Southampton

Programme Specification

MSc Biomedical Engineering (2020-21)

This specification provides a concise summary of the main features of the programme and the learning outcomes that a typical student might reasonably be expected to achieve and demonstrate if s/he takes full advantage of the learning opportunities that are provided.

Awarding Institution	University of Southampton
Teaching Institution	University of Southampton
Mode of Study	Full-time
Duration in years	1
Accreditation details	Institution of Mechanical Engineers (IMechE)
Final award	Master of Science (MSc)
Name of award	MSc Biomedical Engineering
Interim Exit awards	Postgraduate Certificate
	Postgraduate Diploma
FHEQ level of final award	Level 7
UCAS code	N/A
Programme code	7001
QAA Subject Benchmark or other external reference	Engineering 2015
Programme Lead	Markus Heller

Programme Overview

Brief outline of the programme

Within this particular programme of study, we aim to develop and enhance your knowledge of, and enthusiasm for, Biomedical Engineering which can be focussed along key areas of application (currently Musculoskeletal, Cardiovascular, Imaging, Diagnostic Systems, and Audiology).

This programme is suitable for engineering, mathematics and physical science graduates who wish to specialise in Biomedical Engineering or to support continued professional development. The programme aims to provide you with an academically challenging exposure to the current state of the art in Biomedical Engineering underpinned by interdisciplinary approaches and emphasising clinical translation strategies. The programme intends to equip you with the necessary skills to take on a leading role in developing novel engineering solutions which will allow healthcare practitioners and providers including clinicians, clinical support services and carers as well as individuals' themselves to improve or maintain their health and well-being by better preventive, diagnostic, prognostic, restorative, rehabilitative and palliative measures.

Your contact hours will vary depending on your module/option choices. Full information about contact hours is provided in individual module profiles.

Typical course content

Biomedical Engineers work at the interface of engineering, biology, and medicine, combining their engineering expertise with an understanding of human biology and medical needs to make the world a healthier place. This program allows you to develop the breadth and depth of your knowledge, understanding and skills related to engineering principles and practices. The programme aims to provide you with the essential skills to succeed in an interdisciplinary environment, working in teams of clinicians, scientists, engineers, business people, support staff and other professionals to monitor, restore and enhance normal body function, abilities and outcomes.

Understanding the biological and medical healthcare context is key to this Biomedical Engineering course in order to prepare you to solve real problems and provide effective solutions. Compulsory modules running in both semester 1 and semester 2 provide you with the essential training that will enable you to integrate biology and medicine with engineering to solve medical and healthcare challenges facing society. Within these modules, existing initiatives such as the NHS' Public Patient Involvement (PPI) will be utilised to help you understand the nature and context of clinical research. Further, practicing clinicians will present special seminars to illustrate how healthcare needs demand and benefit from collaboration across the life technologies interface. You can then choose additional modules in semesters 1 and 2 to further develop the breadth and depth of your knowledge and skills in Biomedical Engineering and allied areas. An interdisciplinary research project at the end of the program will provide you with a further opportunity to integrate your engineering skills with an understanding of the complexity of biological systems to work successfully at this exciting intersection of science, medicine and mathematics to solve biological and medical problems.

Learning and teaching

The programme will be delivered through a combination of lectures, tutorials (small group teaching), example classes, laboratory experiments, industrial visits, coursework, and projects to enable you to demonstrate knowledge and understanding of the fundamental scientific and technical aspects of Biomedical Engineering, including a wide range of engineering materials, components, devices, and a wide range of measurement and analysis techniques. Knowledge of underlying physical principles as well as basics in biomedicine will further enable advanced and effective engineering developments not only for the clinic but also in healthcare applications more generally. Creating an understanding of the interface between engineering and biomedicine, in order to translate technology for medical purposes, underpins the learning and teaching activities in this programme. By way of example, there are a number of ongoing research collaborations between the Faculties of Engineering and Physical Sciences, Faculty of Medicine and Faculty of Environmental and Life Sciences related to Active and Healthy Aging, the role of Sport and Exercise in Osteoarthritis, new approaches for the prevention and treatment of Osteoporosis and bone fractures more generally, Alzheimer's disease, stroke and heart disease, for example, all of which have inspired content in the Programme. Additionally, cross-faculty interdisciplinary activities at the interface of life sciences including those seeded by the Institute for Life Sciences (IfLS) have helped shaping the programme and underpin the distinct emphasis on understanding the biomedical context and clinical translation in this programme.

