Biomedical Engineering, Master's Programme

120 credits

Biomedical Engineering, masterprogram

6MBME

Valid from: 2017 Spring semester

Determined by
Faculty Board of Institute of Technology

Date determined
2017-01-25

Purpose

Biomedical Engineering encompasses fundamental concepts in engineering, biology and medicine to develop innovative approaches and new devices, materials, implants, algorithms, processes and systems for the assessment and evaluation of technology; for prevention, diagnosis, and treatment of disease; for patient care and rehabilitation and for improving medical practice and health care delivery.

Aim

The Biomedical Engineering curriculum supports and sustains Engineering for Health through a relevant mixture of compulsory and elective courses arranged in a track structure. This enables in-depth as well as broad-based studies.

Knowledge and reasoning in mathematics, natural sciences and engineering
A Master of Science with a major in Biomedical Engineering should be

- thoroughly qualified in mathematics, physics and engineering and thereby able to formulate and solve problems in the medical domain, encompassing the design of devices, algorithms, systems, and processes to improve human health
- familiar with the fundamentals of the human anatomy and physiology on the cellular, organ and organ system levels
- able to use, propose and evaluate engineering tools and approaches relating to life science problems through formulating, modelling and solving the problems using physics, mathematics, chemistry, biology and engineering principles
- confident in the application of theoretical models and reasoning to biomedical engineering and life science problems arising in industry, business, academic institutions, and at major research and development laboratories

Personal and professional skills and attributes
A Master of Science in Biomedical Engineering should possess

- ability to manifest and lead modern research and engineering in the field of life science
- knowledge to identify and manage the particular problems related to the acquisition, processing and interpretation of biomedical texts, signals and images
- skills and techniques for modelling and simulation integrating engineering and life science knowledge
- creativity, initiative and responsibility for their contribution to innovative problem solving
- a systematic attitude towards problem solving

Interpersonal skills: teamwork and communication
A Master of Science with a major in Biomedical Engineering should demonstrate

- capability of professional teamwork and active collaboration within a group,

sharing tasks and responsibilities
- ability to act as a mediator between technical and biomedical personnel in multidisciplinary settings
- ability to conceive, design, implement and evaluate scientific and engineering projects
- English oral and written communicative skills regarding engineering problems in the life science domain
- competence in academic writing

Conceiving, designing, implementing, and operating systems in the enterprise and social context

A Master of Science with a major in Biomedical Engineering should demonstrate

- a holistic view on the process of merging scientific, engineering and biomedicine principles and methods in the development of devices, materials, implants, algorithms, processes and systems
- responsibility for identifying, integrating and creating a thorough understanding of the impact of science and engineering on society and communicating that knowledge to the public

Content

The programme content ensures that the graduates are able to demonstrate competencies in:

- origin and processing of physiological signals using various models for analysis
- thermodynamic models of the circulatory, respiratory, digestive and endocrine systems and there analysing techniques
- methods, technologies and systems used for intensive care and therapy as well as ethical and social issues in highly specialized health care
- physical properties of light and its impact and interaction with biological tissue related to the tissue optical properties based on light transport
- biomedical imaging technologies and their impact on biological tissue and the influence on image quality
- information technology in the health care sector
- multivariate statistical methods with applications in bioscience and related research areas
- problems, methods and traditions within the philosophy of science and problems related to biomedical engineering

Specialisations

To deepen the studies in a particular biomedical engineering field, the student is required to choose one of the following four tracks:

- Medical Informatics: Information management and processing at individual and population level, including indexing and retrieval of medical data and information, medical terminologies, models of and tools for medical decision making and decision support, knowledge discovery and representation, implementation and evaluation of decision support
- Bioengineering: Signal and systems at the molecular level, including methods and models in close interaction with biology and chemistry; interfacing and balancing between engineering and the biological sciences, mathematics, physics, chemistry, engineering, and bioinstrumentation are fundamental
- Biomedical Signals and Instrumentation: Theoretical as well as experimental studies of biomedical signal and systems for diagnostic and therapeutic requirements; activities include modelling and simulation, signal processing but also advanced health systems in hospitals and home health care settings
- Biomedical Imaging: Specializing in imaging modalities and applying engineering principles to visualize systems in the biological sciences and medicine using high-order dimensions of signal analysis; utilize mathematical methods and computing structures for learning and self-organization in finding and describing meaningful relations in multidimensional signals.

Teaching and working methods

The Master of Science programme in Biomedical Engineering, at Linköping University (LiU) consists of a broad compulsory part comprising approximately 50 ECTS credits. Specialization in depth in four tracks: medical informatics, biomedical signals and instrumentation, bioengineering and medical imaging. Each track has approximately 25 compulsory ECTS credits and 15 elective ECTS credits. A final thesis work comprising 30 ECTS points within the main subjects completes the programme.

