Assessment plan for the curriculum of the Bachelor's degree programme in Biomedical Engineering

Curriculum 2022/2023

1. Objectives of the degree programme

Missions, vision and goal
We follow The Whitaker Foundation (2006)[1] in adopting the following definition:

"Biomedical engineering is a discipline that advances knowledge in engineering, biology and medicine, and improves human health through cross-disciplinary activities that integrate the engineering sciences with the biomedical sciences and clinical practice. It includes:
1. *The acquisition of new knowledge and understanding of living systems through the innovative and substantive application of experimental and analytical techniques based on the engineering sciences.*
2. *The development of new devices, algorithms, processes and systems that advance biology and medicine and improve medical practice and health care delivery.*"

Graduates of the UG BME Bachelor's degree programme are therefore educated in the domains of engineering, biology and medicine and are skilled in the abilities described in points 1 and 2 of The Whitaker Foundation[1].

Mission
The mission of the UG BME Bachelor's degree programme is to educate the basic principles of BME design, research and development issues and to prepare students for a BME or Engineering Master's degree programme.

Vision
At the University of Groningen, teaching is intertwined with academic research and students are familiarized with academic research skills. The research- and design-based teaching in the BME programme is grounded in the latest academic theories, research outcomes and design methodologies; these form an integral part of the programme's course units and research projects. Therefore, explicit attention is given in the curriculum to the introduction, practice and assessment of academic and engineering skills.

Goals
The main feature of a Biomedical Engineer's work is to provide engineering solutions to biomedical problems through research, development and design (problem definition and analysis, design and redesign, and design implementation and final design evaluation).
The mission can therefore be subdivided into several objectives for the UG BME Bachelor's degree programme:

- endowing students with the basic knowledge and skills needed to perform thorough problem analyses, draft designs/redesigns and implement, and validate technological products, processes and systems in a medical and technical environment within the field of BME;
- providing students with an academic training in autonomous, critical and analytical thinking and acting, including scientific communication in English;
- offering an interdisciplinary approach as a key element of the programme - one which draws on knowledge from other fields ranging from natural to medical sciences;
- paying special attention in projects and course units to teamwork and personal leadership;
- preparing students for BME or Engineering Master's degree programmes (just like at comparable academic institutes, it is rare for Bachelor's graduates in BME to enter the job market immediately after graduation.)

[1] Abu-Faraj, Ziad (2012) Handbook of Research on Biomedical Engineering Education and Advanced Bioengineering Learning Interdisciplinary Concepts. Page 3. Link

2. Learning outcomes of the degree programme

A. Generic learning outcomes — Knowledge

A1. Bachelor's graduates have general knowledge and understanding of mathematics, natural sciences (biology, physics, chemistry), life sciences (biochemistry, anatomy, physiology) and engineering sciences (mechanical, electrical) underlying biomedical engineering.

A2. Bachelor's graduates are familiar with the quantitative nature of mathematics, natural sciences and engineering sciences, and have a general understanding of the models and methods used in these fields, including computer-aided methods.

A3. Bachelor's graduates are familiar with the learning methods necessary to follow developments in biomedical engineering. They are able to engage in lifelong learning and are prepared to continue in any Master's programme on Biomedical Engineering.

B. Generic Learning outcomes — Application of knowledge

B1. Bachelor's graduates are able to apply knowledge of mathematics, natural sciences, life sciences and engineering sciences to conduct research on basic biomedical problems; to contribute to design of new solutions to biomedical problems and to contribute to the further development of devices, instruments or materials.

B2. Bachelor's graduates are familiar with materials, equipment and technologies typically used in the biomedical practice. They know how to perform measurements on biological systems and are able to interpret the data, and are aware of the problems associated with the interaction between living and non-living materials and systems.

B3. When involved in design, research and/or development, Bachelor's graduates demonstrate the ability to critically formulate the relevant questions, choose or propose appropriate methods, procedures and/or systems.

C. Generic Learning outcomes — Decision making

C1. Bachelor's graduates are aware of the key aspects of professional, ethical and societal responsibilities linked to the biomedical engineering practice, to decision making and to formulating judgments.