Through essays, coursework, group discussions, industrial visits and projects, you will be able to acquire the ability to demonstrate knowledge and understanding of the technical background of Biomedical Engineering to enable critical analysis of the current literature, identification of gaps in information, and also engagement in discussion with peers and a wide range of audiences. You are encouraged throughout to contribute your own professional experiences and thoughts to the learning of the whole class through a free exchange of ideas. Through this programme you can gain knowledge and understanding of the limitations of current knowledge and the changing nature of technologies and society, as well as the need to gain new knowledge through further study and team-based project work.

Research Project

Research projects may concern any of the areas of application covered by the programme. Interdisciplinary projects across engineering and biomedicine will be available with normally supervisors from at least two

disciplines. The research project is intended to bring together the full range of skills in the programme and to provide you with an opportunity to build on all of the learning outcomes described below, while demonstrating in-depth knowledge and understanding of Biomedical Engineering. It involves information gathering and handling, critical analysis and evaluation, and presentation skills. The key requirement, however, is that the project must contain your own ideas and proposals: it should not simply be a technical design carried out to existing standards, but a problem with an element of novelty requiring the application of new information and concepts.

Assessment

Testing of the knowledge base is through a combination of unseen written examinations and assessed coursework in the form of problem solving exercises, laboratory reports, design exercises, essays, and an individual research project with a dissertation. Analysis and problem-solving skills are assessed through unseen written examinations and problem based exercises. Experimental, research and design skills are assessed through laboratory reports, coursework exercises, project reports and oral presentations.

Please note: As a research-led University, we undertake a continuous review of our programmes to ensure quality enhancement and to manage our resources. As a result, this programme may be revised during a student's period of registration; however, any revision will be balanced against the requirement that the student should receive the educational service expected. Please read our Disclaimer to see why, when and how changes may be made to a student's programme.

Programmes and major changes to programmes are approved through the University's programme validation process which is described in the University's quality handbook.

Special Features of the programme

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Educational Aims of the Programme

The aims of the programme are to: The aims of the programme are to:

 \cdot Enable you to acquire advanced knowledge and practical skills needed for a professional career in Biomedical Engineering, and to provide you with specialist knowledge and skills relevant to that end.

• Provide you with a sound understanding of the fundamental principles, operation requirements, design criteria and engineering applications in Biomedical Engineering.

• Enhance your transferable skills, including critical analysis, problem solving, project management, decision making, leadership, and communication by oral, visual and written means.

• Equip you with specialist knowledge, scientific and technical expertise and research skills for further research in Biomedical Engineering.

Having successfully completed this programme you will be able to demonstrate knowledge and understanding of:

Science and Mathematics

Engineering is underpinned by science and mathematics, and other associated disciplines, as defined by the relevant professional engineering institution(s). On graduation you will have achieved:

- SM7. A comprehensive understanding of the relevant scientific principles of Biomedical Engineering
- SM8. A critical awareness of current problems and/or new insights most of which is at, or informed by, the forefront of aerodynamic and computation
- SM9. Understanding of concepts relevant to Biomedical Engineering, some from outside engineering, and the ability to evaluate them critically and to apply them effectively, including in engineering projects

Engineering analysis

Engineering analysis involves the application of engineering concepts and tools to the solution of Acoustical Engineering problems. On graduation you will have achieved:

- EA5. Ability to use fundamental knowledge to investigate new and emerging technologies
- EA6. Ability both to apply appropriate engineering analysis methods for solving complex problems in engineering and to assess their limitations
- EA7. Ability to collect and analyse research data and to use appropriate engineering analysis tools in tackling unfamiliar problems, such as those with uncertain or incomplete data or specifications, by the appropriate innovation, use or adaptation of engineering analytical methods

