Programme Specification[1]

1. Programme Title(s) and Code(s):

Programme Title	*UCAS Code*	*GU Code*
MEng Robotics & Artificial Intelligence		H671-2204

2. Academic Session:

2023-24

3. SCQF Level (see Scottish Credit and Qualifications Framework Levels):

11

4. Credits:

600

5. Entrance Requirements:

Please refer to the current undergraduate prospectus at: https://www.gla.ac.uk/prospectuses/undergraduate/

6. ATAS Certificate Requirement (see Academic Technology Approval Scheme):

ATAS Certificate not required

7. Attendance Type:

Full Time

8. Programme Aims:

Robotics and robotic systems have been and remain at the forefront of technological and industrial development. The foundation of this revolution was in the automation of production lines but now the use of robotics technologies has permeated through every aspect of contemporary life. From robot manipulators used in many applications (e.g. manufacturing, surgery and inspection), all the way to driverless vehicles and biologically inspired replicants, robots have been designed to perform tasks that are difficult or impossible for humans to perform.

[1] 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 full advantage is taken of the learning opportunities that are provided. More detailed information on the learning outcomes, content and teaching, learning and assessment methods of each course can be found in course handbooks and other programme documentation and online at www.gla.ac.uk/

The accuracy of the information in this document is reviewed periodically by the University and may be checked by the Quality Assurance Agency for Higher Education.

In addition, the development of Artificial Intelligence (AI) and Machine Learning has enabled Robotics and Robotic systems to evolve further and improve their operational performance. This has allowed their application areas to expand significantly, e.g. robotic systems have been used for humanitarian operations, providing medical, psychological and protective care to humans at all ages. In addition, robots have been successfully used in education as a mechanism for knowledge transfer and student engagement. As well as teaching, Artificial Intelligence has enabled robotic systems to develop their ability to learn and make sense of its environment through the complex data fusion.

The design and development of these highly versatile electro-mechanical systems involves the synthesis of key topics within electronic, electrical, mechanical, control, software engineering, machine learning and artificial intelligence. These are the main themes that form the structure for this Robotics and Artificial Intelligence degree, supported by laboratories and design activities that enable students to reinforce their learning through practical application of theory and skills within appropriate Robotics and Artificial Intelligence themed activities.

The MEng programme is an integrated Masters programme in Robotics designed as a preparation for professional practice. It provides an extended and enhanced programme of study beyond the BEng and is not simply a one year extension to the BEng. It is designed for the more able student. The programme of study is both broader and deeper than the corresponding BEng.

This degree programme aims to:

- present an integrated in depth multidisciplinary programme of study which will provide the student with knowledge and understanding of Robotics and Artificial Intelligence;
- provide opportunities for the student to study in depth a choice of specialist topics within the field of Robotics, Robotic Systems and Artificial Intelligence;
- provide an opportunity for students to develop transferable problem solving skills in Robotics and Artificial Intelligence in group and large scale individual project work;
- provide technical awareness in appropriate specialist applications of technology in the field of Robotics and Artificial Intelligence;
- develop the student's mathematical rigour, accuracy and numerate skills appropriate for professional engineering;
- present and develop professional, ethical, social, economic and management issues relevant to the Robotics related industries and those industries that use Artificial Intelligence.

9. Intended Learning Outcomes of Programme:

The programme provides opportunities for students to develop and demonstrate knowledge and understanding, skills, qualities and other attributes in the following areas.