C2. Bachelor's graduates are able to reflect on professional, ethical and social responsibilities of biomedical engineering.

D. Generic Learning outcomes — Communication

D1. Bachelor's graduates have a general understanding of functioning methods of multidisciplinary teams and are able to function effectively as team members, contributing to meet deliverable, schedule and budget requirements.

D2. Bachelor's graduates are familiar with the established methods/tools of communication and their limitations.

D3. Bachelor's graduates are able to identify the appropriate method to effectively, clearly and unambiguously communicate their findings/results in a multidisciplinary setting.

3. Overview examiners and modes of assessment per course unit

Table 3.1. Per course unit the intended assessment mode(s), the ECTS per course unit, and the examiner(s) are listed. This satisfies requirement 3 in the Protocol of Duties and Powers. Course units or examiners in italics are new to the BME curriculum as of 2022-2023.

Course units	**Mode of assessment** [a, b]	**ECTS**	**1st Examiner**	**UTQ** [c]	**2nd Examiner**	**UTQ**
Anatomy and Physiology	MC, R	5	dr. T.G. (Theo) van Kooten	UTQ	C. (Cyril) Luman, MSc	UTQ
Applied Medical Visualization	RP, R	5	*dr. ir. P.M.A. (Peter) van Ooijen*	UTQ	*L. (Lise) van Dijk*	-
Bachelor's Project Biomedical Engineering	PR, P, R	15	BME course examiner	-	BME course examiner or Project examiner	-
Big Data for BME	AST, OR, PR, P, R	5	*dr. H. (Hobey) Tam*	-	prof. dr. ir. E. (Erik) van der Giessen	UTQ
Biofabrication	MC, P, WE	5	dr. P.K. (Prashant) Sharma	UTQ	dr. J. (Joep) Kraeima	UTQ
Biological Physics	AST, R, WE	5	prof. dr. P.C.A. (Patrick) van der Wel	pending	prof. dr. W.H. (Wouter) Roos	UTQ
Biomaterials 1	R, WE	5	dr. P. (Patrick) van Rijn	UTQ	dr. P.K. (Prashant) Sharma	UTQ
Biomechanics	AST, WE	5	*dr. A. (Andrea) Giuntoli*	will start	dr. P.K. (Prashant) Sharma	UTQ
Biomedical Instrumentation	PR, WE	5	dr. R. (Romana) Schirhagl	UTQ	prof. dr. ir. N.M. (Natasha) Maurits	UTQ
Biomedical Nanotechnology	R, WE	5	*prof. dr. M.M.G. (Marleen) Kamperman*	UTQ	*D. (Dina) Maniar*	in progress
Biomedical Sensors	WE, P	5	*dr. A.G.P. (Ajay) Kottapalli*	UTQ	*dr. E. (Elisabeth) Wilhelm*	UTQ
Calculus 1 (for BME)	AST, IT, WE	5	*dr. P.M.J. (Pieter) Tibboel*	will start	*dr.ir. R. (Roel) Luppes*	UTQ
Capitum Selectum Medical Imaging Principles and Applications	AST, P, WE	5	dr. M.J.W. (Marcel) Greuter	UTQ	dr. A.T.M. (Antoon) Willemsen	UTQ
Cell Biology and Immunology	R, WE	5	dr. T.G. (Theo) van Kooten	UTQ	dr. J. (Jelmer) Sjollema	UTQ
Design of Biomedical Products 1	PR, R	5	dr. C.C. (Charissa) Roossien	in progress	prof. dr. ir. G.J. Verkerke	-
Design of Biomedical Products 2	PR, P, R	3	*dr. R (René) Fluit*	in progress	prof. dr. ir. G.J. Verkerke	-
Design of Biomedical Products 3	PR, P, R	5	dr. C.C. (Charissa) Roossien	in progress	prof. dr. ir. G.J. Verkerke	-
Electricity and Magnetism	PR, WE	5	dr. M. (Myroslav) Kavatsyuk	UTQ	prof. dr. N. (Nasser) Kalantar-Nayestanaki	in progress
Electronics	AST, PR, WE	5	prof. dr. G. (George) Palasantzas	UTQ	prof. dr. ir. B.J. (Bart J) Kooi	UTQ
Ethics 1: Philosophy of Science and Scientific Integrity	WE	2	*dr. G. (Gorazd) Andrejc*	in progress	*prof. dr. C. (Christoph) Jedan*	UTQ
Ethics 2: Biomedical Ethics	AST	2	*dr. G. (Gorazd) Andrejc*	In progress	*prof. dr. C. (Christoph) Jedan*	UTQ
Ethics 3: Research Ethics	AST	1	*dr. G. (Gorazd) Andrejc*	in progress	*prof. dr. C. (Christoph) Jedan*	UTQ