Design

Design at this level is the creation and development of an economically viable product, process or system to meet a defined need. It involves significant technical and intellectual challenges and can be used to integrate all engineering understanding, knowledge and skills to the solution of real and complex problems. On graduation you will have the knowledge, understanding and skills to:

- D9. Knowledge, understanding and skills to work with information that may be incomplete or uncertain, quantify the effect of this on the design and, where appropriate, use theory or experimental research to mitigate deficiencies
- D10. Knowledge and comprehensive understanding of design processes and methodologies and the ability to apply and adapt them in unfamiliar situations
- D11. Ability to generate an innovative design for products, systems, components or processes to fulfil new needs

Economic, legal, social, ethical and environmental context

Engineering activity can have impacts on the environment, on commerce, on society and on individuals. Graduates therefore need the skills to manage their activities and to be aware of the various legal and ethical constraints under which they are expected to operate, including:

- EL8. Awareness of the need for a high level of professional and ethical conduct in engineering
- EL9. Awareness that engineers need to take account of the commercial and social contexts in which they operate
- EL10. Knowledge and understanding of management and business practices, their limitations, and how these may be applied in the context of Biomedical Engineering
- EL11. Awareness that engineering activities should promote sustainable development and ability to apply quantitative techniques where appropriate
- EL12. Awareness of relevant regulatory requirements governing engineering activities in the context of Biomedical Engineering
- EL13. Awareness of and ability to make general evaluations of risk issues in the context of Biomedical Engineering, including health & safety, environmental and commercial risk

Engineering practice

This is the practical application of engineering skills, combining theory and experience, and use of other relevant knowledge and skills. On graduation you will have achieved:

- P9. A thorough understanding of current Biomedical Engineering practice and its limitations, and some appreciation of likely new developments
- P11. Understanding of different roles within an engineering team and the ability to exercise initiative and personal responsibility, which may be as a team member or leader
- P12. Advanced level knowledge and understanding of a wide range of engineering materials and components

Additional general skills

On graduation you will have developed transferable skills, additional to those set out in the other learning outcomes, that will be of value in a wide range of situations, including the ability to:

- G1. Apply their skills in problem solving, communication, working with others, information retrieval, and the effective use of general IT facilities
- G2. Plan self-learning and improve performance, as the foundation for lifelong learning/CPD
- G3. Monitor and adjust a personal programme of work on an on-going basis
- G4. Exercise initiative and personal responsibility, which may be as a team member or leader

Programme Structure

The programme structure table is below:

Information about pre and co-requisites is included in individual module profiles.

Where optional modules have been specified, the following is an indicative list of available optional modules, which are subject to change each academic year. Please note in some instances modules have limited spaces available.

Part I

The taught component of the MSc consists of a number of compulsory modules plus option modules chosen to total 60 ECTS points (120 CATS), at least 45 ECTS points (90 CATS) of which must be at level 7 (taught modules for MSc). The research project and dissertation are equivalent to 30 ECTS points (60 CATS) at level 7 (Masters).

Part I Compulsory

Code	Module Title	ECTS	Туре
MEDI6226	Human Biology & Systems Physiology	7.5	Compulsory
ISVR6144	Introduction to Biomedical Engineering	7.5	Compulsory
MEDI6219	Translational Medicine	7.5	Compulsory

Part I Core

Code	Module Title	ECTS	Туре
FEEG6012	MSc Research Project	30	Core

Part I Optional

Part I Optional Level 6

No more than 15 ECTS/30 Credits may be taken at Level 6.

Code	Module Title	ECTS	Туре
SESM3028	Biomaterials	7.5	Optional
SESM3030	Control and Instrumentation	7.5	Optional
FEEG3001	Finite Element Analysis in Solid Mechanics	7.5	Optional
SESM3032	Heat Transfer and Applications	7.5	Optional
FEEG3004	Human Factors in Engineering	7.5	Optional
ISVR3061	Human Responses to Sound and Vibration	7.5	Optional
SESG3024	Manufacturing and Materials	7.5	Optional
SESM3033	Orthopaedic Biomechanics	7.5	Optional
ELEC3201	Robotic Systems	7.5	Optional

