**this syllabus is subject to change; changes will be provided in hard copy during class

Biomechanical Engineering, AME/BME 466/566
Fall 2011
University of Arizona
MW 3p-4:15p
AME S336

__Instructor:__ Jonathan P. Vande Geest, PhD

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__office hours:__ M 12p-1p, F 4p-5p

__Preferred method of contact__: email

__Note on office hours__: Please adhere to the office hours above. If you cannot make one of these, then I would appreciate your contacting me via phone to setup a time to meet. Please do not stop by my office randomly. This will require planning on your part!

__Prerequisites:__ Basic knowledge of engineering solid mechanics. Junior, Senior or Graduate Standing. Working knowledge of calculus.

__Course Description:__ The course will present selected basic research applications of biosolid and biofluid mechanics in the field of biomechanical engineering. Typical areas to be covered in this course will include biosolids: "hard" tissues (orthopedics and dentistry), "soft" tissues (cardiovascular, ocular, cartilage). Both natural and artificial biomaterials (grafts, prostheses, tissue engineering) will be discussed. Biofluids areas will include both the macro and micro circulation (circulatory blood flow, flow in stenoses, pulsatile flow-wave propagation, blood rheology, and flow in micro vessels). Finite element analysis will also be introduced to illustrate the analysis of selected complex biological problems. Fundamental engineering principles and some life science background will be developed as necessary for each topic area. In addition, introductory experimental methods in biomechanical engineering will be presented and discussed through student participation in experiments within the Soft Tissue Biomechanics Laboratory and through the fulfillment of a comprehensive laboratory report detailing these experiments.

__Course Objectives:__ Upon completion of this course, students should:

1) understand the meanings of stress and strain as it relates to biological tissues
2) have a thorough knowledge of the experimental techniques used to assess the mechanical behavior of living tissues
3) appreciate the use of the finite element method in analyzing complex biomechanical problems
4) understand what constitutive modeling involves
5) understand the relationship between tissue structure and function in biological materials
6) apply mechanical engineering principles to analyze a mechanically relevant medical problem

7) be able to critically review a topic within biomechanics in both written and oral forms (grad students)

Course Overview

Laboratory Project
Term project (mandatory for 566 students)
Homework
1 Midterm
1 Comprehensive Final Examination

GRADING: The grade distribution for this course will be broken down in the traditional way (100-90 A, 90-80 B, 80-70 C, 70-60 D, < 60 D)

466 Grading:

- 10% Homework
- 10 % Attendance
- 25% Midterm
- 25% Lab report
- 30% Comprehensive Final Exam

566 Grading:

- 10 % Homework
- 10 % Attendance
- 20% Midterm
- 20% Lab report
- 20% Comprehensive Final Exam
- 20% Term Project

Laboratory Project

There will be laboratory sessions in which student groups will perform mechanical testing and computational modeling within the Soft Tissue Biomechanics Laboratory (AME N305, S438). Each student will be responsible for writing a laboratory report detailing a description of the mechanical test or computational model, including presentation and interpretation of acquired data.

Term Project (mandatory for 566)

For all students enrolled in 566, there will be a term project which will involve an extensive written (50%) and oral (50%) critical review of a research paper taken from the biomechanics literature. The paper must address a topic of *current* interest in biomechanical engineering (be taken from a biomechanics journal and published within the last five years). The critical review will include 1) a comprehensive literature review of the paper's topic (you should cite any references), 2) a detailed review of the papers contents, 3) suggestions on how the paper/study could be improved, and 4) a discussion of how the current paper relates/improves the current state of the art in biomechanics (how this paper is related to other research in the literature). Typical length of the written portion of the term project will be 10 typewritten pages (this does not include the list of references). The oral presentation will be ~15 minutes. The oral portion of the project will be scored by both the instructor (85% of score) and all students (15% of score) using the below table/criteria. UNDERGRADUATE EXTRA CREDIT: Students enrolled in AME/BME 466 interested in gaining up to 3% points on their final grade may also participate in the Term Project (this decision needs to be made by the day of Midterm I). Whether you are a 466 or 566 student, you **MUST** have a paper chosen **by the day of the Midterm**. This will involve approval from the instructor by this date (please email me this request).

