# Assessment plan for the curriculum of the Master's degree programme in Biomedical Engineering Curriculum 2024/2025

Programme director: dr. J. (Jelmer) Sjollema

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## 1. Vision on assessment

1. Assessment should evaluate the students ability to apply knowledge, make judgments, and communicate in a professional way (both written and oral) with the aim to increase the quality of medical care and to decrease the cost and manpower, necessary for providing health care nowadays.
2. Assessment should enable qualification of a student to work in med-tech companies and (non-) academic hospitals
3. Assessment should enable qualification of a student to work in academic institutions to perform scientific research to new technologies that will contribute to more efficient health care and high quality of life
4. *Assessment as learning*: Assessment is part of the learning process to provide students feedback in their learning process.
    a. Assessment involves both feedback and summative assessment.
    b. Assessment is contextualized: this means that students receive feedback or are as much as possible tested in practical context-rich assignments.
    c. Learning and developing competencies is often team-based. Peers as well as teachers and/or professional from the field are needed as a mirror, to conduct a discussion, develop new insights and to ask critical questions.
    d. Problem solving and coping with problem solving tasks is seen as the core of the learning process.
5. Assessment should enable the evaluation of learning outcomes.

## 2. Assessment guidelines

*Please explain the general assessment procedures that are used in the programmes. For example, 4-eyes principle in test design, standardised grading forms, rubrics.*

1. Summative and formative assessment should be balanced in order to avoid "assessment steers learning" and stimulate internal motivation.
2. Formative assessment is primarily intended to provide feedback about the learning process and progress.
3. Written and oral deliverables should receive extensive feedback from the available staff. In case staff is unable to deliver this feedback, the use of such deliverables should be reconsidered.
4. Group projects/assignments allow for self-reflection and for intergroup summative assessment. Both of these enrich the academic learning process.

## 3. Learning outcomes of the degree programme

| **Learning Outcomes**<br>*At the end of the programme, the graduate is able to …* | |
|---|---|
| 1 | *Analyse the problem and define aim*<br>A Biomedical Engineer is able to analyse biomedical problems of a complex nature by choosing the appropriate level of abstraction and by critically examining existing theories, models or interpretations based on the assessment of the scientific value of current research within Biomedical Engineering. The Biomedical Engineer thereby creates a cause-effect model, distinguishes the problems that are fundamental and solvable and defines the aim which has the highest priority. |
| 2 | *Execute the Design, Research & Development plan*<br>A Biomedical Engineer is able to execute a Design, Research & Development plan and to adapt it when external circumstances or advancing insight requires it. Depending on the project the focus may be more on the scientific approach to increase knowledge and understanding (research), on prototyping and product improvement (development) or on the design of new devices or systems, |

| | |
|---|---|
| | although all three aspects are essential in the Design, Research & Development cycle of innovative products. |
| 3 | *Communicate results*<br>A Biomedical Engineer, as an interdisciplinary specialist, is able to communicate orally and in writing about Design, Research & Development with colleagues, non-colleagues and other involved parties including health care providers and patients. In addition, the Biomedical Engineer is able to debate about both Biomedical Engineering and the place of Biomedical Engineering in society. |
| 4 | *Embed the results in scientific and social context*<br>A Biomedical Engineer is able to analyse and to discuss the social consequences (economic, social, cultural) of new developments in Biomedical Engineering with colleagues and non-colleagues; has insight into (debates about) scientific practice and is able to analyse and to discuss the ethical and the normative aspects of the consequences and assumptions of the scientific practice with colleagues and non-colleagues and is able to integrate these ethical and normative aspects in its own work. |
| 5 | *Demonstrate a professional attitude*<br>A Biomedical Engineer is able to incorporate the knowledge, skills and competences described above and demonstrates a professional attitude by showing a high level of independence, responsibility and commitment. In addition, the Biomedical Engineer shows social skills (including communication, collaboration and leadership skills) as well as the ability to improve after feedback. |

## 4. Overview of assessment methods, test moments for course units, and examiners

There is a distinction between BME course examiner (table 3.1) and a Project examiner (table 3.2) within the Biomedical Engineering programme.