Part I Optional Level 7

Code	Module Title	ECTS	Туре
ISVR6139	Active Control of Sound and Vibration	7.5	Optional
FEEG6002	Advanced Computational Methods I	7.5	Optional
SESM6034	Advanced Electrical Systems	7.5	Optional
FEEG6010	Advanced Finite Element Analysis	7.5	Optional
SESG6035	Advanced Sensors and Condition Monitoring	7.5	Optional
AUDI6008	Assessment and Management of Vestibular Disorders	7.5	Optional
SESA6066	Biological Flow	7.5	Optional
ELEC6212	Biologically Inspired Robotics	7.5	Optional
ISVR6138	Biomedical Application of Signal and Image Processing	7.5	Optional
SESM6036	Biomedical Implants and Devices	7.5	Optional
NATS6008	Biomedical Spectroscopy and Imaging	7.5	Optional
ELEC6205	Bionanotechnology	7.5	Optional
SESM6038	Computational methods in biomedical engineering design	7.5	Optional
FEEG6009	Design Search and Optimisation (DSO) - Principles, Methods, Parameterizations and Case Studies	7.5	Optional
SESG6040	Failure of Materials and Components	7.5	Optional
AUDI6012	Fundamentals of Auditory Implants	7.5	Optional
ELEC6213	Image Processing	7.5	Optional
ELEC6227	Medical Electrical and Electronic Technologies	7.5	Optional
MATH6141	Numerical Methods	7.5	Optional
AUDI6009	Physiology and Psychology of Hearing	7.5	Optional
AUDI6010	Rehabilitation of Auditory Disorders	7.5	Optional

Progression Requirements

The programme follows the University's regulations for <u>Progression, Determination and Classification</u> <u>of Results : Undergraduate and Integrated Masters Programmes</u> and <u>Progression, Determination</u> <u>and Classification of Results: Postgraduate Master's Programmes</u> Any exemptions or variations to the University regulations, approved by AQSC are located in <u>section VI of the University Calendar</u>.

Support for student learning

There are facilities and services to support your learning some of which are accessible to students across the University and some of which will be geared more particularly to students in your particular Faculty or discipline area.

The University provides:

- library resources, including e-books, on-line journals and databases, which are comprehensive and up-todate; together with assistance from Library staff to enable you to make the best use of these resources
- high speed access to online electronic learning resources on the Internet from dedicated PC Workstations onsite and from your own devices; laptops, smartphones and tablet PCs via the Eduroam wireless network. There is a wide range of application software available from the Student Public Workstations.

- computer accounts which will connect you to a number of learning technologies for example, the Blackboard virtual learning environment (which facilitates online learning and access to specific learning resources)
- standard ICT tools such as Email, secure filestore and calendars.
- access to key information through the MySouthampton Student Mobile Portal which delivers timetables, Module information, Locations, Tutor details, Library account, bus timetables etc. while you are on the move.
- IT support through a comprehensive website, telephone and online ticketed support and a dedicated helpdesk in the Hartley Library.
- Enabling Services offering support services and resources via a triage model to access crisis management, mental health support and counselling. Support includes daily Drop In at Highfield campus at 13.00 15.00 (Monday, Wednesday and Friday out of term-time) or via on-line chat on weekdays from 14.00 16.00. Arrangements can also be made for meetings via Skype.
- assessment and support (including specialist IT support) facilities if you have a disability, long term health problem or Specific Learning Difficulty (e.g. dyslexia).
- the Student Services Centre (SSC) to assist you with a range of general enquiries including financial matters, accommodation, exams, graduation, student visas, ID cards
- Career and Employability services, advising on job search, applications, interviews, paid work, volunteering and internship opportunities and getting the most out of your extra-curricular activities alongside your degree programme when writing your CV
- Other support that includes health services (GPs), chaplaincy (for all faiths) and 'out of hours' support for students in Halls and in the local community, (18.00-08.00)
- A Centre for Language Study, providing assistance in the development of English language and study skills for non-native speakers.

