Appendices master's degree programme Biomedical Engineering

2015-2016

Appendix I. Learning outcomes of the degree programme (art. 1.3)

Learning outcomes after year 1

After year 1 the student should be able to:
1. Select techniques and instruments for diagnostic purposes in neurology, ear nose and troat, ophtalmology, rehabilitation, cardiology and ventilation
2. Explain the possibilities, limits and technical challenges of techniques and instruments in relation to normal and pathological anatomy and physiology and choose which instruments to use to answer diagnostic questions
3. Compare and analyse recordings and explain how artefacts in data can be removed
4. Describe different imaging techniques used at a Radiology Department and explain its basic function and their differences
5. Relate materials and material properties to the desired application, approached from both material science, biology and medical science with clinical relevance
6. Apply the methodical design process by performing a systematic problem analysis and show ability to generate innovative solutions
7. Distinguish the specific difficulties in designing biomedical products
8. Describe clinical tests for a biomedical prototype, based on a FMEA (failure mode effect analysis)
9. Perform a team analysis and optimise the contribution of all team members, including co-operation with international colleagues
10. Set-up and execute project management for a research or design project
11. Explain accepted, normative scientific practices for conducting research and describe issues surrounding the responsible conduct of research and research misconduct; recognise ethical decision-making problems; show awareness of the grey areas and ambiguities of ethical issues
12. Describe written rules and guidelines concerning safety and ethics of medical devices (national and international)
13. Reason soundly and critically reflect on own and others work
14. Communicate about biomedical engineering in English both written and orally
15. Describe the differences in working habit of medical and technical experts
16. Define personal future career choices

<u>Additional learning outcomes for CEMACUBE-students after year 1</u>
After year 1 the student should be able to:
1. Describe and apply knowledge of human physiology and anatomy of the musculoskeletal, circulatory, digestive, respiratory, excretory, and endocrine and nervous systems.
2. Explain the communication and cooperation of organ systems, necessary for the maintenance of homeostasis in particular.
3. Describe basic mechanisms in biochemistry, cell biology and heredity
4. Explain basic biochemistry in terms of the functioning of cell compartments, biological macromolecules, enzyme mechanisms, structure and function of membranes, antibodies, carbohydrates, lipids, proteins.
5. Describe the advanced neurophysiology of the neural system, the sensory system, and the physiology of skeletal muscles.
6. Integrate advanced neurophysiology of the neural system, the sensory system, and the physiology of skeletal muscles
7. Understand the properties of neurons, and sensors and see their reflection in the operation of the whole system.

8. Describe neurophysiology, (neurons, mechano receptors), muscle physiology (contractile machinery, muscle architecture, muscle activation, fatigue)
9. Understand Control Theory (Stability, Control with Internal Models, Control of Complex Systems)
10. Understand multi-joint kinematics and dynamics (2D kinematics, 3D kinematics, 2D dynamics, 3D dynamics, dynamics of a 7 segment 3D human body model)
11. Perform vector algebra and matrix algebra (3D rotations, solving sets of equations)

Learning outcomes after year 2

For the specialization 'Diagnostic Imaging and Instrumentation'
After year 2 the student should be able to:
1. Explain modelling, analysis and design of control systems
2. Explain physics behind radiation oncology
3. Describe pre-treatment quality assurance (qa) of imrt
4. Discuss the benefits and drawbacks of several advanced imaging techniques used in radiology explain the different diagnostic imaging techniques and their pitfalls
5. Explain the theoretical (mathematical) background of modelling image formation, image errors and noise sources, correction methods
6. Design and implement image processing algorithms
7. Explain and predict the outcome of pulse sequences generally used in MRI
8. Study new imaging and instrumentation technologies to improve diagnosis
9. Apply critical thinking and communication skills in a scientific setting.

For the specialization 'Prostheses & Implant Interface Technology'
After year 2 the student should be able to:
1. Describe the cell types involved in the inflammatory response
2. Explain the most commonly used techniques for biomaterials surface characterization
3. Select a suitable surface characterization technique for a specific surface-related phenomenon
4. Interpret the results of most commonly used techniques for biomaterials surface characterization
5. Describe methods to determine biomechanical properties of biological tissues
6. Explain the causative relations between material surface properties and conditioning film composition, cell adhesion processes, interpret the results of scientific studies in the area of cell-material interactions
7. Explain basic principles of tissue engineering and the position of cell-material interaction
8. Describe basic cell biology evaluations
9. Explain concepts and methods for performing research on new surface modification technologies to improve an implant or tissue engineering scaffold.
10. Apply critical thinking and communication skills in a scientific setting.

For the specialization 'Prostheses & Implant Design'
After year 2 the student should be able to:
1. Describe the advantages and disadvantages in terms of motor control of the different types of prostheses and explain the difficulties in learning myocontrol
2. Explain the functioning of the different types of prostheses and argue that mathematical models can be of interest when forming new ideas on prostheses and orthoses
3. Integrate the functions, demands and wishes for a new prosthesis or orthosis into an innovative solution, translate a biomechanical analysis into the prescription of a prosthesis or orthosis and describe the fitting process and preparation of a prosthesis or orthosis for production.
4. Describe and integrate the advanced neurophysiology of the neural system, muscle physiology, the sensory system, and the physiology of skeletal muscles.
5. Understand the properties of neurons, and sensors and see their reflection in the operation of the whole system.