*BME Course examiner*

Course examiners are appointed by the Board of Examiners as first or second course examiner. A BME course examiner can be part of the curriculum of the Master's and/or Bachelor's Biomedical Engineering programme (see Table 4.1).

*Project examiner*

Project examiners are appointed by the Biomedical Engineering (BME) Board of Examiners as examiner of Internships and Master's projects. Project examiners are appointed by the Board of Examiners based on supervised Internships and/or Master's projects in recent years (Table 4.2).
Project examiners only assess Internship and/or the Master's projects. The BME examiner will always have the final say on the final grade of the Internship/Master's project.

Internal and External Biomedical Engineering projects will be assessed by at least one BME course examiner.

Internal projects carried out at the University of Groningen (UMCG clinical departments excluded) will be assessed by (at least one) BME course examiner. The other examiner can be a Project examiner from the Faculty of Science and Engineering or the Faculty of Medical Sciences, appointed by the BME Board of Examiners.

There are two kinds of external projects; 1) at accredited universities or University Medical Center hospitals (UMC), and 2) at companies or regular hospitals.

1) External projects carried out at accredited universities and UMC's will be assessed by a BME course examiner as a first examiner, and by a scientific staff member from the hosting university/UMC as a second examiner.
2) External projects carried out at companies, regular hospitals or abroad will be assessed by two BME course examiners.

*Table 4.1.* 4. Overview of assessment methods, test moments for course units, and BME course examiners, given per programme year and period.

| Year | Period | Course | ECTS | Assessment method(s) * | Does (part of the) assessment have a formative function? | Test moment(s) | Course coordinator/ First examiner | Second examiner |
|---|---|---|---|---|---|---|---|---|
| 1 | 1a | Biomaterials 2 | 5 | AST, MC | AST | last week(s) of the course | dr. P. (Patrick) van Rijn | dr. T.G. (Theo) van Kooten |
| 1 | 1a | Control Engineering for BME | 5 | WE | - | exam week | prof. dr. M. (Maryam) Ghandchi Tehrani | prof. dr. C. (Claudio) De Persis |
| 1 | 1a | Interface Biology | 5 | WE, R | - | last week(s) of the course | dr. T.G. (Theo) van Kooten | dr. P. (Patrick) van Rijn |
| 1 | 1a | MATLAB concepts for image and data analysis | 5 | AST | AST | continuous | dr. A.T.M. (Antoon) Willemsen | dr. J.B.C. (Jan-Bernard) Marsman |
| 1 | 1a | MRI | 5 | OR | - | exam week | dr. R.J. (Remco) Renken | dr. M.J.W. (Marcel) Greuter |
| 1 | 1a | Radiation Physics | 5 | R | R | continuous | dr. E.R. (Emiel) van der Graaf | dr. C.E. (Catherine) Rigollet |
| 1 | 1a | Product Design by the FEM (for BME) | 5 | WE, IT | IT | midterm, final exam | dr. R. (René) Fluit | dr. C.C. (Charissa) Roossien |
| 1 | 1b | Biofilms | 5 | AST, IT, P, WE | AST, IT, P | midterm, final exam | dr. B.W. (Brandon) Peterson | Dr. P.K. (Prashant) Sharma |
| 1 | 1b | Computed Tomography | 5 | MC, WE, PR | - | last week(s) of the course | dr. M.J.W. (Marcel) Greuter | dr. A.T.M. (Antoon) Willemsen |
| 1 | 1b | Conventional Imaging Techniques in Radiology | 5 | WE, P, R, | P, R | continuous | Ir. A.L.J. (Arjen) van Hulzen | dr. M.J.W. (Marcel) Greuter |
| 1 | 1b | Engineering & Biotribology | 5 | WE, P | P | last week(s) of the course | dr. P.K. (Prashant) Sharma | prof. dr. A. (Antonis) Vakis |
| 1 | 1b | Nanomedicines for Biomedical Applications | 5 | IT, WE | IT | midterm, final exam | prof. dr. H.A. (Hélder) Santos | dr. M.A. (Mohammed Ali) Shahbazi |
| 1 | 1b | Prosthetics and Orthotics | 5 | AST, MC, PR, P | MC, P, PR, AST | continuous | dr. Ir. C.C. (Charissa) Roossien | dr. R. (René) Fluit |
| 1 | 1b | Physics in Nuclear Medicine | 5 | WE | - | exam week | dr. A.T.M. (Antoon) Willemsen | dr. O.V. (Oleksandra) Ivashchenko |
| 1 | 2a | Biomedical Instrumentation 2 | 5 | MC, P, PR, R | P, PR, R | continuous | prof. dr. R. (Romana) Schirhagl | dr. J.M. (Juha) Hijmans |
| 1 | 2a | Medical Device Innovation and Translation 1 | 5 | WE | - | exam week | dr. Ir. C.C. (Charissa) Roossien | dr. R. (René) Fluit |
| 1 | 2a | Statistical Methods for BME | 5 | P, PR, R | P, PR, R | continuous | dr. B.W. (Brandon) Peterson | dr. J. (Jelmer) Sjollema |
| 1 | 2b | Internship | 15 | AST, P, WE | AST, P | continuous | dr. J. (Jelmer) Sjollema | supervisor/examiner |

