BIOE 102 - INTRODUCTION TO BIOMECHANICS: ANALYSIS AND DESIGN (4 UNITS)

COURSE OVERVIEW

SUMMARY

- (from course syllabus) BioE 102 “introduces, develops and applies scaling laws and the methods of continuum mechanics to biomechanical phenomena related to tissue or organ levels.”
- Mostly lectures on derivations and examples for applications
- Some guest lectures on more advanced topics towards the end of the semester
- Weekly or biweekly problem sets focused on fundamentals during the first 2/3 of the course (7 in total)
- Two midterms and one final each with one cheat sheet
- One project with one video and one paper
- Textbook: An Introduction to Biomechanics: Solids and Fluids, Analysis and Design (Jay Humphrey and Sherry O’Rourke), Springer 2015

PREREQUISITES

MATH 53 (math53.html), MATH 54 (math54.html), PHYS 7A (phys7a.html)

Additional Notes

TOPICS COVERED

- Introduction to Biomechanics

- Role of Biomechanics in Biomedical Systems
- A Historical Overview of Biomechanics

- Introduction to Vector Calculus and Tensors
- Introduction to Solid Mechanics
- Concepts of Stress, Strain, and Constitutive Relations
- Mechanical Properties of Tissues
- Stress Transformations
- Principal Stresses and Maximum Shear
- Mechanical Properties of Tissues

- Equilibrium, Universal Solutions, and Inflation
- General Equilibrium Equations
- Axially Loaded Rods
- Pressurization and Extension of Thin-Walled Tubes
- Pressurization of Thin Spherical Structures
- Thick-Walled Cylinders
- Extension and Torsion
- Deformations due to Extension
- Shear Stress due to Torsion
- Principal Stresses and Strains in Torsion
- Angle of Twist due to Torque
- Combined Inflation, Extension and Twist

- Beam Bending and Column Buckling
- Shear Forces and Bending Moments
- Stresses and Deformations in Beams
- Principle of Superposition
- Buckling

- Advanced Topics and Applications (guest lectures and project presentations):
  - Biomechanics of Disease
  - Mechanotransduction
  - ...

WORKLOAD

COURSEWORK

- Weekly or biweekly problem sets focused on fundamentals during the first 2/3 of the course (7 in total)
- Two midterms and one final each with one cheat sheet
- One project with one 3-minute video and one 3-page paper
  - Free to form teams of three
  - Free to choose one of the following topics among three big categories (core literature would be provided by the instructor):
    - Biomechanics of the Nucleus
      - Nucleoskeleton Mechanics at a Glance
      - Mechanobiology of Chromatin and the Nuclear Interior
      - Mechanical LINCs of the nuclear envelope: Where SUN meets KASH
    - Biomechanics of the Neuron
      - Torsional Behavior of Axonal Microtubule Bundles
      - Modeling Of The Axon Membrane Skeleton Structure And Implications For Its Mechanical Properties
      - Mechanical Cues In Spinal Cord Injury
    - Biomechanics of the Heart Valves
      - Heart Valve Biomechanics And Underlying Mechanobiology
      - A Strain-Based Finite Element Model For Calcification Progression In Aortic Valves
      - A Computational Model of Aging and Calcification in the Aortic Heart Valve
  - Presentations and Q&A (this semester it was skipped due to the fire-day course cancelation)

TIME COMMITMENT

3 hours of lecture and 1 hour of discussion per week.

Problem sets (~5-6 problems each, with corresponding textbook chapters reading

- mostly application based with a couple derivation or reasoning questions

Project

CHOOSING THE COURSE

WHEN TO TAKE

Fall only

Fulfills ChemE engineering elective

WHAT NEXT?

- BIOE C112 - Molecular Biomechanics and Mecahnobiology of the Cell (bioec112.html)
- BIO 104 - Biological Transport Phenomena (bioe104.html)

ADDITIONAL COMMENTS AND TIPS

Prof. Mofrad is a really nice and fun professor who tries to know each individual student on a personal level and really cares about how he can improve the course as well as students' learning experience. He also tried to give fair exams as he believes there should be no trick questions:

- He usually gives the problems covered in the discussion to the GSI and they could be helpful for exams.
- Pay attention to what he commented as good questions in the lectures.
- Review the HWs and the midterms you took

The course experience might vary depending on the professors and the GSIs.

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Last edited: Fall 2018

Made by Angela Lee, c/o 2019

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