ME-484

Numerical methods in biomechanics

Terrier Alexandre		
Cursus	Sem.	Туре
Bioengineering	MA2, MA4	Opt.
Life Sciences Engineering	MA2, MA4	Opt.
Mechanical engineering	MA2, MA4	Opt.
Robotics	MA2, MA4	Opt.

It is not allowed to withdraw from this subject after the registration deadline.

2 weekly

1 weekly

30

Courses

Exercises

Number of

positions

Summary

Students understand and apply numerical methods (FEM) to answer a research question in biomechanics. They know how to develop, verify and validate multi-physics and multi-scale numerical models. They can analyse and comment results in an oral presentation and a written report.

Content

- Use of numerical methods in biomechanics through some examples (tissue engineering, mechanical biology, artificial organs, external lectures from academics and industry)
- Partial Differential Equations reviewed in this context.
- General physics (solid, fluid, heat, transport) reviewed and extended through examples.
- Finite Element Method explained through practical examples.
- Multi-physics and coupling problems
- Importance of verification and validation
- Practical examples discussed in classroom
- Weekly exercises in different fields of biomechanics
- Group projects

Keywords

Biomechanics, numerical methods, multi-physics, coupling

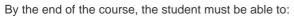
Learning Prerequisites

Important concepts to start the course

- Partial Differential Equations
- Linear algebra
- General Physics (solid, fluid, heat)
- Numerical analysis

Learning Outcomes





- · Compute the kinematics and the forces in articulations, B3
- · Compute shear stresses in blood in particular flow conditions, B4
- Compare the range of validity of different constitutive laws, B7
- Implement a constitutive law in a simulation software, B8
- Describe the feedback loop that, starting from a mechanical signal translated into a chemical signal, allows for the adaptation of the mechanical properties of tissues, B9
- Compute the stresses and strains at the interface of an implant and in the surrounding tissues, B10
- Compute the kinematics and forces in an implant, B11

Transversal skills

- Set objectives and design an action plan to reach those objectives.
- Identify the different roles that are involved in well-functioning teams and assume different roles, including leadership roles.
- Continue to work through difficulties or initial failure to find optimal solutions.
- Take feedback (critique) and respond in an appropriate manner.
- Access and evaluate appropriate sources of information.
- Write a scientific or technical report.
- Make an oral presentation.

Teaching methods

The course is divided into ex cathedra sessions, with interactive examples. Exercises are organised to applied concepts presented in the course. A mini-project is carried out in groups. Examples, exercises and mini-projects are done with Comsol.

Expected student activities

- · Attend cours and do interactive exemples
- Do the exercices
- Do a project in a group

Assessment methods

- Midterm text: cancelled
- Oral presentation of project (1/4)
- Written report of project (1/4)
- Written exam (1/2)

Supervision

Office hours	Yes
Assistants	Yes
Forum	Yes

Resources

Bibliography



Ressources en bibliothèque

Computational Modeling in Biomechanics / Suvranu

Moodle Link

• http://moodle.epfl.ch/course/view.php?id=14383