* Mode of assessment: Written exam (WE), Multiple-choice exam (MC), Oral exam (OR), Report (R), Assignment (AST), Practical work (PR), Presentation (P).

Table 4.1 Continued.

| Year | Period | Course | ECTS | Assessment method(s) * | Does (part of the) assessment have a formative function? | Test moment(s) | Course coordinator/ First examiner | Second examiner |
|---|---|---|---|---|---|---|---|---|
| 2 | 1a | Bio-signal processing for human machine interaction | 5 | AST, P, R | AST, P, R | continuous | dr. E. (Elisabeth) Wilhelm | prof. dr. ir. M. (Ming) Cao |
| 2 | 1a | Advanced Medical Imaging for Diagnosis and Treatment | 10 | AST, P, R, OR | AST, P, R | continuous | dr. ir. N.M. (Marianna) Sijtsema | dr. M.J.W. (Marcel) Greuter |
| 2 | 1a | Integrated Lab Course Biomaterials | 5 | AST, PR, R | PR | continuous | dr. M. (Monize) Caiado Decarli | dr. B.W. (Brandon) Peterson |
| 2 | 1a | Microscopy and Imaging | 5 | WE, P | - | last week(s) of the course | prof. dr. R. (Romana) Schirhagl | dr. B.W. (Brandon) Peterson |
| 2 | 1a | Recent Developments in Biomaterials | 5 | AST, P, R | - | continuous | dr. M.A. (Mohammed Ali) Shahbazi | dr. J. (Jelmer) Sjollema |
| 2 | 1b | 3D Bioprinting for Tissue Engineering | 5 | P, R, WE | P, R | last week(s) of the course | dr. M.K. (Gosia) Wlodarczyk-Biegun | dr. M. (Monize) Caiado Decarli |
| 2 | 1b | Medical Device Innovation and Translation 2 | 5 | P, R | P, R | midterm and final presentation | dr. O. (Olga) Belousova | Prof. dr. A.J. (Arend) Groen |
| 2 | 1b | Technology and the Ethics of Research | 5 | AST, P, R | AST, P | continuous | dr. G. (Gorazd) Andrejc | prof. dr. C. (Christoph) Jedan |
| 2 | 2a 2b | Master's Project | 30 | PR, R, P | PR, R, P | continuous | dr. J. (Jelmer) Sjollema | supervisor/examiner |
| *Courses organized by other programmes* | | | | | | | | |
| 1 | 1b | Mechatronics | 5 | IT, WE | IT | midterm, final exam | dr. S. (saeed) Ahmed | prof. dr. ir. J.M.A. (Jacquelien) Scherpen |
| 2 | 1a | Robotics for IEM | 5 | WE, R | R | last week(s) of the course | dr. B. (Bahar) Haghighat | prof. dr. ir. B. (Bayu) Jayawardhana |
| 2 | 1b | MEMS, NEMS and Nanofabrication | 5 | IT, WE | IT | midterm, final exam | dr. A.G.P. (Ajay) Kottapalli | prof. dr. Y. (Yutao) Pei |
| *BME course not given in 2024-2025 (will return in 2025-2026)* | | | | | | | | |
| 2 | 1b | Medical Physics for Radiation Oncology | 5 | WE, PR | PR | continuous | ir. V.C. (Vincent) Hamming | ing. P. (Pieter) Kloosterman |

* Mode of assessment: Written exam (WE), Multiple-choice exam (MC), Oral exam (OR), Report (R), Assignment (AST), Practical work (PR), Presentation (P).

