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**	Robotics
2	**Programme Code**	ACST17
3	**JACS Code**	H671, H730
4	**Level of Study**	Postgraduate
5a	**Final Qualification**	Master of Science (MSc)
5b	**QAA FHEQ Level**	7
6a	**Intermediate Qualification(s)**	Postgraduate Diploma (PGDip), Postgraduate Certificate (PGCert)
6b	**QAA FHEQ Level**	7
7	**Teaching Institution** (if not Sheffield)	Not applicable
8	**Faculty**	Engineering
9	**Department**	Automatic Control & Systems Engineering
10	**Other Departments involved in teaching the programme**	Not applicable
11	**Mode(s) of Attendance**	Full-time
12	**Duration of the Programme**	1 year
13	**Accrediting Professional or Statutory Body**	Institute of Engineering and Technology (IET), Institute of Measurement and Control (InstMC)
14	**Date of production/revision**	March 2024

15. Background to the programme and subject area

The area of Robotics is receiving considerable interest from both industry and government. The long promised potential for Robotics to revolutionise the way we work, our homes and the world we live in is finally being delivered. Governments are investing heavily and industry is taking up the challenge to translate academic research in order to realise this potential. We are now moving beyond traditional approaches to robotics that relied principally on automation and are entering a new phase of autonomous robotics and systems that requires advanced knowledge, understanding and skills and an interdisciplinary perspective across a broad range of disciplines. As a result, we need to train the next generation of engineers of robotic systems who can think differently and have the creativity and ingenuity to match the potential for Robotics to change our lives. The proposed MSc will provide students the opportunity to translate and develop their existing knowledge, understanding and skills to become experts in Robotics, hence meet the demands for the next generation of engineers of robotic systems.

The key pillars of the MSc are:

- Robotics and Autonomous Systems (RAS) entity – the physical RAS entity is made up of electromechanical and mechatronic components and is best thought of as a cyberphysical system that interacts (through sensing, actions and communication) with the world.
- World – the RAS lives within and interacts with the world including its physical environment, humans and other RAS.
- Sensing and perception – the RAS gathers information about the world and itself which is then organised and interpreted to provide higher level information to the cognitive function.
- Cognition – combined with prior knowledge the RAS uses the information from perception of the world to learn, evaluate, reason and make decisions about what to do. This provides the RAS intelligence and

autonomy.

- Action – the RAS ultimately uses the outputs from the cognitive function to perform actions that interact with and change the world including with other RAS and humans.
- With respect to RAS: verification, certification, legal implications and ethics.

These key pillars will be considered for RAS with applications to:

- Advanced manufacturing including Factory of the Future and Industries 4.0.
- Field robotics including agriculture, infrastructure monitoring, search and rescue.
- Driverless vehicles.
- Unmanned aerial vehicles.
- Home/care robotics.
- Healthcare robotics.

Students will undertake a broad spectrum of modules related to robotics, autonomous systems and engineering and computational intelligence, including underpinning modules in robotics, as well as advanced modules in machine learning, mobile robotics and vision systems.

This course provides the multi-disciplinary knowledge and skills students will need to meet the demand for experts in robotics. Students will be taught by world-leading scientists from the department of Automatic Control & Systems Engineering. The teaching will include lectures, seminars, tutorials, practical sessions and laboratories, individual assignments and a major research project.

The programme is aimed at students looking to specialise in robotics and who have the ambition of either pursuing research or an industrial career in this area. Students with a broad background in engineering, mathematics and numerate science undergraduate degrees will develop the knowledge and skills necessary for a career in robotics.

More information is available at http://www.shef.ac.uk/acse

16. Programme aims

Programmes offered by the department are designed to fulfil the University's mission to provide students from diverse backgrounds with the highest quality education in a research-led environment, maximising employability, innovation and globally-recognised graduate skills, putting graduates at the cutting edge of their discipline and equipping them for their future. The programmes are also designed to fulfil the educational requirements of the Engineering Council for Chartered Engineer status.