The Students' Union provides

- an academic student representation system, consisting of Course Representatives, Academic Presidents, Faculty Officers and the Vice-President Education; SUSU provides training and support for all these representatives, whose role is to represent students' views to the University.
- opportunities for extracurricular activities and volunteering
- an Advice Centre offering free and confidential advice including support if you need to make an academic appeal
- Support for student peer-to-peer groups, such as Nightline.

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Career Destinations, advising on job search, applications, interviews, paid work, volunteering and internship opportunities and getting the most out of your extra-curricular activities alongside your degree programme when writing your CV

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The Southampton University Students' Union (SUSU) provides

An academic student representation system, consisting of Course Representatives, Academic Presidents, Faculty Officers and the Vice-President Education; SUSU provides training and support for all these

representatives, whose role is to represent students' views to the University

· Opportunities for extracurricular activities and volunteering

• An Advice Centre offering free and confidential advice including support if you need to make an academic appeal

· Support for student peer-to-peer groups, such as Nightline

Associated with your programme you will be able to access:

• Induction programme for orientation, introduction of the programme and staff, and dissemination of materials.

• Student Coursebook, including guidance on selection of study programmes.

Administrative and academic material on the Faculty, Programme and individual module web sites and/or Blackboard.

• A personal tutor to assist with organisational and personal matters. This role is taken over by the project supervisor when the research project starts.

- · Careers advice and dissemination of available job advertisements.
- Personal e-mail account and e-mail access to staff via University system.
- · School clusters of computers with relevant specialist software.
- · Formal progress monitoring during research project.
- Support for international students.

Methods for evaluating the quality of teaching and learning

You will have the opportunity to have your say on the quality of the programme in the following ways:

- Completing student evaluation questionnaires for each module of the programme.
- Acting as a student representative on various committees, e.g. Staff/Student Liaison Committees, School Programmes Committee OR providing comments to your student representative to feedback on your behalf.
- Serving as a student representative on Faculty Scrutiny Groups for programme validation.
 Taking part in programme validation meetings by joining a papel of students to meet with the students of th
- Taking part in programme validation meetings by joining a panel of students to meet with the Faculty Scrutiny Group.

Further details on the University's quality assurance processes are given in the *Quality Handbook*.

Career Opportunities

A career in Biomedical Engineering offers you the opportunity to apply yourself to shape a healthier future with an excellent perspective: according to the American Institute for Medical and Biomedical Engineering, the projected growth rate of Biomedical Engineering careers from 2012-2022 is 27% (as of January 2016).

Several of the major challenges facing humanity are associated with healthy ageing and the growing population, and it will be up to biomedical engineers to address these challenges. Biomedical engineers develop devices and procedures that solve medical and health related problems by combining their knowledge of biology and medicine with sound engineering principles and practices. Many do research, either in academia or industry, along with medical scientists, to develop and evaluate systems and products such as artificial organs, prostheses, instrumentation, and diagnostic, health management and care delivery systems. Biomedical engineers may design devices used in various medical procedures and develop imaging systems and devices for observing and controlling body functions. Biomedical engineers therefore make careers in academia, industry, health care and clinical medicine, as well as government.

In order to support your career, you might want to become professionally chartered. Here, accreditation through e.g. the Institution of Mechanical Engineers (IMechE) can confirm that the programme partially meets the educational requirements for Chartered Engineer (CEng) registration. All established MSc programmes offered by the Faculty of Engineering and Physical Sciences have been accredited. However, such accreditation can generally only be obtained after the programme has run and we will thus seek to obtain such accreditation retrospectively, as is routine practice.

You may be interested to continue from your Biomedical Engineering study into more clinical roles such as postgraduate entry medicine, audiology, prosthetics and orthotics. After successful completion of the MSc Biomedical Engineering degree programme you could consider applying for the three-year, work-based postgraduate NHS Scientist Training Programme to become a NHS Clinical Engineer.

Alternatively, you might be interested to bring you own business ideas to life. Self-employment is a growth area of the economy and is something that many people want to do at some point in their career, even if not immediately after graduation. Moreover, Biomedical Engineering offers a multitude of opportunities to turn the challenges our aging society faces into opportunities and solutions. Through the SetSquared Partnership, a world-wide leading business incubator, the University of Southampton supports your entrepreneurial and enterprising activities either during your studies or after graduation.

