The University Of Sheffield.

Programme Specification

A statement of the knowledge, understanding and skills that underpin a taught programme of study leading to an award from The University of Sheffield

1	**Programme Title**	Biomedical Engineering
2	**Programme Code**	BIET02
3	**JACS Code / HECoS Code**	H160, H161, H162, H165 / 101243, 101210, 100430, 100572
4	**Level of Study**	Postgraduate
5a	**Final Qualification**	Master of Science in Engineering (MSc(Eng))
5b	**QAA FHEQ Level**	Masters – Framework Level 7
6a	**Intermediate Qualification(s)**	Postgraduate Certificate (PGCert), Postgraduate Diploma (PGDip)
6b	**QAA FHEQ Level**	Masters – Framework Level 7
7	**Teaching Institution** (if not Sheffield)	Not applicable
8	**Faculty**	Engineering
9	**Department**	Interdisciplinary Engineering (IPE)
10	**Other Departments providing credit bearing modules for the programme**	Mechanical Engineering, Materials Science & Engineering, Infection, Immunity & Cardiovascular Disease
11	**Mode(s) of Attendance**	Full-time
12	**Duration of the Programme**	1 year
13	**Accrediting Professional or Statutory Body**	Not applicable
14	**Date of production/revision**	November 2019. January 2023

15. Background to the programme and subject area

The MSc Biomedical Engineering programme is for students from an engineering/computer or basic sciences background, who want to develop their knowledge at the interface with the life sciences and through this develop solutions to current challenges facing medicine and the biomedical industry sector (growing engineering domain worldwide). The programme will include a range of strategies for identifying and solving problems including: critical analysis, modelling and design, experimentation and research. Teaching methods will include tutorials, lectures, practical work, group project work, virtual learning environments and individual research.

The course will fill the current teaching gap at UoS between UG offering (Bioengineering) and research in the University (for example research conducted by the University Research Institutes for Neuroscience and for Healthy Lifespan and the Institute for in silico medicine, Insigneo) and attract and develop talents from home and abroad, equip them with technical knowledge, expertise and transferable skills to succeed in a growing engineering discipline, work or research effectively at the interface between engineering and the Life Sciences, as well as operate in more traditional engineering environment should they choose to (many of our graduate students in Bioengineering and Biomedical Engineering secure jobs in traditional engineering environments such as engineering consultancy, as well as in the biomedical/bioengineering industrial sector).

The programme will also be open to BEng students from our own UG Bioengineering programmes, or returning professionals who seek to enhance their skills and practices in this new interdisciplinary field.

The programme will have strong roots within the internationally-recognised research expertise and standing of the academics that will deliver the lectures (Insigneo, Polaris, Sheffield Biomaterials and Bioengineering (MSE), Bioengineering and Health Technologies (DEN)) and leverage the experience gained in the two current MSc programmes (MSc Computational Medicine and MSc Biomaterials and Regenerative Medicine) that will be replaced by this new MSc programme. There is one other MSc identified in the Bioengineering sphere run by Biomedical Sciences (MSc in Stem Cells and Regenerative Medicine). This MSc is specifically focussing on stem cell biology, and has only peripheral overlaps with the proposed MSc in Biomedical Engineering. We do not propose any formal interaction between the two MScs.

The programme will offer core modules to provide the necessary foundation knowledge in biomedical engineering plus a pool of advanced optional modules for a more personalised educational path that will gravitate around the students' personal interests.

The individual project will be an important synthesising element of the curriculum which will support the development of self-management skills, depth of knowledge and a point of integration, but also offer the opportunity to develop a personalised educational pathway through the supervised selection of a limited number of optional modules (approx. 4 modules, 60 credits) that will aim at developing the knowledge required by the individual project.

Individual projects will be provided by academics from the contributing departments and include design projects that will give students an opportunity to use more general, but also previously acquired knowledge and skills to those students not necessarily interested in focusing on a specific subject area.

The optional modules will be offered within three major subject areas: Biomechanics and Computational Medicine (within the broader domain of Biomedical Engineering) from the Mech Eng Department, Imaging and Medical Physics (Biomedical Engineering) from the Department of Infection, Immunity & Cardiovascular Disease, and Biomaterials and Tissue Engineering (Bioengineering) from the Materials Science and Eng Department. These will not constitute programme streams (to avoid students' dilution and support cohesion) but rather knowledge domains accessible to all students depending on the knowledge required by their individual project.

The programme benefits from strong University support: Engineering for Life is a strategic priority of the Faculty of Engineering at UoS.

