials

Required Texts

B. J. MacDonald, Practical Stress Analysis with Finite Element, 2nd edition, Glasnevin Publishing, 2011. ISBN: 0955578167

(OTHER TEXTS NOT REQUIRED)

Required Materials

Software available online (free):

FEbio – available from febio.org

Abaqus – free student version available online:

<http://academy.3ds.com/software/simulia/abaqus-student-edition/>

Mimics – access to student version available through instructor (free)

Software available in computer labs:

SolidWorks

Suggested Course Materials

Suggested Readings/Texts

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

Assignments & Academic Calendar

Topics, Reading Assignments, Due Dates, Exam Dates

Homework will be assigned approximately weekly. Students should plan to spend time studying and reviewing material outside of class in addition to time necessary for completing homework. Familiarity with software will be achieved through assignments and a project in the second half of the course that will require time outside of class. In the first half of the course, students will do limited programming in Matlab to understand the methods and their implementation. Students will also utilize SolidWorks for some simple analyses in the first half of the course.

08/24, 08/26

1. Course Overview and Introduction
 - a. Introduction to finite element methods and analysis
 - b. Brief history of finite element methods
 - c. Current use in medical device applications
 - d. Sample analysis example walkthrough (geometry, mesh, loads/BCs, load steps, solution, post-processing)

08/31, 09/02

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, free body diagrams
 - d. Constitutive equations (simple)
 - e. SI units, unit-free methods, failure analyses, Goodman diagram

09/07 – University closed

09/09

3. Finite element procedure
 - a. Types of analyses (quasi-static, buckling, harmonic)
 - b. Steps

09/14, 09/16

4. Elements and nodes
 - a. Element types
 - b. Shape functions
 - c. Gauss points
 - d. Appropriateness of type

09/21

5. Meshing
 - a. Creating
 - b. Adequacy / Independence

09/26

6. Boundary conditions
 - a. Fixed
 - b. displacement
 - c. symmetry

09/28, 10/02

7. Software Introduction
 - a. FEbio, Abaqus, SolidWorks
 - b. Other popular choices
 - c. Limitations (contact, constitutive equations)

10/12, 10/14

8. Solutions
 - a. Behind the scenes of solvers
 - b. Convergence issues and resolving them

10/19, continued after mid-term on 10/26

9. Solving simple problems
 - a. Hand calculations from biomechanics
 - b. SolidWorks
 - c. FEbio
 - d. Abaqus

10/21

Mid-term over materials from 10/14 and earlier

10/28, 11/02a

10. FDA guidance on computational modeling reporting

11/02b, 11/04, 11/09

11. Image segmentation
 - a. Mimics, other software options
 - b. Methods
 - c. Pitfalls

11/11, 11/16, 11/18

12. Case studies of FEA in biomedical engineering
 - a. Knee
 - b. Hip implant
 - c. Cardiovascular stent

11/23, 11/25 - University Closed

11/30, 12/02

13. FEA software revisited
 - a. FEbio, Abaqus
 - b. Post-processing
 - c. Scripting
 - d. Explicit solvers

12/07

14. Advanced material property modeling
 - a. Shape memory materials
 - b. Viscoelastic materials

12/09

15. Final review

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. Unavoidable conflicts must be communicated to the instructor ahead of time. Missed exams without e-mail notification in advance of the absence will result in a grade of zero for the assignment or test.

Late Work

No late work will be accepted without prior authorization.

Class Attendance

Class attendance is expected. 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. No make-up will be offered if a student is unexpectedly absent for reasons other than an emergency situation.

Classroom Citizenship

Each student is expected to participate in the quizzes 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.