The aim of the MSc in Robotics programme is to create graduates who will become future leaders and innovators in the engineering economy by:

1. providing teaching that is informed and invigorated by the research and scholarship of the departments' staff and alert to the benefits of student-centred learning.
2. enabling graduates qualified in other engineering, mathematical and scientific disciplines to develop expertise in the area of robotics.
3. providing a comprehensive knowledge and understanding of, and subject specific skills in, robotics.
4. developing a systematic and creative approach to solving complex problems including deciding on and evaluating appropriate methodologies and taking account of a wide range factors and uncertainty.
5. developing in students initiative, independence of thought, critical thinking, intellectual curiosity, ethical awareness and the business and wider skills necessary for a professional in engineering or a related field.
6. developing in students a diverse range of subject-specific and generic skills appropriate to graduate employment both within and outside engineering, including personal responsibility.
7. enabling students to maximise their potential and imparting in them a commitment to lifelong learning and continuing professional development; and
8. satisfying the academic and practical requirements for the award of Chartered Engineer status by meeting the latest accreditation requirements of the Engineering Council UK-SPEC (UK Standard for Professional Engineering Competence).

17. Programme learning outcomes

Knowledge and understanding:	
On successful completion of the programme, students for the MSc, PGDip and PGCert will have the knowledge and understanding of:	
K1	Scientific principles and methodologies that underpin robotic systems and related disciplines.
K2	Mathematical, computational and statistical methods and models relevant to engineering and robotic systems in particular, including an appreciation of their limitations.
K3	Design processes and methodologies used in robotic systems.
K4	Business, customer and user needs, including considerations such as the wider commercial, economic and social context of engineering processes and the requirement for engineering to promote sustainable development.
K5	The need for a high level of professional and ethical conduct in engineering, professional codes of conduct and how ethical dilemmas can arise.
K6	Management techniques, including project and change management, their limitations and how they may be applied appropriately in engineering; different roles within an engineering team.
K7	Risk issues, including health & safety, environmental and commercial risk, and risk assessment and management techniques.
K8	Relevant legal requirements governing engineering activities, including personnel, health and safety, contracts, intellectual property rights, product safety and liability issues and an awareness that these may differ internationally.
K9	Key drivers for business success, including innovation, calculated commercial risks and customer satisfaction.
K10	Characteristics of particular equipment, processes, or products and a wide range of engineering materials and components.
K11	Technical literature and other information sources.
K12	Current practice, its limitations and likely new developments, appropriate codes of practice, industry standards and awareness of quality issues and their application to continuous improvement.
K13	Undertaking a significant research-led project in a particular aspect of robotics (MSc only).

Skills and other attributes:	
Upon successful completion of the programme, students will be able to demonstrate the ability to:	
S1	Apply and integrate knowledge and understanding across a range of engineering and non-engineering disciplines and the ability to evaluate them critically and apply them effectively in robotics projects including investigating new and emerging technologies.
S2	Apply engineering principles, analytical methods and modelling tools to undertake critical analysis of key engineering processes including identifying, classifying and describing the performance of robotics systems and components.
S3	Apply quantitative and computational methods, including understanding their limitations, in order to solve robotics problems.
S4	Apply an integrated or systems approach to solving complex robotic systems problems.
S5	Extract and evaluate pertinent data, to apply engineering analysis techniques to the solution of unfamiliar robotic systems problems, to work with information that may be incomplete or uncertain and understand how to mitigate against this.
S6	Investigate and define the problem, identifying any constraints including environmental and sustainability limitations; ethical, health and safety, security and risk issues; intellectual property; codes of practice and standards.

S7	Apply advanced problem-solving skills, technical knowledge and understanding to establish rigorous and creative solutions that are fit for purpose for all aspects of the problem including production, operation, maintenance and disposal.
S8	Apply and adapt design processes and methodologies to generate innovative designs for products, systems, components or processes to fulfil new needs and in unfamiliar situations; plan and manage the design process, including cost drivers; evaluate outcomes and commercial risk.
S9	Communicate their work to technical and non-technical audiences.
S10	Apply relevant practical and laboratory skills.
S11	Apply engineering techniques taking account of a range of commercial and industrial constraints.
S12	Exercise initiative and personal responsibility as a team member or leader including monitoring and adjusting a personal programme of work; plan self-learning and improve performance.