[a] Mode of assessment: Written exam (WE), Multiple-choice exam (MC), Oral exam (OR), Report (R), Interim Test (IT), Assignment (AST), Practical work (PR), Presentation (P).
[b] Mode of assessment can be subject to change due to Corona/Covid measures.
[c] University Teaching Qualification (UTQ) status UTQ – received UTQ certificate; pending - process finalised, waiting for the UTQ qualification; in progress - started the UTQ; will start – will start UTQ process in 2022-2023.

Table 3.1. Continued.

Course units	**Mode of assessment** [a, b]	**ECTS**	**1st Examiner**	**UTQ** [c]	**2nd Examiner**	**UTQ**
Imaging Laboratory 1	AST, PR, P, R	5	dr. M.J.W. (Marcel) Greuter	UTQ	dr. A.T.M. (Antoon) Willemsen	UTQ
Imaging Laboratory 2	AST, PR, P, R	5	dr. M.J.W. (Marcel) Greuter	UTQ	Dr. A.T.M. (Antoon) Willemsen	UTQ
Imaging Techniques in Radiology 1	AST, MC	5	dr. ir. H. (Hildebrand) Dijkstra	UTQ	dr. M.J.W. (Marcel) Greuter	UTQ
Lab course Biomaterials	OR, PR, R	5	dr. P. (Patrick) van Rijn	UTQ	dr. P.K. (Prashant) Sharma	UTQ
Linear Algebra for BME	AST, WE	5	dr. P.M.J. (Pieter) Tibboel	will start	prof. dr. S. (Stephan) Trenn	UTQ
Material Science	AST, P, WE	5	dr. P.K. (Prashant) Sharma	UTQ	dr. P. (Patrick) van Rijn	UTQ
Microbiology	PR, R, WE	5	dr. B.W. (Brandon) Peterson	UTQ	dr. ir. G. (Girbe) Buist	UTQ
Molecules of Life for BME	AST, WE	5	dr. dr. M.M. (Michael) Lerch	pending	dr. W.C. (Wiktor) Szymanski	UTQ
Physicochemical Concepts in Bionanotechnology	IT, MC, WE	5	dr. J. (Jelmer) Sjollema	UTQ	dr. P.K. (Prashant) Sharma	UTQ
Physics Lab for BME	PR, R, WE	5	dr. J.S. (Jelle) Blijleven	pending	dr. J. (Jelmer) Sjollema	UTQ
Python and Numerical Methods	AST, IT	5	dr. J.W.A. (Jan-Willem) Brijan	UTQ	dr. ir. P.M.A. (Peter) van Ooijen	UTQ
Quantitative Image Analysis	MC, WE	5	*prof. dr. ir. C. (Charalampos) Tsoumpas*	UTQ	dr. M.J.W. (Marcel) Greuter	UTQ
Research course Biomedical Engineering	PR, P, R	9	*dr. M.A. (Mohammed Ali) Shahbazi*	in progress	prof. dr. H.A. (Hélder) Santos	UTQ
Statistics 1 for BME	AST, P, WE	5	dr. B.W. (Brandon) Peterson	UTQ	dr. J. (Jelmer) Sjollema	UTQ
Surface characterization	P, WE	5	dr. R. (Romana) Schirhagl	UTQ	dr. J. (Jelmer) Sjollema	UTQ
Tissue Engineering and Regenerative Medicine	AST, MC, WE	5	*prof. dr. M.C. (Marco) Harmsen*	UTQ	dr. T.G. (Theo) van Kooten	UTQ
Transport in Biological Systems	ASM, LC, T	5	dr. R (René) Fluit	in progress	dr. C.C. (Charissa) Roossien	in progress
Waves and Optics for BME	AST, MC, PR, R	5	dr. R. (Rifka) Vlijm	in progress	prof. dr. W.H. (Wouter) Roos	UTQ
Courses organised by other programmes						
Dynamics and Vibrations	WE	5	*prof. dr. M. (Maryam) Ghandchi Tehrani*	PCAP	Prof. dr. ir. E. (Erik) Van der Giessen	UTQ
Mammalian Cell Biology	MC, WE	5	prof. Dr. G. (Geert) van den Bogaart	-	dr. R. (Rifka) Vlijm	in progress
Signals and Systems	WE	5	prof. dr. ir. B. (Bayu) Jayawardhana	UTQ	prof. dr. ir. J.M.A. (Jacquelien) Scherpen	-
Thermodynamics	WE	5	*dr. W.L.J. (Wouter) Hinrichs*	UTQ	*prof. dr. ir. K. (Kees) van der Voort Maarschalk*	-

