

Programme Information		
Programme Title	Programme Code	HECoS Code
Human and Biological Robotics	BHM1	For Registry Use Only

Award	Length of Study	Mode of Study	Entry Point(s)	Total Credits	
				ECTS	CATS
MSc	1 Calendar year (12 months)	Full-Time	Annually in October	90	180
PG Diploma – H673UD	N/A	N/A	N/A	60	120
PG Certificate – H673UC	N/A	N/A	N/A	30	60
The PG Certificate and PG Diploma are exit awards and are not available for entry. The PG Certificate and PG Diploma are not accredited by any professional body. You must apply to and join the MSc.					

Ownership			
Awarding Institution	Imperial College London	Faculty	Faculty of Engineering
Teaching Institution	Imperial College London	Department	Bioengineering
Associateship	Diploma of Imperial College (DIC)	Main Location(s) of Study	South Kensington and White City Campuses
External Reference			
Relevant QAA Benchmark Statement(s) and/or other external reference points		Master's Awards in Engineering UK-SPEC	
FHEQ Level		Level 7	
EHEA Level		2nd Cycle	
External Accreditor(s) (if applicable)			
External Accreditor 1:	The Institution of Engineering and Technology		
Accreditation received:	2016	Accreditation renewal:	2026
External Accreditor 2:	Institution of Mechanical Engineers		
Accreditation received:	2016	Accreditation renewal:	2024
External Accreditor 3:	Institute of Materials, Minerals & Mining		
Accreditation received:	2016	Accreditation renewal:	2029

External Accreditor 4:	Institution of Engineering Designers		
Accreditation received:	2018	Accreditation renewal:	2029
Collaborative Provision			
Collaborative partner	Collaboration type	Agreement effective date	Agreement expiry date
N/A	N/A	N/A	N/A
Specification Details			
Programme Lead		Professor Etienne Burdet	
Student cohorts covered by specification		2024-25 entry	
Date of introduction of programme		October 21	
Date of programme specification/revision		March 24	

Programme Overview

Bioengineers use their technological knowledge and understanding to help people live longer, healthier, happier lives. Our one-year full-time MSc Programme in Human and Biological Robotics has a unique focus on engineering methods which investigate human and animal sensing and sensorimotor control, and on the design of biomimetic systems and assistive devices for humans. It builds upon the unique strengths of the Department of Bioengineering and the wider university in this new field.

When studying on this programme you will learn about the emerging research field of human and biological robotics which covers both robotics of human and animals and robotics for humans. This includes:

- The use of tools and techniques from robotics to investigate the sensorimotor control in humans and animals.
- The development of robotics tools to assist humans, e.g. interfaces to working in hazardous environments or with physically or neurologically impaired individuals.

In our wide-ranging programme you will have modules that introduce the topics of robotics for humans and society, service and social robotics, rehabilitation technology, as well as machine vision, artificial intelligence and machine learning. Through your choice of elective modules you will be able to develop an understanding of neuromechanics, biomimetics design, signal and image processing and the application of robotics in health and everyday life.

The MSc Human and Biological Robotics is a one-year full-time programme leading to the MSc award. Students of the programme will benefit from interaction with students on other programmes in the Department to develop their interdisciplinary knowledge. Our programme combines lectures, study groups, and taught classes where you gain a theoretical understanding, with a substantial engineering project where you will work on a real-world problem in Bioengineering related to robotics. You may choose to develop your practical and laboratory skills either through the selection of taught modules with practical content, or during your project work. Taught modules typically run during the Autumn and Spring terms which allows you to focus full-time on your project in the latter half of the year. It may be possible for projects to be carried out partly or wholly at an external organisation and requests will be considered on a case by case basis. The programme is taught on both the South Kensington and White City Campuses. Laboratories as part of taught modules will normally be at the South Kensington Campus.

Pre-requisites: you should demonstrate a strong mathematical background with experience of advanced calculus including Ordinary Differential Equations, linear algebra including the manipulation of vectors and matrices and probability theory. You should also have some prior programming experience.

In addition to the main programme content, the department hold regular seminars and workshops with guest speakers whose research spans the Bioengineering discipline. You are encouraged to attend the seminars to

deepen and broaden your understanding of robotics and the wider Bioengineering field. Our programme will prepare you to analyse and solve problems in bioengineering using an integrated, multidisciplinary approach, and our graduates are well-placed to gain employment in a growing industry.

Learning Outcomes

The following Learning Outcomes are in line with FHEQ level 7 and the UK-SPEC outcomes required for accreditation by professional engineering bodies.