Entry requirements

- A bachelor's degree in biomedical, electrical, physical, biological or computer engineering, electronics or physics, or equivalent
- At least 30 ECTS credits in mathematics/applied mathematics and/or application of mathematics relevant for the programme including calculus, linear algebra, vector calculus and complex functions
- At least 10 ECTS credits in physics including mechanics
- English corresponding to the level of English in Swedish upper secondary education (English 6/B)

Degree thesis

The thesis should be based on the high quality scientific content and carried out in close contact with the research groups involved in the programme and in the area of the profile chosen by the students. Without special permission a thesis work may be performed in the following subject areas:

- Biomedical Engineering
- Biomedical instrumentation
- Biotechnology
- Computational Physics
- Image Processing
- Medical Informatics
- Physiological Measurement Technology

Degree requirements

The programme is designed to give the Master's Degree "Teknologie masterexamen i Medicinsk teknik" translated to "Master of Science (120 credits) in Biomedical Engineering".

The requirements are the following:

- a Bachelor's degree as specified in the entrance requirements.
- course requirements for a total of 120 ECTS credits from courses from the curriculum of the programme, or after special decision from the programme board, and thesis work.
- passed the requirements for all compulsory courses.
- courses on advancement level A (advanced) 90 ECTS credits including:
    - at least 30 ECTS credits courses from the major subject, Biomedical Engineering.
    - a 30 ECTS credits Master's Thesis in the major subject, Biomedical Engineering.
- at least 45 ECTS credits from courses in mathematics or applications of mathematics from the Bachelor level (basic) or Master level (advanced), see list of specific courses.
- a Master's thesis presented and passed as per Linköping Institute of Technology degree regulations.

Courses overlapping each other regarding contents are not allowed to be included in the degree. Courses used for the Bachelor's degree can never be included in the Master's degree.

Degree in Swedish

Master of Science (120 credits) with a major in Biomedical Engineering

Degree in English

Master of Science (120 credits) with a major in Biomedical Engineering

Specific information

Graduate Level Courses

Certain PhD courses can be taken by master students. Please contact the directors of graduate studies:

- Department of Biomedical Engineering, forskarstudierektor@imt.liu.se
- Department of Physics, Chemistry and Biology, forskarstudierektor@ifm.liu.se
- Department of Electrical Engineering, forskarstudierektor@isy.liu.se
- Department of Computer and Information Science, forskarstudierektor@ida.liu.se
- Department of Mathematics, forskarstudierektor@mai.liu.se

In order to include graduate course in the degree the student must apply to the Board of Studies

Common rules

See also common rules

Curriculum

Semester 1 (Autumn 2017)

Course code	Course name	Credits	Level	Timetable module	ECV
Period 1					
TBME04	Anatomy and Physiology	6	G2X	3	C
TBMI19	Medical Information Systems	6*	A1X	2	C
TSDT14	Signal Theory	6	A1X	1	C
Period 2					
TBME03	Biochemistry and Cell Biology	6	G2X	2	C
TBMI19	Medical Information Systems	6*	A1X	3	C
TBMT01	Biomedical Signal Processing	6	A1X	1	C

Semester 2 (Spring 2018)

Course code	Course name	Credits	Level	Timetable module	ECV
Period 1					
TBMT02	Medical Imaging	6	A1F	3	C
TBMT09	Physiological Pressures and Flows	6	A1X	1	C
THEN24	Communication, Ethics and Sustainable Development	6*	G1X	-	C
TBMI01	Medical Decision Support	6	A1X	4	E
TBMI03	Medical Information Models and Ontologies	6	A1X	4	E
TBMI26	Neural Networks and Learning Systems	6	A1X	2	E
TFYA04	Materials Optics	6	A1X	4	E
Period 2					
TBME08	Biomedical Modeling and Simulation	6	A1X	3	C
TBMT26	Technology in Intensive Care and Surgery	6	A1X	1	C
THEN24	Communication, Ethics and Sustainable Development	6*	G1X	-	C
TFMT19	Chemical Sensor Systems	6	A1X	4	E
TFTB40	Biomedical Materials	6	A1X	1	E
TFYA38	Optoelectronics	6	A1X	3	E

Semester 3 (Autumn 2018)

Course code	Course name	Credits	Level	Timetable module	ECV
Period 1					
TAMS39	Multivariate Statistical Methods	6	A1X	4	E
TATM38	Mathematical Models in Biology	6	A1X	3	E
TBMT14	Biomedical Engineering - Project Course	12*	A1X	4	E
TBMT36	Biomedical Optics	6	A1X	1	E
TDTS06	Computer Networks	6	G2X	1	E
TFYA43	Nanotechnology	6	G2X	3	E
TFYA88	Additive Manufacturing: Tools, Materials and Methods	6	A1X	3	E
TNM067	Scientific Visualization	6	A1X	3	E
TSBB06	Multidimensional Signal Analysis	6*	A1X	2	E
TSBB08	Digital Image Processing	6	A1X	4	E
Period 2					
TBMI02	Medical Image Analysis	6	A1X	1	E
TBMT14	Biomedical Engineering - Project Course	12*	A1X	4	E
TDDD37	Database Technology	6	G2X	1	E
TMMS07	Biomechanics	6	A1X	4	E
TSBB06	Multidimensional Signal Analysis	6*	A1X	3	E

Semester 4 (Spring 2019)

Course code	Course name	Credits	Level	Timetable module	ECV
Period 1					
TQXX30	Degree project - Master’s Thesis	30*	A1X	-	C
Period 2					
TQXX30	Degree project - Master’s Thesis	30*	A1X	-	C

ECV = Elective / Compulsory /Voluntary
*The course is divided into several semesters and/or periods