For further information about Biomedical Engineering and your career opportunities here please also consult the following web resources:

- · Institution of Mechanical Engineers (IMechE): About Biomedical Engineering
- · Institution of Mechanical Engineers (IMechE): Career Information
- · Institute of Physics and Engineering in Medicine (IPEM): Career Information
- American Institute for Medical and Biological Engineering
- · IEEE Engineering in Medicine and Biology Society (EMB): About Biomedical Engineering
- · IEEE Engineering in Medicine and Biology Society (EMB): Career Centre

External Examiner(s) for the programme

Name: Professor Cathy Holt - Cardiff University

Students must not contact External Examiner(s) directly, and external examiners have been advised to refer any such communications back to the University. Students should raise any general queries about the assessment and examination process for the programme with their Course Representative, for consideration through Staff: Student Liaison Committee in the first instance, and Student representatives on Staff: Student Liaison Committees will have the opportunity to consider external examiners' reports as part of the University's quality assurance process.

External examiners do not have a direct role in determining results for individual students, and students wishing to discuss their own performance in assessment should contact their Personal Academic Tutor in the first instance.

Please note: This specification provides a concise summary of the main features of the programme and the learning outcomes that a typical student might reasonably be expected to achieve and demonstrate if they take full advantage of the learning opportunities that are provided. More detailed information can be found in the programme handbook.

Appendix 1:

Students are responsible for meeting the cost of essential textbooks, and of producing such essays, assignments, laboratory reports and dissertations as are required to fulfil the academic requirements for each programme of study. In addition to this, students registered for this programme also have to pay for:

Additional Costs

Main Item	Sub-section	PROGRAMME SPECIFIC COSTS
Approved Calculators		Students may use calculators in the examination room only as specified by the University and as permitted by the rubric of individual examination papers. The University specifies permissible models from time to time and these may be purchased from any source.
Stationery		You will be expected to provide your own day-to-day stationery items, e.g. pens, pencils, notebooks, etc).
Textbooks		Where a module specifies core texts these should generally be available on the reserve list in the library. However due to demand, students may prefer to buy their own copies. These can be purchased from any source.
		Some modules suggest reading texts as optional background reading. The library may hold copies of such texts, or alternatively you may wish to purchase your own copies. Although not essential reading, you may benefit from the additional reading materials for the module.
Equipment and Materials	Design equipment and materials:	We provide a wide range of resources to support project based modules and activities and these will allow you to complete your assessed exercises to the highest standard. However, you may wish to customise your project by purchasing additional resource e.g. alternative manufacturing materials, electronic components, etc. You may also incur additional costs for printing e.g. large format drawings.
Printing and Photocopying Costs		In some cases, coursework and/or projects may be submitted electronically. Where it is not possible to submit electronically students will be liable for printing costs. Students are expected to cover the costs associated with the printing of drawings and graphic presentations. These are typically expected to be of the order of £20 - 50 per student.

Main Item	Sub-section	PROGRAMME SPECIFIC COSTS
Visits to the Anatomy Laboratory and Biomedical Imaging Unit at Southampton General Hospital and to the Genomics Centre in the Wessex Investigational Sciences Hub laboratory (WISH Lab).		You will be expected to cover the cost of travel.
Although not foreseen and unlikely at the time of writing, we cannot exclude a requirement to travel between Highfield and SGH sites for specific lectures in modules or individual seminars.		You will be expected to cover the cost of travel
In relation to project work we cannot exclude a requirement to travel between Highfield and SGH sites.		You will be expected to cover the cost of travel
	Disclosure and Barring Certificates or Clearance	We cannot categorically rule out the necessity to perform Disclosure and Barring Service (DBS) check in relation to your MSc Project (i.e. criminal records check (Enhanced with list checks). In the rare conditions under which a check would be necessary you might be required to cover the cost.

In some cases you'll be able to choose modules (which may have different costs associated with that module) which will change the overall cost of a programme to you. Details of such costs will be listed in the Module Profile. Please also ensure you read the section on additional costs in the University's Fees, Charges and Expenses Regulations in the University Calendar available at www.calendar.soton.ac.uk.