

**MSc Human and Biological Robotics**

This document provides a definitive record of the main features of the programme and the learning outcomes that a typical student may reasonably be expected to achieve and demonstrate if s/he takes full advantage of the learning opportunities provided. This programme specification is primarily intended as a reference point for 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.

**Programme Information**

Programme Title	Human and Biological Robotics		
Award(s)	MSc		
Programme code	BHM1		
Awarding Institution	Imperial College London		
Teaching Institution	Imperial College London		
Faculty	Faculty of Engineering		
Department	Department of Bioengineering		
Main Location of Study	South Kensington		
Associateship	None		
Mode and Period of Study	1 calendar year full-time (12 months)		
Cohort Entry Points	Annually in October		
Relevant <a href="#">QAA Benchmark Statement(s)</a> and/or other external reference points	Master's awards in Engineering		
Total Credits	ECTS:	90	CATS: 180
<a href="#">FHEQ Level</a>	Level 7		
<a href="#">EHEA Level</a>	2 <sup>nd</sup> cycle		
External Accrator(s)	<a href="#">Institute of Physics and Engineering in Medicine</a> <a href="#">Institution of Mechanical Engineers</a> <a href="#">Institute of Materials, Minerals &amp; Mining</a> Institution of Engineering Designers		
<b>Specification Details</b>			
Student cohorts covered by specification	2021-22 entry		
Person Responsible for the specification	Professor Emm Drakakis		

Date of introduction of programme	October 2016
Date of programme specification/revision	October 2021

### Description of Programme Contents

The programme focusses on the emerging research field of Human and Biological Robotics - robotics of humans and animals, robotics for humans, including:

- 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.

Students take core modules, selected elective modules including a practical-based module if they wish, and the individual research project.

### Learning Outcomes

- Neuromechanics modelling of sensory or motor functions in biological systems and in particular in humans, taught by lectures and problem classes
- Biomimetics design and applications
- Signal and image processing techniques taught by lectures and computer laboratory exercise
- Robotics and its applications to assistive devices for everyday life
- Equipment and techniques to acquire physiological and chemical information from the human body taught by lectures and laboratory classes
- Brainstorming for identifying hazards (risk analysis exercise)
- Ability to perform original research by producing a dissertation
- Ability to perform data and statistical analysis
- Ability to present data both orally and as part of a technical report
- Ability to consider biological and human factors in modelling and for biomimetic design
- Project management
- Problem solving with critical thinking and analytical skills
- Communication of technical and non-technical information through a range of methods, to a variety of audiences
- Teamwork, negotiation, leadership and advocacy skills
- Ability to work independently, plan projects, and manage time and resources effectively
- Ability to understand interdisciplinary concepts and apply them in innovative ways

The Imperial Graduate Attributes are a set of core competencies which we expect students to achieve through completion of any Imperial College degree programme. The Graduate Attributes are available at: [www.imperial.ac.uk/students/academic-support/graduate-attributes](http://www.imperial.ac.uk/students/academic-support/graduate-attributes)

### Entry Requirements

Academic Requirement	A 2.1 UK Bachelor's Degree with Honours or equivalent in a physical science or mathematics subject to include an element of mathematics
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	(or a comparable qualification recognised by the College).
Additional Requirements	<p>Grade A in A level Mathematics or equivalent</p> <p>Applicants should have a knowledge and understanding of the following mathematics at undergraduate level:</p> <ul style="list-style-type: none"> <li>• Linear algebra in N dimensional spaces.</li> <li>• N-dimensional calculus.</li> <li>• Basic probability theory (including mean, variance, correlation, Gaussian distribution, binomial distribution, Bayes theorem).</li> <li>• Previous experience of programming and use of MatLab or similar software to solve engineering problems.</li> </ul>
Applicants may be invited to attend an interview	
English Language Requirement	IELTS 6.5 with a minimum of 6.0 in each element or equivalent
<p>The programme's competency standards document is available online at:  <a href="http://www.imperial.ac.uk/media/imperial-college/faculty-of-engineering/bioengineering/public/student/Competency-Standards---Bioengineering-UG-PG---June-2016-Final.pdf">http://www.imperial.ac.uk/media/imperial-college/faculty-of-engineering/bioengineering/public/student/Competency-Standards---Bioengineering-UG-PG---June-2016-Final.pdf</a></p>	
<b>Learning &amp; Teaching Strategy</b>	
Scheduled Learning & Teaching Methods	<ul style="list-style-type: none"> <li>• Demonstrations</li> <li>• Group exercises</li> <li>• Guided practical classes</li> <li>• Laboratory work</li> <li>• Lectures</li> <li>• Individual research project</li> <li>• Presentations</li> <li>• Seminars</li> <li>• Workshops</li> </ul>
E-learning & Blended Learning Methods	<ul style="list-style-type: none"> <li>• Virtual Learning Environment: Blackboard</li> <li>• Online groups/discussions</li> <li>• Online quizzes and interactive content</li> <li>• You tube videos</li> <li>• Anonymous feedback</li> <li>• Lectures recorded using Panopto</li> </ul>
Project and Placement Learning Methods	<ul style="list-style-type: none"> <li>• Group and individual project work</li> </ul>
<b>Assessment Strategy</b>	

