Course Specifications
Valid as from the academic year 2018-2019

Modeling in Medicine and Biomedical Engineering: Case Studies
(E092913)

Course size

<table>
<thead>
<tr>
<th>Credits</th>
<th>Study time</th>
<th>Contact hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.0</td>
<td>90 h</td>
<td>30.0 h</td>
</tr>
</tbody>
</table>

Course offerings and teaching methods in academic year 2018-2019

A (semester 2)
- English
  - microteaching: 7.5 h
  - seminar: 7.5 h
  - lecture: 15.0 h

B (semester 2)
- Dutch
  - guided self-study: 15.0 h
  - seminar: 7.5 h
  - microteaching: 7.5 h

Lecturers in academic year 2018-2019

- Segers, Patrick TW06 lecturer-in-charge
- Debbaut, Charlotte TW06 co-lecturer

Offered in the following programmes in 2018-2019

<table>
<thead>
<tr>
<th>Credits</th>
<th>offering</th>
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<tbody>
<tr>
<td>Master of Science in Biomedical Engineering</td>
<td>3 A</td>
</tr>
<tr>
<td>International Master of Science in Biomedical Engineering</td>
<td>3 A</td>
</tr>
<tr>
<td>Master of Science in Biomedical Engineering</td>
<td>3 A, B</td>
</tr>
</tbody>
</table>

Teaching languages
Dutch, English

Keywords
(Study of) bio-fluids, modeling heat and mass transfer in biomedicine, multi-scale models, medical imaging

Position of the course
The role of engineers in the biomedical field has vastly increased in the past decades, particularly supporting ongoing research in human physiology and medical technology (e.g. medical imaging, medical devices) via experimental and computer modeling. However, most biomedical research problems are of a complex nature, comprising a broad spectrum of different physical disciplines like fluid mechanics, tissue mechanics, heat and mass transfer problems, etc... Hence, advancing the knowledge and technology in the domain of biomedical engineering requires translating these multi-physics problems at hand into appropriate experimental and/or computational models.

Contents
Based on recently published research papers, a number of advanced modelling applications are studied, in the domain of:
- Blood flow and bio-fluid mechanics (e.g. blood flow in the cardiovascular system or extracorporeal circulations, lymphatic flow, air flow in the lungs or medical devices, flow through heart valves, ...)
- Biorheology: understanding and modeling the non-Newtonian nature of complex biofluids as blood.
- Heat (e.g. ablation techniques) and mass transport (lipid transport in the vascular wall, microfluidic devices, ...)
- Electrophysiology: modeling electrical conductance and currents in the heart to understand electrophysiological disorders and to support pacemaker design
- Multi-scale modeling: modeling organs and systems from the micro to macroscale
- Multi-physics models to support the development of medical imaging, e.g. generating synthetic ultrasound data of arterial blood flow and wall motion and deformation

(Approved)
• Topics are introduced by the lecturer based on one or more recent scientific papers, and the necessary theoretical background to understand the problem and methodology and to solve the problem is provided. This introduction is then complemented by practical exercises and/or discussion of related papers by the students (suggested to the students or their own choice). At the end of the course, students will discuss one or more papers of their own choice in detail. Besides the above described literature-based assignments and sessions, students work on their own research project. Students get computer code that they should use in a creative way to answer a research question or hypothesis.

Initial competences
- physics, transport phenomena

Final competences
1. Perform a literature search using scientific literature data bases (pubmed, web of science)
2. Objectively and critically assess the results of others, and to independently formulate and defend your opinion
3. Report orally and graphically on a scientific topic in English
4. Analyse complex multidisciplinary biomedical problems based on (recent) scientific research
5. Develop a logically structured, technologically realisable and ethically justified research plan
6. Acquire insight into complex biomechanical, biological or physiological processes by means of advanced models and paradigms

Conditions for credit contract
Access to this course unit via a credit contract is determined after successful competences assessment

Conditions for exam contract
This course unit cannot be taken via an exam contract

Teaching methods
- Guided self-study, lecture, microteaching, project, seminar, self-reliant study activities

Learning materials and price
- Copy of slides, research papers

References

Course content-related study coaching

Evaluation methods
- end-of-term evaluation and continuous assessment

Examination methods in case of periodic evaluation during the first examination period
- Open book examination

Examination methods in case of periodic evaluation during the second examination period
- Open book examination

Examination methods in case of permanent evaluation
- Assignment

Possibilities of retake in case of permanent evaluation
- examination during the second examination period is not possible

Calculation of the examination mark
- open book exam: 50%, report and presentation on project and/or chosen research paper(s): 50%. Students only pass if they pass for both the open book exam and the project report and presentation.

(Approved)