6. Understand Control Theory (Stability, Control with Internal Models, Control of Complex Systems)
7. Understand Multi-Joint Kinematics and Dynamics (2D Kinematics, 3D Kinematics, 2D Dynamics, 3D Dynamics, Dynamics of a 7 segment 3D human body model)
8. Perform Vector Algebra and Matrix Algebra (3D rotations, Solving sets of equations)
9. Explain concepts and methods for performing research on new materials, mechanical or mechatronical technologies to improve an implant
10. Apply critical thinking and communication skills in a scientific setting.

Appendix II. Specialisations of the degree programme
(art. 2.2)

The degree programme is divided into the following specialisations:

a. Diagnostic Imaging and Instrumentation
b. Prostheses & Implant Interface Technology
c. Prostheses & Implant Design

Appendix III. Content of degree programme (art. 2.3)
Course details and mode of assessment and examination are described in Ocasys.

1. Course elements year 1

1a. General course elements

Course element	ECTS
Biomaterials 2	5
Biomedical Instrumentation 2	5
Control Engineering	5
Interdisciplinary Project	5
Mechatronics	5
Modelling and Simulation	5
Technology and the Ethics of Research	5
Electives	10
Internship *	15
Colloquia (4) *	-

* As described in the Guidelines on Nestor

1b. CEMACUBE course elements

Course element	ECTS
Basic Biomedical Knowledge 1	5
Basic Biomedical Knowledge 2	5
Biomaterials 2	5
Biomedical Instrumentation 2	5
Interdisciplinary Project	5
Modelling and Simulation	5
Technology and the Ethics of Research	5
Electives	10
Internship *	15
Colloquia (4) *	-

* As described in the Guidelines on Nestor

2. Course elements year 2

2a. Course elements of the specialisation *Diagnostic Imaging & Instrumentation*

Course element	ECTS
Imaging Techniques in Radiology 2	5
Magnetic Resonance Physics	5
Medical Physics in Radiation Oncology	5
Physics in Nuclear Medicine	5
Elective	5
Master's Project *	35
Colloquia (4) *	-

* As described in the Guidelines on Nestor

2b. Course elements of the specialisation *Prosthesis & Implant Interface Technology*

Course element	ECTS
Colloid and Interface Science	5
Interface Biology	5
Recent Developments in Biomaterials	5
Surface Characterization	5
Elective	5
Master's Project *	35
Colloquia (4) *	-

* As described in the Guidelines on Nestor

2c. Course elements of the specialisation *Prosthesis & Implant Design*

Course element	ECTS
Interface Biology	5
Neuromechanics	5
Product Design by the Finite Element Method	5
Prosthetics and Orthotics	5
Elective	5
Master's Project *	35
Colloquia (4) *	-

* As described in the Guidelines on Nestor

Appendix IV. Electives (art. 2.4)

Course details and mode of assessment and examination are described in Ocasys

1. Electives year 1

1a. General Electives

Course element	**ECTS**
Engineering & Biotribology	5
Radiation Physics	5
Sensory Biophysics	5
Statistical Methods in Physics	5

1b. CEMACUBE Electives

Course element	**ECTS**
Neuromechanics	5
Imaging Techniques in Radiology 1	5
Sensory Biophysics	5
Statistical Methods in Physics	5

2. Electives year 2

2a. Electives specialization *Diagnostic Imaging & Instrumentation*

Course element	**ECTS**
Image Processing	5
Scientific visualization	5

2b. Electives specialisation Prosthesis & Implant Interface Technology

Course element	**ECTS**
Robotics	5
Integrated Lab Course Biomaterials	5

2c. Electives specialisation *Prosthesis & Implant Design*

Course element	**ECTS**
Robotics	5
Integrated Lab Course Biomaterials	5

3. Courses selected by students

Upon request of the student, the Board of Examiners may approve a course that is not mentioned above.
The request procedure must be started at least 6 weeks before the start of the course, and starts when the Board of Examiners receives a new programme proposal, supplemented with argumentation for the request, plus a detailed course description. The argumentation should contain the relevance of the selected course for the student's individual curriculum.

The Board of Examiners will decide on an individual basis if permission is granted. The student will be informed about the Board's decision, within 6 weeks by email.

Appendix VI. Admission to the degree programme and different specializations (art. 4.1.1 + art. 4.2)

Admission to the Master's degree programme

1. Holders of a Bachelor's degree in Life Science & Technology with a major Biomedical Engineering from the University of Groningen, holders of a Bachelor's degree in Physics with the track Life and Health from the University of Groningen, and holders of a Dutch University Bachelor's degree in Biomedical Engineering are considered to have sufficient knowledge and skills and will be directly admitted to the Master's degree programme.

2. Holders of a non-university Bachelor's degree in electrical engineering or mechanical engineering may be admitted individually, under the condition of successfully finishing a premaster programme first. This premaster programme will have a fixed amount of ECTS (15, 30, 45 or 60 ECTS).

3. All other students who apply for the Master's degree programme are individually screened by the BME Admissions Board. Depending on deficiencies, successfully finishing a premaster programme may be necessary before admission to the master programme is granted. This premaster programme will have a fixed amount of ECTS (15, 30, 45 or 60 ECTS). Another option is that any relevant deficiencies have to be neutralized in the first year of the Master's degree programme.

4. CEMACUBE students follow adjusted course elements in year 1 to catch up on the necessary biological background knowledge. In year 2, CEMACUBE students follow one of the regular specialization programmes.

5. International students (these are students with a non-Dutch Bachelor's degree) need to submit their application via the online application system of the University of Groningen to the Admissions Office. The admission deadlines are presented in Appendix IV. All international candidates are screened by the BME Admissions Board for admission.