18. Teaching, learning and assessment

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

Lectures and Seminars are presentations to a class of students by a lecturer. The purpose of a lecture is to motivate interest in a subject, to convey the core concepts and information content succinctly and to point students towards further sources of information. Lectures are interactive and students are encouraged to ask questions at suitable points. Students are expected to take notes during lectures, adding detail to published course materials (which should be printed and brought to the lecture, when provided in advance on electronic media).

The transition to self-motivated learning is encouraged through specialist teaching materials such as lecture handouts or copies of lecture slides, supplied via the University's VLE. Set course texts and background materials are available through the University libraries, at bookshops and also via the Internet. Active learning is fostered and promoted through engagement in practical work, such as exercises, assignments and projects.

Practical/Laboratory Classes introduce experimental methods and provide opportunity for developing team working and communication skills. Students gain essential practical skills in the use of equipment, design and conduct of experiments, and use of appropriate analysis tools. Includes computer laboratories where students learn to work with computers, programming, software engineering or use of software tools. Laboratories also reinforce lecture material and demonstrate theoretical concepts in a practical context and subject to limitations and uncertainty.

Tutorials and Problem-Solving Classes are sessions conducted by a lecturer with a class of students, in which exercises are completed interactively and solutions are provided within the period. The purpose of such a class is to help students engage with, and assimilate the material presented in lectures, start to apply this knowledge and develop problem solving skills. These classes also provide students with the opportunity to resolve issues with their understanding of the lecture material.

Coursework Assignments can be individual or connected exercises in which the student is tasked with conducting a study, the design and implementation of a software system to perform a given task or the researching of a body of information. The results of this work are evaluated by the student and a report submitted of the work carried out.

Design Classes enable students to work on 'open-ended' and often loosely-defined problems related to real engineering situations. They also provide good opportunities for developing team-working and communication skills as well as individual skills.

Individual Investigative Project (for MSc only) is an individual research and/or industrial project at the frontiers of engineering. It is completed under the supervision of a member of academic staff and provides an excellent opportunity for a student to pull together every aspect of their development during the degree. Students will be expected to demonstrate initiative, creativity and a wide range of technical knowledge and understanding and skills appropriate to the project.

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

Written Examinations are used in many modules as the major assessment method and assess students' knowledge and understanding and problem-solving skills.

Laboratory Exercises are assessed in some modules (or may be assessed via associated coursework assignments – see below). These are used to assess the development of skills, appropriate use of laboratory equipment and experimental design. These can be formative, summative or pass/fail.

Coursework Assignments are widely used in design studies, computational exercises, laboratory reports, essays or other work designed to assess the understanding of the module. Assignments are mainly undertaken on an individual basis but are sometimes carried out in small groups. Some modules use coursework assignments as the only or main method of assessment whilst others have this as a minor part with a written examination forming the major part of the overall assessment.

Oral and Poster Presentations are used in some coursework assignments and projects in order to assess the development of presentation and communication skills. These can be conducted by individuals or groups.

In-Class/Online Tests are small tests conducted either during the main teaching periods or in students' own time to assess progress and understanding; they supplement more formal examinations. These can be formative or summative.

Individual Investigative Project (MSc only) is assessed on the student's commitment and progress throughout the project, technical knowledge and understanding, professional and wider skills including critical analysis, independence and initiative. Specific assessment will include reports and presentations.

Self/Peer assessment is used in some modules to assess individual contributions during group work. Students peer assess each other using well defined methodologies, e.g. WebPA. The lecturer will oversee this process and moderate peer assessment as appropriate.

The main teaching, learning and assessment methods adopted for each learning outcome are shown below. In most cases a combination of methods is used.