The Learning Outcomes are categorised into the following groups:

- Knowledge and Understanding **[KU]**
- Intellectual Abilities **[IA]**
- Practical and Transferable skills **[PT]**

Upon successful completion of the *MSc Human and Biological Robotics* programme you will be able to:

[KU1] Assess the underlying scientific principles, engineering mathematics and computational models and tools that underpin the field of Human and Biological Robotics and identify their limitations.

[KU2] Evaluate the core concepts, principles and theories relevant to Human and Biological Robotics and how these are relevant to historical, current and future developments and technologies in the Human and Biological Robotics field

[KU3] Evaluate how robotics and associated engineering technologies have been used to provide innovative and creative engineering solutions to healthcare problems and quality-of-life issues and critically discuss these examples in terms of their commercial, economic, social and sustainability implications.

[KU4] Recognise and justify the need for a high level of professional and ethical conduct in engineering, based on a knowledge of professional codes of conduct, how ethical dilemmas can arise and the management of risk issues.

[KU5] Evaluate management and business practices that may be applied in the development of technologies in the Human and Biological Robotics field, with reference to regulatory requirements applicable to medical devices and healthcare solutions.

[IA1] Critically select and apply engineering principles and tools for the analysis and solution of familiar and unfamiliar Human and Biological Robotics problems including investigation of new and emerging robotic technologies

[IA2] Apply diagnostic skills, technical knowledge and understanding of engineering design processes and materials to establish rigorous and creative solutions to complex Human and Biological Robotics problems and to fulfil new needs.

[IA3] Extract, analyse and critically evaluate information and data gathered from academic and technical resources.

[IA4] Work with information that may be incomplete or uncertain, quantify the effect of this on the design or development of an engineering solution and, where appropriate, use theory or experimental research to mitigate deficiencies through the generation of new data

[PT1] Work effectively within a team, demonstrating leadership, project management and communication skills that show an appreciation for the different roles within an engineering team.

[PT2] Exercise initiative and judgement in a range of situations, identifying areas for self-learning and development, and accepting accountability for decisions made and the quality of outcomes produced.

[PT3] Work individually and/or within a group to plan, conduct and professionally communicate the results of a programme of original research or advanced technical design activities, in a safe and ethical manner in laboratory or computational settings.

Upon successful completion of the *PG Diploma Human and Biological Robotics* programme you will be able to:

[KU1] Assess the underlying scientific principles, engineering mathematics and computational models and tools that underpin the field of Human and Biological Robotics and identify their limitations.

[KU2] Evaluate the core concepts, principles and theories relevant to Human and Biological Robotics and how these are relevant to historical, current and future developments and technologies in the Human and Biological Robotics field

[KU3] Evaluate how robotics and associated engineering technologies have been used to provide innovative and creative engineering solutions to healthcare problems and quality-of-life issues and critically discuss these examples in terms of their commercial, economic, social and sustainability implications.

[KU4] Recognise and justify the need for a high level of professional and ethical conduct in engineering, based on a knowledge of professional codes of conduct, how ethical dilemmas can arise and the management of risk issues.

[KU5] Describe and critically discuss management and business practices that may be applied in the development of technologies in the Human and Biological Robotics field, with reference to regulatory requirements applicable to medical devices and healthcare solutions.

[IA1] Critically select and apply engineering principles and tools for the analysis and solution of familiar and unfamiliar Human and Biological Robotics problems.

[IA2] Extract, analyse and critically evaluate information and data gathered from academic and technical resources.

[IA3] Work with information that may be incomplete or uncertain, quantify the effect of this on the design or development of an engineering solution and, where appropriate, use theory or experimental research to mitigate deficiencies through the generation of new data

[PT1] Work effectively within a team, demonstrating leadership, project management and communication skills.

[PT2] Work individually and/or within a group to plan, conduct and professionally communicate the results of a programme of original research or advanced technical design activities, in a safe and ethical manner in laboratory or computational settings.

Upon successful completion of the *PG Certificate Human and Biological Robotics* programme you will be able to:

[KU1] Assess the underlying scientific principles, engineering mathematics and computational models and tools that underpin the field of Human and Biological Robotics and identify their limitations.

[KU2] Evaluate the core concepts, principles and theories relevant to Human and Biological Robotics and how these are relevant to historical, current and future developments and technologies in the Human and Biological Robotics field

[KU3] Evaluate how robotics and associated engineering technologies have been used to provide innovative and creative engineering solutions to healthcare problems and quality-of-life issues and critically discuss these examples in terms of their commercial, economic, social and sustainability implications.

[KU4] Recognise and justify the need for a high level of professional and ethical conduct in engineering, based on a knowledge of professional codes of conduct, how ethical dilemmas can arise and the management of risk issues.