Assessment Methods	<ul style="list-style-type: none"> <li>• Written examinations (open and closed book)</li> <li>• Oral presentations</li> <li>• Written reports, including a dissertation</li> <li>• Coursework including multiple choice progression tests, problem sheets, and quizzes</li> </ul>
Academic Feedback Policy	
<p>Feedback will be provided on coursework within two weeks of submission. Feedback may be provided in one of a number of formats, including:</p> <ul style="list-style-type: none"> <li>• Oral (during or after lectures)</li> <li>• Personal (discussion with academics during office hours)</li> <li>• Interactive (problem solving tutorials with GTAs &amp; study groups)</li> <li>• Written (solutions/model answers to coursework)</li> </ul> <p>In line with College policy, feedback will not be provided on written examinations.</p> <p>Numerical results will be published after the meeting of the final Board of Examiners.</p>	
Re-sit Policy	
<p>Eligibility for resits is determined by the Examination Board in line with the College 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. The College's Policy on Re-sits is available at: <a href="http://www.imperial.ac.uk/registry/exams/resit">www.imperial.ac.uk/registry/exams/resit</a></p>	
Mitigating Circumstances Policy	
<p>The College's Policy on Mitigating Circumstances is available at: <a href="http://www.imperial.ac.uk/registry/exams">www.imperial.ac.uk/registry/exams</a></p>	
<b>Assessment Structure</b>	
	Module % Weighting
Systems Physiology [Core Element]	5.6%
Statistics and Data Analysis [Core Element]	5.6%
Medical Device Entrepreneurship [Core Element]	5.6%
Robotics [Core Element]	5.6%
Human Neuromechanical Control and Learning [Core Element]	5.6%
<i>Five modules from elective group (A/B) to include at least four modules from elective group (A) [Specialist Element]</i>	5.6% each
MSc Human and Biological Robotics Individual Project [Project Element]	44.4%

## Rules of Progression

- There are three elements – project element, core element, and specialist element.
- In order to pass the MSc, a student must:
  - Achieve an aggregate of at least 50% in each element
  - Pass each module at 50%
- At the discretion of the Exam Board, up to 15 ECTS worth of modules, across the degree, having marks below 50% may be awarded a compensated pass as long as their respective element mark is 50% or greater.

The Board would not normally award more than 5 ECTS worth of compensated passes in each of the core and specialist element if their mark was below 40%, and would require their marks to be closer to 40% than their element aggregate mark is above 50%.
- In order to gain a Merit classification, a student must achieve an aggregate of at least 60% in each element
- In order to gain a Distinction classification, a student must achieve an aggregate of at least 70% in each element