*Table 4.2*. Project examiners for the Internship (I) and/or the Master's project (M) from accredited Dutch universities and UMC's. The Project examiner will operate next to a BME course examiner (see Table 4.1).

| **Project examiner** | **Department/Expertise** | **Project type** |
|---|---|---|
| dr. M.I. (Monica) Acuautla Menese | UG - Discrete Technology & Production Automation | M |
| dr. ir. P. (Paul) Baron | UMCG - MRI Physics researcher | I M |
| prof. dr. ir. D. (Deniz) Baskent | UMCG - dB-SPL Lab-Oterhinolaryngology department | I M |
| dr. ir. C.A.T. (Nico) van den Berg | UMC Utrecht - Computational Imaging | I M |
| prof. dr. R.M.F. (Rolf) Berger | UMCG - Pediatrics | I M |
| dr. F. (Frans) Bianchi | UG - Biochemistry & Molecular Biology | M |
| prof. dr. H.J.G. (Henk) Bilo | UMCG - Internist | I M |
| prof. dr. G.H. (Truuske) de Bock | UMCG - Oncological Epidemiology | I M |
| dr. R.P.H. (Reinoud) Bokkers | UMCG - Intervention radiologist | I M |
| dr. R.J.H. (Ronald) Borra | UMCG - Imaging/MRI | I M |
| prof. dr. S. (Stefan) Both | UMCG - Radiology Oncology | I M |
| prof. dr. R. (Raffaella) Carloni | UG - Robotics Lab | M |
| dr. B. (Branislava) Curcic-Blake | UMCG - Neuroimaging | I M |
| dr. K. (Kevin) Damman | UMCG - Cardiology | I M |
| dr. L.V. (Lisanne) van Dijk | UMCG - Personalizing radiotherapy with AI | I M |
| dr. P.R. (Peter) van Dijk | UMCG - Endocrinologist | I M |
| prof. dr. P. (Pim) van Dijk | UMCG - Audiology, Tinnitus, Biophysics of Hearing | I M |
| prof. dr. P.U. (Pieter) Dijkstra | UMCG - Rehabilitation | I M |
| prof. dr. D.W. Donker | UTwente - Cardiovascular and Respiratory Physiology | M |
| dr. C. (Christian) Greve | UMCG - Movement science | I M |
| dr. J.M. (Juha) Hijmans | UMCG – Rehabilitation | I M |
| dr. A. (Anouk) van der Hoorn | UMCG - Radiology, Nuclear Medicine & Medical Imaging | I M |
| prof. J.H.P. (Han) Houdijk | UMCG - Clinical Movement Sciences | I M |
| dr. G.A. Araiza Illan | UMCG - Human-robot interaction, haptics | I M |
| prof. dr. P.C. (Paul) Jutte | UMCG - Orthopedics | I M |
| dr. ir. E.W. (Erik) Korevaar | UMCG - Medical Physicist Radiation oncology | I M |
| dr. A.O. (Anastasiia) Krushynska | UG - Mechanics, Mechanical Engineering, Acoustics | M |
| dr. R. (Roald) Lambrechts | UMCG - Molecular and Cellular Biology | I M |
| prof. dr. C.J.C. (Claudine ) Lamoth | UMCG -Movement Analysis and Smart Technology in Aging | M I |
| prof. dr. H.G.D. (Henri) Leuvenink | UMCG - Groningen Institute for Organ Transplantation | I M |
| dr. P. (Peter) van Luijk | UMCG - Damage and Repair in Cancer Development and Cancer Treatment (DARE) | I M |
| dr. J.B.C. (Jan-Bernard) Marsman | UMCG - Neuroimaging | I M |
| prof. dr. H.C. (Henny) van der Mei | UMCG - Materials Science, Biomaterials | M |
| dr. V.E. (Vincent) de Meijer | UMCG - HPB and Liver Transplant Surgeon | I M |
| prof. dr. S. (Sarthak) Misra | UTwente/UMCG - Surgical Robotics Lab | I M |
| dr. C. (Cyril) Moers | UMCG -Tansplantation, Organ preservation | I M |

