Spring 2022

ENG BE 420 Introduction to Solid Biomechanics

Dimitrije Stamenović (Instructor)
Katie Bunde and Joseph Hall (TAs)

Tues. & Thurs., 3:30 – 5:15 pm

This is an introductory course whose main goal is to acquaint students with basic concepts of stress, strain, constitutive laws and their applications to biomechanics. ***The focus will be on the theoretical developments and basic foundations of solid mechanics using the mathematical framework of vectors, and tensors.*** The course will prepare students for advanced courses in traditional fields of solid mechanics (elasticity, plasticity, viscoelasticity, poroelasticity), finite element methods and other numerical methods in solid mechanics, as well as emerging fields (computational mechanics, nanotechnology, biotechnology). Illustrative examples from tissue and cell biomechanics will be given where appropriate.

- **Prerequisites:** differential equations (MA 226), linear algebra (EK 103), and engineering mechanics-statics (EK 301) or equivalent.
- **Textbook:** Hjelmstad, K. D. *Fundamentals of Structural Mechanics*, 2nd edition, Springer, New York, 2005.
- **Lecture Notes:** Available on-line.
- **Additional Texts:**
  1. Atkin, R. J., and Fox, N. *An Introduction to the Theory of Elasticity*, Longman, London, UK, 1980
  2. Humphrey, J. D., and Delange, S. L. *An Introduction to Biomechanics*, Springer, New York, 2004.
  3. Ward, J. P. *Solid Mechanics – An Introduction*, Kluwer, Dordrecht, Netherlands, 1992.
  4. Beer F. P., Johnston, E. R. Jr., and DeWolf, J. T. *Mechanics of Materials*, 4th edition, McGraw-Hill, 2006.
  5. Hibbler, R. C. *Mechanics of Materials*, 6th edition, Pearson Prentice Hall, 2005.
  6. T. J. Lardner, R. R. Archer: *Mechanics of Solids: an Introduction*, McGraw-Hill, 1994.

- **Lecture Topics:**
  1. Introduction.
  2. Statics of trusses, beams, and frames (application of tensed cable nets in biomechanics of cells and tissues, shear forces and bending moments diagrams of beams and frames).
  3. Simple beam theory (extension, bending, buckling, and torsion).
  4. Vectors and tensors (algebra and calculus).

5. Kinematics of deformation (deformation, deformation gradient, stretch, strain, rotation, principal strain).
6. Traction and stress (traction vector, stress tensor, shear and normal stress, principal stresses.)
7. Elastic constitutive theory (linear and nonlinear equations, strain energy).
8. Linear viscoelasticity (creep, relaxation, hysteresis, lumped spring-dashpot models). If time permits.

- **Course Grade:**
  1. Weekly quizzes (Thurs., 20 min.; 10 best quizzes, total 50 pts.)
  2. Weekly homework (given on Tues.; homework assignments are not graded.)
  3. Two midterm exams (2 h, 50 pts. each). The exams are tentatively scheduled for **February 24** and **April 7**.
  4. Final exam (2 h, 50 pts.).

The exam with the lowest score will be dropped from the final score. Students who on all quizzes and two midterms do better than 90% will be **exempted from the final exam** with the final grade of an A (95-100%) or an A– (90-95%). Students who are not exempted will be graded according to a z-score criterion: z = (your score – class average)/standard deviation.

Students are encouraged to attend lectures, discussions and office hours.

- **Cheating on the exams and quizzes will be sanctioned by an F grade in the course and will be reported to the Academic Conduct Committee.** Cheating includes: copying work of other students; using platforms such as Chegg; using of internet, including search engines, repositories, Wikipedia, etc. during exams and quizzes; using of communication platforms (email, social media, chat, text, etc.) during exams and quizzes; using of help from another person in any manner (other than professor) during exams and quizzes.

- **Incompletes & Withdrawals:** Incompletes (I) will be given to students making good academic progress (C or better) who have a compelling reason for being unable to complete the course schedule. Students may withdraw from the course prior to the University's deadline for doing so. Students who take the final exam will not be allowed an incomplete. Students who observe special religious holidays which may conflict with quizzes/exams, please let me know in advance in order to reschedule quizzes/exams.

- **Instructor's Office Hours:** Wednesday 1:00-2:00 pm or by appointment.

- **E-mail:** dimitrij@bu.edu