16. Programme aims

The aims of the programmes are to:

1. provide access to Masters' degree programmes to graduates or professionals from a variety of engineering and pure sciences backgrounds;
2. help fulfilment of student potential and engender a commitment to self-improvement and development of personal transferable skills;
3. provide graduate engineers with technical, professional and analytical skills, design experience and an advanced understanding of a specialist branch of engineering;
4. Provide teaching that is informed and invigorated by the research and scholarship of the staff;
5. prepare students for technical leadership in a professional career;
6. compare and contrast the concepts, design and application of technology in the UK, Europe and overseas;
7. enable students to obtain greater knowledge and deeper understanding of computational and experimental approaches in biomedical tissues and human physiology.

17. Programme learning outcomes

Knowledge and Understanding:

On successful completion of the programme, students will be able to demonstrate knowledge and understanding of:

K1	Safety principles, risk management and legislative requirements governing best practice in areas of biomaterials and biomedical engineering;
K2	The role of biomaterials and/or biomedical engineering in medicine considering the technological, social and ethical aspects of the field and its development;
K3	Fundamental laws and principles of physics and/or engineering and how they apply to medical applications, some of which are at, or are informed by, the forefront of the discipline;
K4	Strategies to solve complex problems in biomedical engineering using a variety of experimental, analytical, design, statistical, mathematical and/or computational techniques;
K5	Managing own learning and make selective use of a variety of resources including appropriate module content, texts, research articles and other primary sources in their work.

Skills and other attributes:

On successful completion of the programme, students will be able to:

S1	Apply appropriate anatomical and physiological knowledge to relevant clinical situations where physics and engineering are used in medicine;
S2	Apply a range of computational and experimental skills to relevant scientific tasks in biomaterials or biomedical engineering, such as the use or design of image processing software, treatment planning systems and medical equipment management systems;
S3	Manage, from initial planning stage to final dissemination of results, an experiment or investigation (requiring a literature review) in a field of biomaterials or biomedical engineering;
S4	Communicate scientific concepts to a range of audiences in a concise, accurate and informative manner, leading to the presentation of logical conclusions at a level appropriate to the audience;
S5	Critically evaluate experimental and/or computational findings against previous measurement or the scientific literature, in terms of statistical significance and research methodology.

18. Teaching, learning and assessment

Development of the programme learning outcomes is promoted through the following teaching and learning methods:

Lectures – used to transmit information, explain theories and concepts, and illustrate methods of analysis or design. For most lecture programmes, tutorial sheets and audio recordings are provided to enable students to develop their understanding during private-study. These will be delivered by research-active academics from the Departments of Mechanical Engineering, Materials Science and Immunity, Infection and Cardiovascular Disease.

Seminars - enable the discussion of a particular topic in some detail in the form of 'reading groups' reviewing specific research papers. The seminars support and provide constructive feedback for the student's independent learning. Through participation a student develops relevant knowledge, learns to apply conceptual tools, and improves cognitive, communicative and transferable skills, including the capacity to present reasoned arguments in oral form, to give presentations, to pursue independent learning and show critical judgement. These will be delivered by academics, clinicians, researchers and industrialists and disseminated to the Masters' Programme through the Insigneo Institute and its website.

Laboratories - computational and experimental laboratories will be available to students on the Masters course, complete with state-of-the art modelling and analysis software. These will enable hands-on exploration of analysis tools, applied for example to medical imaging data and human movement data collected in our laboratories. Some laboratories will be performed in groups, to encourage learning group dynamics and interactions.

Coursework assignments - these will require students to seek additional information and work on their own, or sometimes in small groups, to develop understanding of subject matter.

Projects - This is a major piece of work, which will be mainly completed after the formal examinations of the other modules. Students will work closely with one of the Masters' teaching staff upon a topic of their choice, usually related closely to current research questions or unmet clinical needs. This will provide valuable experience of the research process for students seeking a PhD or research career in computational medicine.

Private Study- in preparation for lectures, seminars and assessment students will have the opportunity to undergo a certain amount of independent study to develop their own understanding of theoretical and empirical issues, and increases their knowledge-base in the discipline. The amount of independent study varies from module to module, and reading lists provided for each module will guide students in this task.

Opportunities to demonstrate achievement of the programme learning outcomes are provided through the following assessment methods:

Written examinations – typically of 1 to 2 hours' duration. The examinations papers consist of short-answers, numerical examples, and essay questions, depending upon the nature of the material covered by each module;

Coursework submissions - these include design studies, laboratory reports, computational assignments and research reports;

Poster and oral presentation - at the end of their individual project students' learning outcomes will be assessed both through the assessment of their coursework/thesis and an oral poster presentation where the students' communication skills will also be assessed;

Formative assessment - in approximately half of the core modules offered within the programme students will be informally assessed during the early stages of their learning process to check and possibly modify teaching activities to ultimately improve students' attainment.