*Table 4.2*. Continued.

| **Project examiner** | **Department/Expertise** | **Project type** |
|---|---|---|
| dr. A. (Alina) Sigaeva | UMCG - Free radicals regulation and cell communication | I M |
| dr. T. (Taraneh) Mokabber | UG - Biomaterials Materials Science | M |
| dr. A.R. (Rob) den Otter | UMCG - Neurosciences, Rehabilitation | I M |
| dr. R.N. (Nils) Planken | UMC Amsterdam - Cardiovascular imaging | I M |
| dr. R.C.L. (Richte) Schuurmann | UMCG - Surgery | I M |
| prof. dr. C.K. (Corry) van der Sluis | UMCG - Rehabilitation Medicine | I M |
| dr. J. (Joyce) van Sluis | UMCG - Imaging (PET) | I M |
| dr. H. (Hans) Timmerman | UMCG - Anesthesiology | I M |
| prof. dr. ir. C. (Charalampos) Tsoumpas | UMCG - Nuclear Science & Technology, Radiology, Nuclear Medicine & Medical Imaging | I M |
| dr. H.C. (Hugo) van der Veen | UMCG - Orthopedic surgery | I M |
| dr. R.J.K. (Riemer) Vegter | UMCG - Human Movement Science | I M |
| prof. dr. J.P.P.M. (Jean-Paul) de Vries | UMCG - (Vascular) surgery | I M |
| dr. R. Wijsman | UMCG - Radiotherapist Oncology | I M |
| dr. T.P. (Tineke) Willems | UMCG - Cardiovascular Centre | I M |
| dr. M.K. (Gosia) Wlodarczyk-Biegun | UG - Polymer Science | M |
| dr. P.J. (Pieter) van der Zaag | UMCG - Radiology, Nuclear Medicine & Medical Imaging | I M |
| prof. dr. I.S. (Inge) Zuhorn | UMCG - Nanoscience & Nanotechnology | M |

## 5. Relationship between course units and details of the learning outcomes

Table 5.1. Learning outcomes that are assessed in each course are indicated with 'x' in the table below, given per track.

A. Track: Biomaterials Science and Engineering

| | Courses | Learning outcomes | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | **1. Acquire expertise in Biomedical Engineering** | **2. Analyse the problem and define aim** | **3. Create a Design, Research & Development proposal** | **4. Execute the Design, Research & Development plan** | **5. Analyse and interpret the data** | **6. Communicate results** | **7. Embed the results in scientific and social context** | **8. Demonstrate a professional attitude** |
| | **Year 1** | | | | | | | | |
| 1a | Biomaterials 2 | x | | x | | | x | x | |
| 1a | Product Design by FEM (for BME) * | x | x | x | x | x | x | | x |
| 1a | MATLAB Concepts for Image and Data Analysis * | x | | | x | x | | | |
| 1a | Interface Biology | | x | | | x | x | x | |
| 1b | Biofilms | | x | | | x | x | | |
| 1b | Nanomedicines for Biomedical Applications | | x | x | x | x | x | | |
| 2a | Biomedical Instrumentation 2 | | x | | | x | | | |
| 2a | Medical Device Innovation and Translation 1 | | x | x | x | | x | x | x |
| 2a | Statistical Methods in BME | | x | | x | x | x | | |
| 2b | Internship | x | x | x | x | x | x | x | x |
| | **Year 2** | | | | | | | | |
| 1a | Integrated Lab Course in Biomaterials | | | | | x | x | x | |
| 1a | Microscopy and Imaging * | | | | x | x | | | |
| 1a | Product Design by FEM (for BME) * | x | x | x | x | x | x | | x |
| 1a | Recent Developments in Biomaterials | x | | x | | x | x | | |
| 1b | Colloid and Interface Science | x | | | | x | | | |
| 1b | Medical Device Innovation and Translation 2 | | | x | x | | x | x | x |
| 1b | Technology and the Ethics of Research | | x | | | x | x | x | x |
| 2a 2b | Master's thesis project | x | x | x | x | x | x | x | x |
| | Start symposium | x | | | | | x | x | |
| | End symposium | x | | | | | x | x | |
| | Seminars | x | | | | | x | | |