[KU5] Describe and critically discuss management and business practices that may be applied in the development of technologies in the Human and Biological Robotics field, with reference to regulatory requirements applicable to medical devices and healthcare solutions.

[IA1] Critically select and apply engineering principles and tools for the analysis and solution of familiar and unfamiliar Human and Biological Robotics problems

[IA2] Extract, analyse and critically evaluate information and data gathered from academic and technical resources.

[IA3] Work with information that may be incomplete or uncertain, and where appropriate, use theory to mitigate deficiencies through the generation of new data [PT1] Work effectively within a team, demonstrating leadership, project management and communication skills.	
The Imperial Graduate Attributes are a set of core competencies which we expect students to achieve through completion of any Imperial degree programme. The Graduate Attributes are available at: www.imperial.ac.uk/about/education/our-graduates/	
Entry Requirements	
Academic Requirement	The minimum entry requirement is normally a 1st class UK Honours degree (or equivalent) in a physical science, engineering or mathematical discipline. As an engineering degree, the MSc Human and Biological Robotics requires a strong maths competency and successful applicants will typically be expected to have scored the equivalent of a 2.1 or above in maths topics during their undergraduate degree. Your mathematical background should include experience of advanced calculus including Ordinary Differential Equations, linear algebra including the manipulation of vectors and matrices and probability theory. You should also have some prior programming experience. For further information on entry requirements, please go to: www.imperial.ac.uk/study/apply/postgraduate-taught/entry-requirements/
Non-academic Requirements	None
English Language Requirement	Higher requirement (PG) Please check for other Accepted English Qualifications
Admissions Test/Interview	Applicants may be invited to attend an interview with one or more members of academic staff
The programme's competency standards documents can be found at: www.imperial.ac.uk/media/imperial-college/faculty-of-engineering/bioengineering/public/student/Competency-Standards---Bioengineering-UG-PG--June-2016-Final.pdf	
Learning & Teaching Approach	
Learning and Teaching Delivery Methods You will be taught through a combination of lectures, study groups and tutorials, computing labs, guest lectures and presentations. Study groups and tutorials will enable you to discuss and develop your understanding of topics covered in lectures whilst in smaller groups of around 30 students. These are usually based around problem sheets, questions or computational tasks set by the module lecturers. You will be expected to solve these either individually or as part of a small group. Study groups and tutorials are supported by graduate teaching assistants. Timetabled sessions may be delivered online or in person, or in a hybrid format. Depending on your elective choices you may also attend laboratory sessions to develop your practical skills. These may include computer, wet labs or electrical labs. The virtual learning environment Blackboard will be used as a repository for teaching materials including recordings of all lectures, lecture notes and problem sheets. Learning technologies will be used to support teaching activities including in-class polling with Mentimeter, online self-diagnostic quizzes and online class forums. Independent Learning You are expected to spend significant time on independent study outside of timetabled learning and teaching sessions. From our experience students that undertake independent learning have improved academic	

performance, increased motivation and confidence in themselves and their abilities. By undertaking independent learning, you are also preparing yourself for professional practice where it is expected that you will manage your own continued professional development. Independent learning activities that you will be expected to undertake will typically include accessing online resources, completing problem sheets, reading journal articles and books, undertaking research in the library, reviewing lecture notes and watching lecture recordings, working on individual and group projects, working on coursework assignments and revising for exams.

Bioengineering uses flipped teaching for some modules, meaning that you need to actively engage with on-line resources ahead of attending timetabled sessions. This independent learning is followed by sessions led by the teacher where all students work in small groups to apply that knowledge to more practical examples. This helps you to further consolidate and enhance your understanding of the topics you study and allows us the time to focus on more challenging concepts in the taught sessions. These taught sessions are normally in the place of study groups for a flipped module.

Major Individual Project

A key part of our MSc programme is the Major Individual Project. This project gives you an opportunity to build on the knowledge and skills you will have developed in your taught modules and apply this to current engineering, design and research problems that interest you. The project also helps you to develop important project management, team working and communication skills that are highly valued by employers and international research groups.

The project is conducted throughout the year but the majority of work is normally undertaken in the summer term, when you will be expected to work on this full time. Whilst this project will be based in Bioengineering it may involve collaboration with groups in other Imperial departments or with Industry.

Overall Workload

Your overall workload consists of face-to-face sessions and independent learning. While your actual contact hours may vary according to the optional modules you choose to study, the following gives an indication of how much time you will need to allocate to different activities at each level of the programme. At Imperial, each ECTS credit taken equates to an expected total study time of 25 hours. Therefore, the expected total study time for the MSc Human and Biological Robotics is 2,250 hours per year.