Category	Total points (0=worst, 10=best)
Background (Why is the work important? What is the clinical significance? Goals/purpose of paper clearly outlined?)	
Methods (Technical detail sufficient and understandable?)	
Results (Interpreted correctly? Clearly presented?)	
Discussion (Tie in results with goals/purpose? How is the paper clinically relevant? Limitations of paper?)	
Critique of paper (What do you feel that they did wrong, if anything? What could they have done better? What are some sources of error? If you were to re-do this study, what would you do differently?)	
Future work (What do you feel are the next steps in follow up to this study?)	
Adherence to time limit for presentation – 10 min max for actual oral presentation	
Answers to questions from audience	
Quality of presentation (delivery, visual aids, etc.)	
TOTAL	

Other grading policies:

- Midterm and Final Exam must be taken on the day they are scheduled….no exceptions, no makeups!
- Late homework and reports will not be accepted (HW due at beginning of lecture)
- Projects and homework which are not CLEARLY written will receive a zero score
- For short answer questions, circle or box all answers on homeworks and exams
- Attendance will be counted as 10pts for each day of class attendance. Students will be given one excused or unexcused absence, and will receive 0/10 for all other absences.

Guest Lecturers.

Timothy Secomb, PhD (Mathematics and Physiology)
Marvin Slepian, MD (Sarver Heart Center, SynCardia)

Appendix Other References

1. Books

An Introduction to Biomechanics: Solids, Fluids, and Design, Jay D. Humphrey and Sherry L. Delange

Computational Methods in Bioengineering, R. L. Spilker and B. R. Simon (eds.), ASME BED-Vol. 9, New York, 1988.

Biodynamics: Circulation, Y. C. Fung, Springer-Verlag, New York, 1984.

Biomechanics of Diarthrodial Joints, I & II, Springer-Verlag, New York, 1990.

Biomechanics: Its Foundations and Objectives, Y. C. Fung, N. Perrone, and M. Anliker (eds.),
Prentice-Hall, Englewood Cliffs, 1972.

Biomechanics: Mechanical Properties of Living Tissues, Y. C. Fung, Springer-Verlag, New York, 1993.

Biomechanics: Motion, Flow, Stress, and Growth, Y. C. Fung, Springer-Verlag, New York, 1990.

Biomaterials, An Introduction, J. B. Park, Plenum, New York, 1979.

Bone Mechanics, S. C. Cowin, CRC Press, 1989.

Data Book on the Mechanical Properties of Living Cells, Tissues, and Organs, H. Abe, K. Hayashi, and M. Sato, Springer-Verlag, New York, 1996.

Finite Elements in Biomechanics, R. H. Gallagher, B. R. Simon, P. C. Johnson, and J. F. Gross (eds.), Wiley, New York, 1982.

A First Course in Continuum Mechanics, Y. C. Fung, Springer-Verlag, New York, 1980.

Frontiers in Biomechanics, G. W. Schmid-Schonbein, S. L-Y. Woo, and B. W. Zweifach (eds.), Springer-Verlag, New York, 1986.

Foundations of Solid Mechanics, Fung, Y. C., Prentice-Hall, New Jersey, 1965.

Classical & Computational Solid Mechanics, Fung, Y. C and Tong, P., World Scientific Publ, 2001.

Handbook of Bioengineering, R. Skalak and S. Chien (eds.), McGraw Hill, New York, 1987.

Introduction to Bioengineering, S. A.Berger, W. Goldsmith, E. R. Lewis (eds.), Oxford, 1996.

Proc. Intl. Conf. Finite Elements in Biomechanics,Vols. 1 and 2, B. R. Simon (ed.), U. of Arizona, Tucson, 1980.

Strength of Biological Materials, H. Yamada (F. G. Evans, ed.), Williams & Wilkins, Baltimore, 1970.

The Finite element method in the 1990's : a book dedicated to O.C. Zienkiewicz, Onate, E. . Other FEM texts also available at Science Library.

A First Course in the Finite Element Method using Algor, Logan, PWS Publ, 2001.

Cardiovascular Solid Mechanics, Cells Tissues and Organs, Jay D. Humphrey 2002

2. selected conference proceedings (some on CD in Dr. Vande Geest's office)

ASME Summer Bioengineering Conferences
BMES annual meetings
Association of Research in Vision and Ophthalmology

3. Biomechanics Journals
   - Annals of Biomedical Engineering
   - Computer Methods in Biomechanics and Biomedical Engineering
   - Journal of Applied Biomechanics
   - Journal of Biomechanics
   - Journal of Biomechanical Engineering
   - Biomechanics and Modeling in Mechanobiology
   - Journal of Orthopaedic Research

Students with Disabilities

If you anticipate issues related to the format or requirements of this course, please meet with me. I would like us to discuss ways to ensure your full participation in the course. If you determine that formal, disability-related accommodations are necessary, it is very important that you be registered with Disability Resources (621-3268; drc.arizona.edu) and notify me of your eligibility for reasonable accommodations. We can then plan how best to coordinate your accommodations.