BE3310 and BE5310 Biomechanics, Fluid Flow and Computational Lab
Spring 2016

Time T/TH 5:30 - 6:50 p.m. **Room** ERB 130 **Computer Lab** ERB 280

Instructor Dr. C. Chuong

TA Ishan Khan, TA hours: T/TH 2:00 - 4:00 pm in ERB 280

Goals

- To understand the basic force-deformation relationship and how stresses are developed in a physical object (including living things) when under applied loads
- To study the deformation and resulting motion experienced by living things in response to applied loads
- To understand the meanings of stress, strain, strain rate, and the relations tie them together in the context of bio-solid and bio-fluid
- To learn how to describe the mechanical properties of bio-solid and bio-fluid
    - Stress-strain relationship (example - Hooks law),
    - stress-shear rate relationship (example - Newtonian fluid)
- To understand the concept of equilibrium (equation of equilibrium, equation of motion)
- To acquire quantitative understanding the working of living things at different levels (cells, tissues, organs, organisms), their hierarchical links, and the resulting physiological functions use experimental, analytical, and computational methods.
- To understand biomechanical proprieties description of living things and their relevance in physiological processes and functions at tissue, organ, or organismal levels
- To learn the basics of finite element modeling technique and its applications in the study bioengineering and biomedical engineering problems, including the design of medical devices.

Prerequisites Undergraduate general physics part 1, 2 (topics of statics/dynamics, strength of materials, introductory solid mechanics and fluid mechanics)

Course contents - topics to be covered

Didactic component

1. A review of biology
2. Introduction to solid mechanics – rigid body kinematics, linear elasticity with small deformation and finite deformation
3. Different load-deformation relationships - axial load, bending, torsion, buckling.
4. Stress, strain, stress-strain relationship (constitutive equation), finding principal stresses using Mohr's circle approach, equation of equilibrium and equation of motion
5. Introduction to fluid mechanics – from Newtonian to non-Newtonian fluid, Navier-Stokes eq.
6. Rheological description of blood and synovial fluid,
7. Hemodynamics - blood flow in different vessels at physiological and disease states

Computational lab

8. Using SolidWorks to build 3D geometry of component parts
9. Using COMSOL for stress analysis (analysis of blood vessels under loadings)
10. Stress analysis of dental implant (other BME examples - prosthetic devices, braces, hip replacement, TKR, heart valves, tissue-engineered vessels, devices for correcting scoliosis, etc.)

Specific outcomes of instruction:
Students should be able:

- To understand different types of load-deformation relationships
  - axial load, bending, torsion, buckling
- To understand the concepts of stress, strain, constitutive equations, equation of equilibrium (or motion), principal components (Mohr's circle approach) and why they are important
- To apply the basics of solid mechanics in the design for components and final assembled structure (medical devices)
- To apply the basics of fluid dynamics in quantitative understanding of the blood flow in human body and how to use the information to help understand the vascular functions at normal and disease states
- To design in-vitro experiments to analyze and to interpret data from experiments
- To formulate engineering problems and to derive quantitative solution for given biological problem described in qualitative terms
- To build a finite element computational models to carry out analysis, simulation, and to interpret the modeling results

Project

Team project with group presentation and individual project report.

Textbook

Humphrey, JD and O'Rourke SL, An introduction to Biomechanics, Solids and Fluids - Analysis and Design, 2nd edition, Springer, 2015.

Reference book

Jacob, CR, Huang H, and Kwon RY, Introduction to Cell Mechanics and Mechanobiology, Garland Science, 2013

Grading

Midterm 1	22%
Midterm 2	22%
Final	22%
Homework	14%
Participation	5%
Project report and presentation	15%

Late Homework

Homework set is due at 5:00 pm of the announced due date at the classroom (or otherwise specified). There will be penalty for late submission calculated as 10% for every one hour.