Indicative Module List												
Code	Title	Core/ Elective	Year	L&T Hours	Ind. Study Hours	Place- ment Hours	Total Hours	% Written Exam	% Course- work	% Practical	FHEQ Level	ECTS
BIOE97050 (BE9-MSPHYS)	Systems Physiology	Core	1	30	95	0	125	80%	20%	0%	7	5
BIOE97049 (BE9-MSTDA)	Statistics and Data Analysis	Core	1	28	97	0	125	100%	0%	0%	7	5
BIOE97042 (BE9- MDEVEN)	Medical Device Entrepreneurship	Core	1	28	97	0	187.5	0%	100%	0%	7	7.5
BIOE97089 (BE9-MHNCL)	Human Neuromechanical Control and Learning	Core	1	27	98	0	125	80%	20%	0%	7	5
BIOE97052 (BE9-MMIP)	MSc Human and Biological Robotics Individual Project	Core	1	50	950	0	1000	0%	90%	10%	7	40
DESE60005 (DE3-ROB)	Robotics 1: Introduction to Robotics	Core	1	See module leader							6	5
BIOE97047 (BE9- MBMIME)	Biomimetics	Elective (A)	1	27	98	0	125	0%	80%	20%	7	5
BIOE97040 (BE9-MCNS)	Computational Neuroscience	Elective (A)	1	37	88	0	125	100%	0%	0%	7	5

Indicative Module List												
Code	Title	Core/ Elective	Year	L&T Hours	Ind. Study Hours	Place- ment Hours	Total Hours	% Written Exam	% Course- work	% Practical	FHEQ Level	ECTS
BIOE97043 (BE9-MBMX)	Biomechanics	Elective (A)	1	28	97	0	125	70%	30%	0%	7	5
BIOE97075 (BE9-MBMI)	Brain Machine Interfaces	Elective (A)	1	30	95	0	125	80%	20%	0%	7	5
ELEC97053 (EE462)	Selected Topics in Computer Vision	Elective (A)	1	See module leader							7	5
BIOE97091	Image Processing	Elective (A)	1	38	87	0	125	80%	20%	0%	7	5
BIOE70001	Application Specific Integrated Circuits for Bioengineering	Elective (A)	1	27	98	0	125	0	100%	0%	7	5
BIOE96069 (BE3-HHCARD)	Human Centred Assistive and Rehabilitation Devices	Elective (B)	1	30	95	0	125	0%	30%	70%	6	5
BIOE97154 (BE9-MALBIR)	Animal Locomotion and Bioinspired Robots	Elective (B)	1	27	95	0	125	0%	100%	0%	7	5
ME3-HECM	Embedded C for Microcontrollers	Elective (B)	1	See module leader							6	6
COMP96019 (CO333)	Robotics	Elective (B)	1	See module leader							6	5
COMP97143	Reinforcement Learning	Elective (A)	1	27	98	0	125	33.3%	66.7%	0%	7	5

## Supporting Information

The Programme Handbook is available online at:  
<http://www.imperial.ac.uk/bioengineering/admin/msc/>

The Module Handbook is available online at:  
<http://www.imperial.ac.uk/bioengineering/admin/msc/>

The College's entry requirements for postgraduate programmes can be found at:  
[www.imperial.ac.uk/study/pg/apply/requirements](http://www.imperial.ac.uk/study/pg/apply/requirements)

The College's Quality & Enhancement Framework is available at:  
[www.imperial.ac.uk/registry/proceduresandregulations/qualityassurance](http://www.imperial.ac.uk/registry/proceduresandregulations/qualityassurance)

The College's Academic and Examination Regulations can be found at:  
<http://www3.imperial.ac.uk/registry/proceduresandregulations/regulations>

Imperial College is an independent corporation whose legal status derives from a Royal Charter granted under Letters Patent in 1907. In 2007 a Supplemental Charter and Statutes was granted by HM Queen Elizabeth II. This Supplemental Charter, which came into force on the date of the College's Centenary, 8th July 2007, established the College as a University with the name and style of "The Imperial College of Science, Technology and Medicine".  
<http://www.imperial.ac.uk/admin-services/secretariat/college-governance/charters/charter-and-statutes/>

Imperial College London is regulated by the Office for Students (OfS)  
<https://www.officeforstudents.org.uk/>

## Modifications

Change to classification rules	Programmes Committee	25 October 2016	PC.2016.24
Introduce elective module BE9-MBMI (Brain Machine Interfaces)	Teaching Committee	11 October 2016	-
Introduce elective module EE462 (Machine Learning for Computer Vision)	Teaching Committee	27 October 2016	-