Course syllabus

Biomekanik för vävnader
Tissue Biomechanics

BMEN10, 7,5 credits, A (Second Cycle)

Valid for: 2023/24
Faculty: Faculty of Engineering, LTH
Decided by: PLED BME
Date of Decision: 2023-04-13

General Information

Elective for: BME4-bdr, F4, F4-mt, F4-bm, MD4, N4, Pi4-biek
Language of instruction: The course will be given in English

Aim

The aim of the course is to deepen the knowledge in biomechanics and mechanobiology of the skeletal tissues (bone, articular cartilage, tendons and ligaments) and to understand the pathomechanics of injury, adaption and degenerative changes with aging, as well as how biomaterials can be used in loaded regions of the body. Moreover, the course aims to provide an insight into current biomechanical research of skeletal tissues.

Learning outcomes

Knowledge and understanding
For a passing grade the student must

* understand the musculoskeletal system of the human body
* understand the composition-structure-function relationships of the skeletal tissues and be able to described these in mechanical terms (linear elasticity, poroelasticity, viscoelasticity)
* understand the basics of mechanobiology; how tissues are formed, repaired and optimized (remodeling) as a result of mechanical simulation
* understand how systems of joints, e.g. the hip and the knee, works in a mechanical sense, and how prosthesis, implants and biomaterials are designed in order to function mechanically in the human body.
* understand the mechanical consequences of the main pathologies and degenerative diseases of the skeletal tissues

Competences and skills
For a passing grade the student must

* be able to formulate and solve mechanical problems for the skeletal tissues.
* be able to read, understand and recapture scientific articles related to the course topics.
* be able to make use of experimental techniques to mechanically characterize both hard and soft skeletal tissues.
* be able to make use of numerical techniques to solve and optimize biomechanics and mechanobiological problems.

Judgement and approach
For a passing grade the student must

* be able to assess and design implants for joint replacement.
* be able to evaluate methods to understand and characterize mechanical properties of skeletal tissues.
* be able to interpret and discuss scientific literature related to biomechanics.

Contents

The tissues in the human body that builds up the musculoskeletal system (i.e. bone, articular cartilage, ligaments and tendons) are largely mechanical in nature and are critical for our health. Their mechanical competence are affected by their composition-structure-function relationship.
This course is structured around solid mechanics of materials and their application to the study of mechanical behavior of skeletal tissues, bones, cartilage, bone-implant systems, joints and biomaterials. 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). The role of mechanobiology in the evolution and development of the musculoskeletal system is described, as well as its influence during tissue repair, remodeling and degeneration.
The course describes and applies the available methods to assess and understand these tissues both from an experimental and numerical approach, and how to use experimental data to develop theoretical models, as well as on using the knowledge gained to address common health related problems related to aging, disease and injury. The design and function of implants and prosthesis are also described and coupled to the mechanics and biology of the system.

Examination details

Grading scale: TH - (U,3,4,5) - (Fail, Three, Four, Five)
Assessment: One assignment is performed in a group and presented both in a written report and as an oral presentation. Two sets of laboratory exercises, both including experimental and finite element modeling exercise, is performed in group. These are reported in one combined report (exp + num) for each laboratory set, individually. Each assignment and exercise will receive written feedback from the course coordinator, and be graded with the grades failed, 3, 4, 5. The final grade is given based on a combination of the course assignments and the laboratory report. Procedures for extra assignments to pass the course when failed, are arranged after contact with the course coordinator.

The examiner, in consultation with Disability Support Services, may deviate from the regular form of examination in order to provide a permanently disabled student with a form of examination equivalent to that of a student without a disability.

Parts
Code: 0115. **Name:** Assignment 1.

Credits: 1,5. **Grading scale:** TH. **Assessment:** Assignment is judged with U,3,4,5
Code: 0215. **Name:** Project 1: Hard Tissues.
Credits: 3. **Grading scale:** TH. **Assessment:** Project is judged with U,3,4,5
Code: 0315. **Name:** Project 2: Soft Tissues/biomaterials.
Credits: 3. **Grading scale:** TH. **Assessment:** Project is judged with U,3,4,5

Admission

Assumed prior knowledge: Basic courses in mathematics, mechanics, solid mechanics, and Biomechanics (BMEN05 /FHLF05 or equivalent).
The number of participants is limited to: No

Reading list

- Research based material (mostly handouts and review articles) are provided in the course.

Contact and other information

Course coordinator: Hanna Isaksson, hanna.isaksson@bme.lth.se
Course homepage: http://bme.lth.se/course-pages/tissue-biomechanics/tissue-biomechanics/