Typically, you will spend in the order of 15% of your time on lectures, seminars and similar (around 300 hours) and in the order of 85% of your time on independent study. Around half of your independent study hours are spent on your Major Individual Project.

Assessment Strategy

Assessment Methods

A variety of assessment methods will be used to test your understanding. Assessments are grouped as formative and summative.

Formative assessments do not contribute to the module mark but provide information on your progress as an individual and in the context of the class. This allows you to learn by using your new skills to solve problems and receive feedback on your performance to guide your future learning. This supports you to achieve a better performance in the summative assessments which do count towards your module marks. Formative assessments also provide feedback to the teaching staff which allow us to adapt our teaching.

Summative assessments are used to assess your learning against the intended module learning outcomes and contribute towards your achievement of the programme learning outcomes, detailed above. There is summative assessment during and/or at the end of each module and these assessments will contribute towards your mark for each year.

The choice of assessment method is largely determined by the learning objectives being assessed and includes:

Assessed Coursework

- Problem sheets
- Laboratory reports – individually or as part of a portfolio.
- Practical demonstrations

- Project reports
- Oral presentations
- Poster presentations
- Academic tutorials
- In class progress tests

Examinations

- Written examinations
- Oral examinations

The design of our programme will allow you to test your understanding of the subject using formative assessments such as problem sheets, on-line diagnostic tests and mock/past examinations before you complete the summative assessments that count towards your final mark.

The exact balance of the summative assessment through the programme depends upon which elective modules are taken, but an indicative breakdown is:

Coursework	30%
Exams	35%
Practicals	35%

Academic Feedback Policy

Feedback will be provided to you in one of many formats, including:

- Oral (during or after lectures, personally or as a group feedback session)
- Personal (discussion with academics during office hours, meetings with Personal Tutors)
- Interactive (problem solving with GTAs & study groups, peer feedback)
- Written (solutions/model answers to coursework, notes on submitted reports)
- Online (results of online tests with correct answers provided)
- Self-reflective (personal journals, reflective essays and class discussion)

It is department policy to provide feedback to students normally within 10 working days of assessment submission. This timeframe may be extended for significantly large assessments or for final examinations. In this case the date when feedback will be available by will be communicated to you when the assessment is set.

Individual feedback will not be provided on written examinations. However, feedback on the general performance of the cohort on the exam questions will be given. Numerical results for each module will be published after the meeting of the final Board of Examiners

Imperial's Policy on Academic Feedback and guidance on issuing provisional marks to students is available at: www.imperial.ac.uk/about/governance/academic-governance/academic-policy/exams-and-assessment/

Re-sit Policy

Eligibility for resits is determined by the Examination Board in line with Imperial's policy. The Department of Bioengineering does not normally offer resits in September. Students with marginal failure may be offered a supplementary qualifying test in place of a re-sit opportunity.

Imperial's Policy on Re-sits is available at: www.imperial.ac.uk/about/governance/academic-governance/academic-policy/exams-and-assessment/

Mitigating Circumstances Policy

Imperial's Policy on Mitigating Circumstances is available at: www.imperial.ac.uk/about/governance/academic-governance/academic-policy/exams-and-assessment/

Additional Programme Costs

This section should outline any additional costs relevant to this programme which are not included in students' tuition fees.		
Description	Mandatory/Optional	Approximate cost
N/A	N/A	N/A

Important notice: The Programme Specifications are the result of a large curriculum and pedagogy reform implemented by the Department and supported by the Learning and Teaching Strategy of Imperial College London. The modules, structure and assessments presented in this Programme Specification are correct at time of publication but might change as a result of student and staff feedback and the introduction of new or innovative approaches to teaching and learning. You will be consulted and notified in a timely manner of any changes to this document.

