SYLLABUS
ME/BE/MS 524: Skeletal Tissue Mechanics

Professor Morgan
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3-2791
ENG 221
Office Hours: M 3:00 – 4:30 p.m.; F 1:30 – 3 p.m.

Course Description: Skeletal tissues—bone, cartilage, tendon and ligament—serve functions that are largely mechanical in nature and that are critical for our health. This course is structured around classical topics in mechanics of materials and their application to study of the mechanical behavior of skeletal tissues, whole bones, bone-implant systems, and diarthroidal joints. Topics include: mechanical behavior of tissues (anisotropy, viscoelasticity, fracture and fatigue) with emphasis on the role of the microstructure of these tissues; structural properties of whole bones and implants (composite and asymmetric beam theories); and mechanical function of joints (contact mechanics, lubrication and wear). Emphasis is placed on using experimental data to test and to develop theoretical models, as well as on using the knowledge gained to address common health related problems related to aging, disease, and injury.

Course Format: Semiweekly lectures with 6 approx. semimonthly homework assignments (30%), one midterm (30%), one course project (oral presentation, 15%), and a final exam (25%).

Course Prerequisites: An undergraduate-level understanding of the mechanics of rigid bodies, mechanics of materials, and linear algebra is required. No previous courses in anatomy, physiology or biochemistry are required.

Course Text and Readings:
1. Martin, R. Bruce, Burr, David B., Sharkey, Neil A. Skeletal Tissue Mechanics. New York: Springer-Verlag, 1998. Sci/Eng reserve QP88.2.M184
2. Readings distributed over course of semester

Course Policies: *Academic Conduct.* This course adheres to the policies stated in the conduct code of the College of Engineering. *Homework.* Homework solutions must be neat and well-written. If you use computer programs to solve any of the homework problems, the code/script must be included with your solutions. If you include any graphs as part of your homework solutions, each graph must be clearly labeled, and the remainder of the solution should unambiguously refer to the graph/figure by its label and page number. Any reference materials, whether print materials or personal communication, must be cited. Late homework will receive a maximum of 50% credit and will be accepted only if an extension was given prior to the due date. *Project.* Each student will give a presentation covering two related journal articles in the general area of mechanical behavior of skeletal tissue. The presentations will be 10 minutes long followed by a 5-minute-long class discussion. Presentations will be given during the last three lecture periods of the course. The articles must be approved by the instructor and emailed to the instruction one week before the presentation. *Exams.* One in-class midterm exam will be given.

A comprehensive final exam will be given during the exam period.

Schedule:

Theme/Date	Topic	Reading ("Suppl."=supplemental)
The Skeleton as a Structure		
9/3	Course Introduction and Basic Anatomy	Suppl.
9/5	Static Analysis of Muscle and Joint Forces	Suppl., 1.1-1.8
Mechanics of Hard and Soft Skeletal Tissues		
9/10, 9/12	Mathematical Preliminaries	Suppl., 4.1-4.2
9/17, 9/24*, 9/27	Anisotropic Elasticity	2.1-2.5, 4.4-4.7, Suppl.
10/1, 10/3	Viscoelasticity	2.6, 7.1-7.2, 8.1-8.11, Suppl.
10/8, 10/10, 10/17*	Poroelasticity, Mixture Theories, Swelling	Suppl.
10/22, 10/29*	Damage, Fracture and Fatigue	Suppl., 5.1-5.12
Mechanics of Whole Bones and Bone-Implant Systems		
10/31	**MIDTERM**	
11/5	Asymmetric Bending	Suppl.
11/7, 11/12	Composite Beam Theory	Suppl.
Mechanical Adaptation of Skeletal Tissues		
11/14, 11/19, 11/21	Remodeling and Tissue Differentiation	Suppl., 2.9, 3.1-3.6, 6.1-6.9
Synthesis and Summary		
12/3*, 12/5, 12/10	Student Presentations	
TBD	**FINAL EXAM**	

* No class on 9/19, 10/15, 10/24, 11/26, 11/28

Reserve Texts (This Course):

Malvern, Lawrence E. Introduction to the Mechanics of a Continuous Medium. Englewood Cliffs: Prentice-Hall, 1969. Sci/Eng reserve QA808.2.F691

Carter, Dennis R. and Beaupré, Gary S. Skeletal Function And Form: Mechanobiology Of Skeletal Development, Aging, And Regeneration. Cambridge: Cambridge University Press, 2001. Mugar reserve RC925.5.C27

Nigg, Benno M. and Herzog, Walter, eds. Biomechanics of the Musculoskeletal System. 2nd edition. New York: Wiley, 1999. Sci/Eng reserve QP301.B478

Nordin, Margareta and Frankel, Victor H., eds. Basic Biomechanics of the Musculoskeletal System. 3rd edition. Philadelphia: Lippincott Williams & Wilkins, 2001. Sci/Eng reserve QP303.N57

Archer, Charles W., Caterson, B., Benjamin, M. Ralphs, JR., Biology of the Synovial Joint. Amsterdam: Harwood Academic, 1999. Sci/Eng reserve QP323.B54

Bilezikian John P., Raisz, Lawrence G., Rodan, Gideon A. Principles of Bone Biology. 2nd edition. Volumes 1 and 2. San Diego: Academic Press, 2002. Sci/Eng reserve QP88.2.P735

Reserve Texts (General) :

Mow, Van C., Huiskes, Rik. Basic Orthopaedic Biomechanics and Mechanobiology. 3rd edition. Baltimore: Lippincott Williams & Wilkins, 2005. Mugar RD732.B353

Grant, J.C. Boileau. Atlas of Anatomy. Baltimore: Williams & Wilkins, 1978. Sci/Eng reserve HS367.BK02 and Mugar Reference X QM25.G7

Fung, Yuan-Cheng. Biomechanics : Mechanical Properties of Living Tissues. New York : Springer-Verlag, 1981. Sci/Eng reserve QP88.F87

Other Texts:

Cowin, Stephen C., ed. Bone Mechanics. Boca Raton: CRC Press, 1989. Sci/Eng QP303.B66

Fung, Yuan-Cheng. Biomechanics : motion, flow, stress, and growth. New York : Springer-Verlag, 1990. Sci/Eng QP303.F86

Sahay, K.B. and Saxena, R.K. Biomechanics. New York: Wiley, 1989. Sci/Eng QP303.B568

Wainwright, S.A. Mechanical Design in Organisms. Princeton: Princeton University Press, 1982. Sci/Eng QP303.M4

Martin, R. Bruce and Burr, David B. Structure, Function, and Adaptation of Compact Bone. New York: Raven Press, 1989. Sci/Eng QP88.2.M185

Currey, John D. The Mechanical Adaptations of Bones. Princeton: Princeton University Press, 1984. Sci/Eng QP88.2C87

Chadwick, Peter. Continuum Mechanics: Concise Theory and Problems. New York: Wiley, 1976. Sci/Eng QA808.2 C48

Currey, John D. Bones. Princeton: Princeton University Press, 2002.

Bartel, Donald L., Davy, Dwight T., and Keaveny, Tony M. Orthopaedic Biomechanics: Mechanics and Design in Musculoskeletal Systems. Prentice Hall, 2006.