19. Reference points

The learning outcomes have been developed to reflect the following points of reference:

Subject Benchmark Statements
https://www.qaa.ac.uk/quality-code/subject-benchmark-statements

Framework for Higher Education Qualifications (2014)
https://www.qaa.ac.uk/docs/qaa/quality-code/qualifications-frameworks.pdf

Masters Level Accreditation Framework Courses
https://www.ipem.ac.uk/CareersTraining/IPEMAccreditedcourses/MastersDegreeAccreditation.aspx

University Strategic Plan
http://www.sheffield.ac.uk/strategicplan

Education Strategy (2020-2025)
https://staff.sheffield.ac.uk/vision/education

20. Programme structure

The programme is designed to cover fundamental aspects of biomedical engineering (core modules) and more specific topics (optional modules) depending on the students' own preferences and the individual project pre-requisite knowledge.

In semester 1, students take two core modules designed to ensure that all students, irrespective of their background, develop an appropriate knowledge in human anatomy and physiology, as well as the global context of regulations for biomedical software and medical devices. From a very early stage in the programme students will be required to express their preferences regarding their choice of individual project. This will allow them to tailor their selection of optional modules to the knowledge requirements of their individual project. Students will select two optional modules (30 credits) from a pool of 4 modules covering computational biomechanics (musculoskeletal) and bio-tissue engineering disciplines. During this semester and as part of their individual project, the students will undertake an in depth survey of the literature and elaborate a first draft of the project manuscript, covering the wider biomedical engineering context leading to the project aim and objectives together with a first exploration of the project activities.

In semester 2, students take two compulsory modules. One on the use of modelling and state-of-the-art visualization technology (virtual reality, 3D printing, 3D images, etc.) that will teach them effective ways of communicating engineering data to multidisciplinary audiences. A second module will cover fundamental knowledge of medical image technology, acquisition and analysis. Students will then select two optional modules (30 credits) from a pool of 8 modules to give them another opportunity to advance along their individual educational path and develop knowledge and skills to support the project activities. Optional modules range from fundamental and cardiovascular biomechanics, combined with a laboratory course for hands-on, problem-based learning of cardiovascular modelling, through lab-based exploration of biomechanics of human movement, up to disciplines that focus more on biomaterials and tissue engineering. Some other modules focus on human factors and how they influence of design of processes and devices.

The project lasts from the beginning of the first semester (October) until the end of September and is supported by one-to-one supervision. Progression to the project (and thereby completion of the course) is contingent on passing all taught modules. If students successfully complete all taught modules but are unable to complete the research Dissertation, a Diploma is available in place of the Masters.

We will also arrange the MSc students into groups of 4, to meet regularly with an assigned personal tutor. The tutorials will be scheduled bi-weekly for the first 4 weeks, then every three weeks for the following 6 weeks (Autumn semester). For the spring semester, two personal tutorials are scheduled, and it is expected that support will also be provided by the project supervisor.

Detailed information about the structure of programmes, regulations concerning assessment and progression and descriptions of individual modules are published in the University Calendar available on-line at http://www.sheffield.ac.uk/calendar/.

21. Student development over the course of study

The individual project will be an important synthesising element of the curriculum which will support the development of self-management skills, depth of knowledge and a point of integration, but also offer the opportunity to develop a personalised educational pathway through the supervised selection of a limited number of optional modules (approx. 4 modules, 60 credits) that will aim at developing the knowledge required by the individual project. The programme will offer core modules to provide the necessary foundation knowledge in biomedical engineering plus a pool of advanced optional modules for a more personalised educational path that will gravitate around the students' individual projects and personal interests.

22. Criteria for admission to the programme

Bachelor degree in Engineering (Mechanical Engineering, Electrical Engineering, Control Engineering, General Engineering, Chemical Engineering) or pure sciences (Maths, Physics), class 2.2.

Our standard English requirement is IELTS 6.5 (with no marks less than 6.0 in each component) or equivalent.

Detailed information regarding admission to programmes is available from the University's On-Line Prospectus at http://www.shef.ac.uk/courses/.

23. Additional information

None

This specification represents a concise statement about the main features of the programme and should be considered alongside other sources of information provided by the teaching department(s) and the University. In addition to programme specific information, further information about studying at The University of Sheffield can be accessed via our Student Services web site at http://www.shef.ac.uk/ssid.