Programme Structure ¹					
Year 1 – FHEQ Level 7 (except *) You will study the core modules including the ‘MSc Major Individual Project’ (Total 40 ECTS) and the six compulsory modules (Total 30 ECTS). You then choose either zero or one module from Group A (0 or 5 ECTS) and either three or four modules from Group B (15 or 20 ECTS) to give a total of 4 modules from Groups A&B (Total 20 ECTS) *Except modules where indicated as Level 6 **Modules hosted by other departments. These are subject to availability.					
Code	Module Title	Core/ Compulsory/ Elective	Group	Term	Credits
BIOE70025	MSc Major Individual Project	Core	N/A	Autumn-Summer	40
BIOE70077	Reinforcement Learning for Bioengineers	Compulsory	N/A	Autumn	5
DESE61006	Robotics 1: Introduction to Robotics*	Compulsory	N/A	Autumn	5
BIOE70026	Systems Physiology	Compulsory	N/A	Autumn	5
BIOE70027	Probability, Statistics and Data Analysis	Compulsory	N/A	Autumn	5
BIOE70016	Human Neuromechanical Control and Learning	Compulsory	N/A	Spring	5
BIOE70014	Medical Device Entrepreneurship	Compulsory	N/A	Autumn	5
BIOE70029	Biomechanics L7	Elective	B	Autumn	5
MECH70013	Embedded C for Microcontrollers B**	Elective	A	Autumn-Spring	5
BIOE70003	Animal Locomotion and Bioinspired Robots	Elective	A	Spring	5
BIOE70001	Application Specific Integrated Circuits (ASICs) for Bioengineering	Elective	B	Spring	5
BIOE70150	Artificial Intelligence for Drug Discovery	Elective	B	Spring	5
BIOE70012	Biomimetics	Elective	B	Spring	5
BIOE70011	Brain Machine Interfaces	Elective	B	Spring	5
BIOE70013	Computational Neuroscience	Elective	B	Spring	5
BIOE60007	Human Centred Design of Assistive and Rehabilitation Devices	Elective	A	Spring	5
BIOE70036	Image Processing L7	Elective	B	Spring	5
Credit Total					90

¹ **Core** modules are those which serve a fundamental role within the curriculum, and for which achievement of the credits for that module is essential for the achievement of the target award. Core modules must therefore be taken and passed in order to achieve that named

award. **Compulsory** modules are those which are designated as necessary to be taken as part of the programme syllabus. Compulsory modules can be compensated. **Elective** modules are those which are in the same subject area as the field of study and are offered to students in order to offer an element of choice in the curriculum and from which students are able to select. Elective modules can be compensated.

Award and Classification for Postgraduate Students

Award of a Postgraduate Certificate (PG Cert)

To qualify for the award of a postgraduate certificate you must have a minimum of 30 credits at Level 7 (this may include a maximum of 10 credits from Level 6 where this is approved as part of the award).

Award of a Postgraduate Diploma (PG Dip)

To qualify for the award of a postgraduate Diploma you must have a minimum of 60 credits at Level 7 (this may include a maximum of 15 credits from Level 6 where this is approved as part of the award) of which no more than 10 credits as a Compensated Pass.

Award of a Masters Degree (including MRes)

To qualify for the award of a postgraduate degree you must have:

1. accumulated credit to the value of no fewer than 90 credits across Levels 6 and 7 (of which 75 credits must be at Level 7);
2. and no more than 10 credits as a Compensated Pass;
3. met any specific requirements for an award as outlined in the approved programme specification for that award.

Classification of Postgraduate Taught Awards

The university sets the class of Degree that may be awarded as follows:

1. Distinction: 70.00% or above.
2. Merit: 60.00% or above but less than 70.00%.
3. Pass: 50.00% or above but less than 60.00%.

For a Masters, your classification will be determined through the Programme Overall Weighted Average and the designated dissertation or final major project module meeting the threshold for the relevant classification band.

Your degree algorithm provides an appropriate and reliable summary of your performance against the programme learning outcomes. It reflects the design, delivery and structure of your programme without unduly over-emphasising particular aspects.

Programme Specific Regulations

As an accredited degree, students on this MSc programme are subject to the standards set by the UK Engineering Council in relation to compensation. A maximum of 10 ECTS credits can be compensated across the programme.

Supporting Information

The Programme Handbook is available at: www.imperial.ac.uk/bioengineering/admin/current-pgt/msc-hbr/

The Module Handbook is available from the department.

Imperial's entry requirements for postgraduate programmes can be found at:
www.imperial.ac.uk/study/apply/postgraduate-taught/entry-requirements/

Imperial's Quality & Enhancement Framework is available at:
www.imperial.ac.uk/registry/proceduresandregulations/qualityassurance

Imperial's Academic and Examination Regulations can be found at:
www.imperial.ac.uk/about/governance/academic-governance/regulations

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www.imperial.ac.uk/admin-services/secretariat/college-governance/charters/

Imperial College London is regulated by the Office for Students (OfS)
www.officeforstudents.org.uk/advice-and-guidance/the-register/

This document provides a definitive record of the main features of the programme and the learning outcomes that you may reasonably be expected to achieve and demonstrate if you take full advantage of the learning opportunities provided. This programme specification is primarily intended as a reference point for prospective and current students, academic and support staff involved in delivering the programme and enabling student development and achievement, for its assessment by internal and external examiners, and in subsequent monitoring and review.