	TEACHING / LEARNING						ASSESSMENT						
LEARNING OUTCOME (abbreviated - see Section 17 for full text)	Lectures	Practicals / laboratory classes	Tutorials and examole classes	Design Classes	Individual Project / Dissertation		Written examinations	Laboratory Exercises	Coursework assignments	Oral and poster presentations	Class Tests	Individual project dissertation	Self / peer assessment
K1 Fundamental principles	X	X	X	X	X		X	X	X		X	X	
K2 Mathematics	X	X	X	X	X		X	X	X		X	X	
K3 Design processes	X	X	X	X	X		X	X	X	X	X	X	
K4 Business, customer & user needed	X				X		X		X	X		X	
K5 Professional Conduct	X	X	X		X			X	X	X		X	X
K6 Management	X		X	X	X				X	X		X	X
K7 Risk	X	X		X				X	X	X		X	

K8 Legal requirements	X	X						X	X	X		X	
K9 Business success	X						X	X	X	X		X	
K10 Characteristics of equipment		X		X	X			X	X			X	
K11 Technical literature		X		X	X			X	X	X		X	
K12 Current practices	X	X		X	X			X	X	X		X	
K13 Project work					X					X		X	
S1 Apply and integrate knowledge	X	X	X	X	X		X	X	X	X	X	X	X
S2 Apply engineering principles	X	X	X	X	X		X	X	X		X	X	X
S3 Quantitative methods	X	X	X	X	X		X	X	X		X	X	X
S4 Systems approach	X			X	X		X		X	X		X	
S5 Extract and evaluate data	X	X		X	X		X	X	X			X	
S6 Problem solving	X	X		X	X		X	X	X	X		X	
S7 Creative solutions		X		X	X			X	X	X		X	
S8 Design processes				X	X				X	X		X	
S9 Communication				X	X				X	X		X	
S10 Practical skills		X		X	X			X				X	
S11 Industrial context				X	X				X	X		X	
S12 Personal responsibility				X	X							X	X

19. Reference points

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

Mission Statement of the University of Sheffield, as presented in its Strategic Plan http://www.sheffield.ac.uk/strategicplan

The Education Strategy of the University of Sheffield.

The appropriate qualification descriptors contained in the QAA Framework for Higher Education Qualifications in England Wales and Northern Ireland – August 2015.

The QAA Subject Benchmark Statement – Engineering, March 2023.

AHEP4, published in the Engineering Council reports: UK-SPEC (2020).

Feedback from Course Accreditation Panels representing the Institution of Engineering and Technology and the Institute of Measurement and Control.

The research interests of departmental staff and the research strategy of the Department of Automatic Control and Systems Engineering.

20. Programme structure and regulations

Students will undertake 120 credits of taught modules during semesters 1 and 2. This will consist of 105 credits of core modules (60 in semester 1 and 45 in semester 2) that provide students with a core knowledge and understanding of robotics and mechatronic systems. Students will select the other 15 credits from a range of modules giving them the opportunity to specialise in various aspects of robotics depending on their specific interests.

The individual advanced investigative project worth 60 credits allows students to demonstrate the full range of personal, communication and academic skills met within the programme of study. Assessment of the project is primarily based on the quality of the final project dissertation produced by the student although other factors such as the oral presentation, personal qualities demonstrated, etc are taken into account too. Students will be expected to display levels of creativity, originality and judgement with those expected of masters degree graduates.

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

Students will undertake a broad range of modules during semesters 1 and 2. This includes compulsory modules that provide core knowledge and understanding of robotics and mechatronics to ensure all students have a base level of knowledge and understanding. Students will also undertake a number of optional modules that will develop their knowledge, understanding and skills within specialist areas of interest to the student. Students will develop a wide range of theoretical, experimental, computational and simulation skills throughout the taught modules. The taught component will provide students with the knowledge, understanding and skills to undertake a number of careers in industry or research and will prepare them for undertaking a substantial research or industry focussed individual project.

Through the advanced individual project, students will develop their professional and technical skills including research, project management and communication. Depending on the specific nature of their project, students will further develop theoretical, experimental, computational and simulation skills. Students will be expected to demonstrate initiative, creativity, independence together with high levels of critical thinking and analysis during the project. These will further enhance their employability in a range of careers.

22. Criteria for admission to the programme

Minimum 2.1 honours degree or equivalent in a numerate subject such as engineering, mathematics or physical sciences. Students with alternative backgrounds will be considered on an individual basis. General University requirements regarding English qualifications must also be satisfied.

Detailed information regarding admission to programmes is available from the University's On-Line Prospectus at https://www.sheffield.ac.uk/acse/masters/robotics.

23. Additional information

For further information, students are directed to the Department of Automatic Control & Systems Engineering website at http://www.shef.ac.uk/acse

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.