[a] Mode of assessment: Written exam (WE), Multiple-choice exam (MC), Oral exam (OR), Report (R), Interim Test (IT), Assignment (AST), Practical work (PR), Presentation (P).
[b] Mode of assessment can be subject to change due to Corona/Covid measures.
[c] University Teaching Qualification (UTQ) status UTQ – received UTQ certificate; pending - process finalised, waiting for the UTQ qualification; in progress - started the UTQ; will start - will start UTQ process in 2022-2023, PCAP - Professional Certificate in Higher Education Teaching from UK obtained in 2021

4. Relationship between course units and details of the learning outcomes

In table 4.1 is the relation between learning outcomes (as listed in section 2) and the course elements of the Bachelor's degree programme given. A description of course elements and the learning outcomes students must acquire is available via OCASYS. The programme also includes compulsory training in a number of relevant society-oriented subjects during courses such as Ethics (year 1, 2 and 3) and the Bachelor project (year 3).

Table 4.1. Relationship between the Learning outcomes and Course elements of the BME bachelor degree. Contribution to the learning outcomes: 1 = small contribution, 2 = large contribution.

A) Year 1

	Courses												
	Year 1												
Learning outcomes Bachelor programme:	**Anatomy and Physiology**	**Biomaterials 1**	**Biomechanics**	**Calculus 1 (for BME)**	**Design of Biomedical Products 1**	**Ethics 1: Philosophy of Science & Scientific**	**Linear Algebra for BME**	**Mammalian Cell Biology**	**Materials Science**	**Microbiology**	**Molecules of Life for BME**	**Physics Lab for BME**	**Statistics 1 for BME**
A. Knowledge													
A1: math, biology, physics, (bio)chem, anatomy, physiology, engineering	2	2	2	2			2	2	2	2	2	2	2
A2: models and methods used in these fields, including computer-aided methods		1	2	1	2		1		1			2	2
A3: learning methods necessary to follow developments. prepare for lifelong learning and Masters.	1	2	1		1			1	1	1	1		1
B. Application of knowledge													
B1: apply knowledge for design of new solutions to biomedical problems	1	2	1		2			1	1	1	1		1
B2: perform measurements on biological systems and are able to interpret the data					1			1		2		1	2
B3: critically formulate the relevant questions, choose or propose appropriate methods, procedures and/or systems.	1	1								1		2	1
C. Decision making													
C1: key aspects of professional, ethical and societal responsibilities					1	2							1
C2: reflect on professional, ethical and social responsibilities					1	2							1
D. Communication													
D1: understanding of functioning methods of multidisciplinary teams					2	1						1	
D2: familiar with the established methods/tools of communication and their limitations					2	1						1	
D3: effectively, clearly and unambiguously communicate their findings/results in a multidisciplinary setting		1			2	1						1	1

Table 4.1. Continued.