Knowledge and Understanding:

Graduates will be able to:

- Use their knowledge and understanding of a broad range of mathematical, scientific and computational tools that underpin Robotics, Robotic Systems and Artificial Intelligence (*SM2m*), to solve analytical, design or theoretical problems in the field of Robotics and Artificial Intelligence with critical rigour (*EA1m*);
- Apply a comprehensive knowledge and understanding of physical laws, mathematics, numerical analysis and other relevant information, including from cognate disciplines, in order to appreciate historical, current and future developments in Robotics and Artificial Intelligence based technologies (*SM1m*), and to classify and model current Robotic Systems (*EA2m*), appreciating the limitations of such models (*SM5m*);
- Draw on materials from an extensive range of courses and wider reading in Robotics and Artificial Intelligence (*EP1m*) principles and in related disciplines in order to effectively solve problems in Robotics and Artificial Intelligence with critical rigour (*SM3m*);
- Describe developing technologies in Robotics, Robotic Systems and Artificial Intelligence (*SM4m*), and assess the key drivers for the commercial success of such technologies (*ET7m*);
- Discuss the contexts in which engineering knowledge can be applied (*EP1m*) and the industry standards applicable to their chosen specialisms (*EP6m*)

- Apply business and management techniques, including project and change management, that are relevant to Robotics and Artificial Intelligence, and Robotics Engineers (*ET3m*);
- Explain the role of Robotics Engineers in society and the constraints within which their engineering judgement will be exercised, including safety, contractual, intellectual property and other legal constraints (*ET5m, EP5m*);
- Explain the professional and ethical responsibilities of Robotics Engineers and how ethical dilemmas concerning Robotics and Artificial Intelligence can arise (*ET1m*);
- Discuss the requirements of engineering activities to support sustainable development, and quantify such requirements where appropriate (*ET4m*);
- Explain the national and international (*ET5m*) role of the Robotics Engineer and the impact of Robotics and Artificial Intelligence based engineering solutions in a global commercial, economic and social context (*ET2m*).

Skills and Other Attributes:

Graduates will be able to:

Subject-specific/practical skills

- Plan and execute safely a series of experiments in Robotics and Artificial Intelligence;
- Design, from user requirements, market needs or 'customer' specifications (*D1m*), a Robotics and Artificial Intelligence based System (*EA4m*), up to the preliminary design stage, and present this design via a series of poster, written and oral presentations from both group and individual work;
- Use laboratory and workshop equipment to generate data from a wide range of Robotics and Artificial Intelligence materials, equipment, processes and systems (*EP2m*) with appropriate rigour (*EP3m*);
- Analyse experimental results in depth and determine their strength and validity;
- Assess the potential efficacy of the design of a device or system subject to realistic constraints (including environmental, ethical, legal, health and safety, security and risk, intellectual property and from codes of practice and standards) (*D2m*);
- Prepare technical drawings and technical reports and give technical presentations in oral form, as posters or in written form;
- Write up the results and conclusions of experimental and design work, plotting experimental or computational results and interpreting experimental data by the use of appropriate statistical analysis—assessing uncertainties in input data, how such uncertainties will affect results, and how such uncertainties can be mitigated against (*D3m, EP8m*);
- Use scientific literature effectively and by drawing on their knowledge from lectures and wider reading around the subject be able to solve Robotics and Artificial Intelligence related problems (*EP4m*);
- Develop and update a research plan and adjust a work programme in order to conduct a major design project in academia or industry (*D5m*);
- Undertake a significant supervised research project in academia or industry, applying advanced technical skills and developing rigorous and creative solutions to practical engineering problems, and present the results of this work (*D4m*);
- Work effectively in both individual and group projects (*EP11m*);
- Document their solutions to engineering problems so that they, and others, can validate and assess the quality of their work, leading to continuous improvement (*EP7m*);
- Apply professional engineering practice and judgement in project work;
- Write computer programs and use computational tools and packages, selecting a range of alternate packages and tools to solve Robotics and Artificial Intelligence related problems through differing approaches, and assessing the limitations of each technique (*EA3m*).