Americans with Disabilities Act:

The University of Texas at Arlington is on record as being committed to both the spirit and letter of all federal equal opportunity legislation, including the Americans with Disabilities Act (ADA). All instructors at UT Arlington are required by law to provide "reasonable accommodations" to students with disabilities, so as not to discriminate on the basis of that disability. Any student requiring an accommodation for this course must provide the instructor with official documentation in the form of a letter certified by the staff in the Office for Students with Disabilities, University Hall 102. Only those students who have officially documented a need for an accommodation will have their request honored. Information regarding diagnostic criteria and policies for obtaining disability-based academic accommodations can be found at www.uta.edu/disability or by calling the Office for Students with Disabilities at (817) 272-3364.

If you require an accommodation based on disability, I would like to meet with you in the privacy of my office, during the first week of the semester, to make sure you are appropriately accommodated.

Academic Integrity and Academic Dishonesty:

It is the philosophy of The University of Texas at Arlington that academic dishonesty is a completely unacceptable mode of conduct and will not be tolerated in any form. All persons involved in academic dishonesty will be disciplined in accordance with University regulations and procedures. Discipline may include suspension or expulsion from the University. According to the UT System Regents' Rule 50101, §2.2, "Scholastic dishonesty includes but is not limited to cheating, plagiarism, collusion, the submission for credit of any work or materials that are attributable in whole or in part to another person, taking an examination for another person, any act designed to give unfair advantage to a student or the attempt to commit such acts."

Classroom and Office Emergency Actions for Faculty

Provided by Office of Emergency Management-817-272-0117

Siren-(Sounds like an air-raid siren)

If you are outside and hear a warning siren, go inside and turn on a weather alert radio, radio or a T.V. for information on actions to take. Sirens can be activated for 5 reasons:

1.) Tornado in the immediate area,
2.) Severe weather with winds over 70 mph,
3.) Large damaging hail,
4.) Elected official or President of the University designates siren activation for other emergencies and,
5.) Testing on the 1st Wednesday of each month at 12:30, if the weather is clear.

Lightning Siren-(Sounds like a train horn)

Siren identifies that there is a potential for lightning to strike in the area. Go inside as quickly as possible.

Utility Failure

If the lights go out, then call the Service Call Center-817-272-2000.
Give your name, phone #, building name, floor or area affected, and room #. Remain in your location. Fire panels, responders, or MavAlert will provide further instructions.

Evacuation

Leave the building by the nearest exit and go to an area that will not impede responder actions. Stand in an area far enough away that you are not affected by the event.

Fire Evacuation

As you leave the building, activate the building fire alarm, if it is not already sounding. Leave the building by the nearest exit and go to an area that will not impede responder actions. Call 9-1-1 **OR** if on campus Call 817-272-3003 from a campus phone or cell phone **OR** use the code blue emergency phones.

Active Shooter

If an active shooter is outside your building:

- Go to a room that locks, turn off lights, lock all windows, and stay out of sight. Silence your phone.
- Call 9-1-1 or UTA Police at 817-272-3003. If it is safe, stay on the line to provide information.
- Do not leave until given instructions to do so by Police or MavAlert.

If an active shooter is in the same building as you:

- If the room locks, follow the procedures above.
- If the room cannot be locked, then determine if there is a room is nearby that does lock and can safely be reached, or if you can safely exit the building.

If an active shooter enters your office or class room:

- Dial 9-1-1 and give your location. If you cannot speak, leave the line open.
- If you cannot escape, attempt to negotiate. Only as a last resort should you attempt to overpower the shooter.
- If the shooter leaves the area, immediately go to a safer place. Call 9-1-1 or UTA Police at 817-272-3003.

Shelter in Place

Shelter-in-place means to take refuge inside a building. If time permits, select interior room(s) below ground floor, with the fewest windows or vents. If there is no time or space available, then follow instructions below.

- Stop work or class.
- Do not go outside.
- Close and lock all windows, exterior doors, and any openings to the outside.
- Listen to fire panel, radio, television, or MavAlert for further instructions.