B) Year 2

Learning outcomes Bachelor programme:	Courses: Year 2 — Biological Physics	Biomedical Instrumentation	Capitum Selectum Medical Imaging Principles and	Cell Biology and Immunology	Design of Biomedical Products 2	Electricity and Magnetism	Ethics 2: Biomedical Ethics	Imaging Laboratory 1	Imaging Techniques in Radiology 1	Lab course Biomaterials	Dynamics and Vibrations	Python and Numerical Methods	Signals & Systems	Surface characterization	Transport in Biological Systems	Waves and Optics for BME
A. Knowledge																
A1: math, biology, physics, (bio)chem, anatomy, physiology, engineering	2		1	2	1	2		1	2	1	2		2		2	2
A2: models and methods used in these fields, including computer-aided methods	1	2	1		2	1		1	2		2	2	2	2	1	1
A3: learning methods necessary to follow developments. prepare for lifelong learning and Masters.	1			1	2	1				2	1	1	1			2
B. Application of knowledge																
B1: apply knowledge for design of new solutions to biomedical problems		2		1	2	1				1			1	2		1
B2: perform measurements on biological systems and are able to interpret the data		2		1		1				1		2		2		2
B3: critically formulate the relevant questions, choose or propose appropriate methods, procedures and/or systems.	1		2	1	2			2	1	2	1		2	1		2
C. Decision making																
C1: key aspects of professional, ethical and societal responsibilities				1	1		2									
C2: reflect on professional, ethical and social responsibilities				1	1		2									
D. Communication																
D1: understanding of functioning methods of multidisciplinary teams				2	2	1	1									2
D2: familiar with the established methods/tools of communication and their limitations				1	1		1	1	1							
D3: effectively, clearly and unambiguously communicate their findings/results in a multidisciplinary setting	1		1	2	2	1	1	1	1	2				2		2

Table 4.1. Continued.

C) Year 3

	Courses														
	Year 3														
Learning outcomes Bachelor programme:	**Biomedical Nanotechnology**	**Biofabrication**	**Quantitative Image Analysis**	**Applied Medical Visualization**	**Big Data for BME**	**Design of Biomedical Products 3**	**Ethics 3: Research Ethics**	**Research course Biomedical Engineering**	**Thermodynamics**	**Imaging Laboratory 2**	**Biomedical Sensors**	**Physicochemical Concepts in Bionanotechnology**	**Tissue Engineering and Regenerative Medicine**	**Electronics**	**Bachelors Project Biomedical Engineering**
A. Knowledge															
A1: math, biology, physics, (bio)chem, anatomy, physiology, engineering	2	1	2		1				2	1	1	2	1	2	
A2: models and methods used in these fields, including computer-aided methods	1	1	2	2	1	1		1	2	1	1	2	1	1	
A3: learning methods necessary to follow developments. prepare for lifelong learning and Masters.	1		1	1	1	1	1	2	2		1		1	2	
B. Application of knowledge															
B1: apply knowledge for design of new solutions to biomedical problems	2	1	1	1	2	2	1	1	2		2	1	2	1	2
B2: perform measurements on biological systems and are able to interpret the data	1	1	1	1	2			1	2						2
B3: critically formulate the relevant questions, choose or propose appropriate methods, procedures and/or systems.	1	2		2	2	2	1	2	1	2	2	1		1	2
C. Decision making															
C1: key aspects of professional, ethical and societal responsibilities					1	2	2	1			1		1	1	2
C2: reflect on professional, ethical and social responsibilities				1	1	1	2	1					1		2
D. Communication															
D1: understanding of functioning methods of multidisciplinary teams		1		1	2	2		2			1		2		1
D2: familiar with the established methods/tools of communication and their limitations		1			1	2		1			2		1		2
D3: effectively, clearly and unambiguously communicate their findings/results in a multidisciplinary setting	1	2		1	1	2		2		2	1		1		2