# Fall 2017

## ENG BE 420 Introduction to Solid Biomechanics

Dimitrije Stamenović (Instructor)
Hugo Sebastian Ruiz Ayala (TA)

Mon. & Wed., 4:30 – 6:15 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:** MA 226, EK 102 or MA 142 or MA 242, and 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 beams, frames and membranes (statically determinate and indeterminate trusses, prestress, tensegrity, axial force, shear force and bending moment diagrams for 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)

- **Course Grade:**
  1. Biweekly quizzes (Wed., 20 min.; 5 best quizzes, total 50 pts.)
  2. Weekly homeworks (given on Mon. due next Wed.; 10 best HWs, total 50 pts.)
  3. Two midterm exams (2 hr., 50 pts. each; the midterm with the lower score will be dropped). The exams are tentatively scheduled for **Oct. 18** and **Nov. 15**.
  4. Two projects (25 pts. each)
  5. Comprehensive final exam (3 hr., 100 pts.). Time and place will be assigned later.

Students who on quizzes, homeworks, projects 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 a z-score criterion: $z$ = (your score – class average)/standard deviation.

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

***Texting and web surfing during lectures and discussions is not allowed!!!***

- **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.

- **Office Hours:** Tuesday 4-5 pm or by appointment.

- **Address:** ERB, 44 Cummington Mall, Room #339

- **Phone:** x-5902.

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