B. Track Medical Device Design

| | Courses | Learning outcomes | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | **1. Acquire expertise in Biomedical Engineering** | **2. Analyse the problem and define aim** | **3. Create a Design, Research & Development proposal** | **4. Execute the Design, Research & Development plan** | **5. Analyse and interpret the data** | **6. Communicate results** | **7. Embed the results in scientific and social context** | **8. Demonstrate a professional attitude** |
| | **Year 1** | | | | | | | | |
| 1a | Product Design by FEM (for BME) | x | x | x | x | x | x | | x |
| 1a | MATLAB Concepts for Image and Data Analysis * | x | | | x | x | | | |
| 1a | Interface Biology* | | x | | | x | x | x | |
| 1a | Control Engineering for BME | x | x | x | x | x | | | x |
| 1b | Engineering and Biotribology | x | x | | | x | x | x | |
| 1b | Mechatronics | x | x | | | x | | | |
| 1b | Prosthetics and Orthotics | x | x | x | x | x | x | x | |
| 2a | Biomedical Instrumentation 2 | | x | | | x | | | |
| 2a | Medical Device Innovation and Translation 1 | | x | x | x | | x | x | x |
| 2a | Statistical Methods in BME | | x | | x | x | x | | |
| 2b | Internship | x | x | x | x | x | x | x | x |
| | **Year 2** | | | | | | | | |
| 1a | Biomaterials 2 | x | | x | | | x | x | |
| 1a | Bio-signal processing for human machine interaction | | x | | | x | | | |
| 1a | Robotics for IEM | | | x | x | x | x | | |
| 1b | MEMS, NEMS and Nanofabrication | | | | | x | x | | |
| 1b | Medical Device Innovation and Translation 2 | | | x | x | | x | x | x |
| 1b | Technology and the Ethics of Research | | x | | | x | x | x | x |
| 2a 2b | Master's thesis project | x | x | x | x | x | x | x | x |
| | Start symposium | x | | | | | x | x | |
| | End symposium | x | | | | | x | x | |
| | Seminars | x | | | | | x | | |

C. Track: Medical Imaging (MI)

| | Courses | Learning outcomes | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | **1. Acquire expertise in Biomedical Engineering** | **2. Analyse the problem and define aim** | **3. Create a Design, Research & Development proposal** | **4. Execute the Design, Research & Development plan** | **5. Analyse and interpret the data** | **6. Communicate results** | **7. Embed the results in scientific and social context** | **8. Demonstrate a professional attitude** |
| | **Year 1** | | | | | | | | |
| 1a | Radiation Physics | | | x | x | x | x | | |
| 1a | MATLAB Concepts for Image and Data Analysis | x | | | x | x | | | |
| 1a | MRI | x | | | | | x | | |
| 1b | Conventional Imaging Techniques and Ultrasound | | | | | x | | | |
| 1b | Computed Tomography | x | x | x | x | x | x | x | x |
| 1b | Physics in Nuclear Medicine | x | | | | x | | | |
| 2a | Biomedical Instrumentation 2 | | x | | | x | | | |
| 2a | Medical Device Innovation and Translation 1 | | x | x | x | | x | x | x |
| 2a | Statistical Methods in BME | | x | | x | x | x | | |
| 2b | Internship | x | x | x | x | x | x | x | x |
| | **Year 2** | | | | | | | | |
| 1a | Microscopy and Imaging | | | | x | x | | | |
| 1a | Advanced Medical Imaging for Diagnosis and Treatment | | | | | x | x | x | |
| 1b | Medical Physics for Radiation Oncology | | | | | x | | | |
| 1b | Medical Device Innovation and Translation 2 | | | x | x | | x | x | x |
| 1b | Technology and the Ethics of Research | | x | | | x | x | x | x |
| 2a 2b | Master's thesis project | x | x | x | x | x | x | x | x |
| | Start symposium | x | | | | | x | x | |
| | End symposium | x | | | | | x | x | |
| | Seminars | x | | | | | x | | |