Intellectual skills

Graduates will be able to:

- Apply appropriate quantitative mathematical, scientific and engineering tools to the analysis of problems (*EA1m*);
- Apply rigour in mathematics;
- Plan, conduct and report a programme of original research (*D1-8m*), applying and adapting design and analysis skills in unfamiliar situations (*D7m*);
- Analyse and solve novel engineering problems (*EA1-6m*);

- Design a Robotic and Artificial Intelligence based system, component or process to meet a requirement, considering the wider engineering context, public perception and aesthetics (*D1m*), managing the design process (including costs) and evaluating the final design (*D5m*);
- Be creative and rigorous in the solution of problems and in the development of designs, assessing whether those designs are fit for purpose in all aspects (D4m);
- Integrate knowledge and understanding of other scientific, mathematical, computational or engineering disciplines in order to support their engineering specialisation, evaluating such knowledge critically and applying it effectively (*SM3m*);
- Formulate and test hypotheses modifying the hypotheses depending on the data obtained;
- Evaluate designs, processes and products and make improvements (*D5m, EP7m*);
- Integrate and evaluate information and data from a variety of sources, including from outside engineering, applying them in engineering projects after critical evaluation (*SM6m*);
- Take a holistic approach in solving problems and designing systems, applying professional judgements to balance risks, costs, benefits, safety, reliability, aesthetics and environmental impact (*ET6p*).

Transferable/key skills

The skill set of the Robotics and Artificial Intelligence Engineer graduating from the MEng programme will be of use in a wide range of applications because of the multi-disciplinary nature of the subject. Their skills will be, by definition, transferable.

Graduates will be able to:

- Apply extensive knowledge of engineering fundamentals, problem solving and analytical thinking to the assessment of new and emerging technologies (*EA5m*);
- Use skills in data extraction and analysis to solve unfamiliar problems (*EA6m*);
- Apply appropriate numeracy and literacy skills in written reports, project work and examinations;
- Work in a group project environment and contribute effectively to the group project, including working as a member of an interdisciplinary team in a number of roles (*EP11m*);
- Work on an individual project involving novelty, innovation and self-directed research (*D8m*);
- Communicate effectively (in writing, verbally and through drawings) to a range of audiences (*D6m*);
- Apply mathematic skills (algebra, geometry, modelling, analysis);
- Transfer techniques and solutions from one field of engineering to another and to the field of Robotics and Artificial Intelligence;
- Use information and communications technology;
- Manage resources and time effectively;
- Exercise initiative and responsibility as team member of leader (*EP11m*);
- Learn independently in familiar and unfamiliar surroundings with open-mindedness and in the spirit of critical enquiry;
- Learn effectively for the purpose of continuing professional development and in a wider context throughout their career.

10. Typical Learning and Teaching Approaches:

Staff involved in the degree programme utilise a wide range of teaching methods that they deem the most appropriate for a particular course. These include:

- Lectures where the students write information presented to them via slide show, overhead or written by the lecturer;
- Lectures where the students have some printed notes/handouts and may annotate, or expand these during a spoken lecture;
- Lecture material placed on web-pages or other e-learning environment;
- External lectures from industry or clinicians;
- Feedback given to students during tutorials;
- Small group and large group tutorial sessions;
- Question and answer sessions during lectures or staff Office Hours;
- Guided reading of texts, journal articles etc., for individual and group projects;
- Completion of web-based exercises or computer based laboratory sessions;

- Laboratory sessions.

11. Typical Assessment Methods:

Assessment Methods to be used are:

- Written examinations (Summative assessment);
- Oral presentations of individual and group work;
- Individual written project report(s) of both individual and group projects;
- Group written project report(s) of group projects;
- Interview of group project manager and assessment of group project minutes;
- Poster presentation of group project work;
- Practical skills will be assessed through laboratory experiments, write-ups, coursework reports, project reports and presentations;
- Experimental, research and design skills will be assessed through laboratory experiments write-ups, coursework reports, project reports and presentations;
- Presentation skills through group presentations and poster presentations.

12. Programme Structure and Features:

Structure

Course Title	Course Code	Credits	Core	Optional	Semester(s) taught
MEng Year 1					
Analogue Electronics 1	ENG1003	10	C		1
Design & Manufacture 1	ENG1015	10	C		2
Electrical Engineering 1Y	ENG1022	20	C		2
Engineering Skills 1	ENG1026	10	C		1 & 2
Materials 1	ENG1033	10	C		1
Dynamics 1	ENG1062	10	C		2
Engineering Mathematics 1	ENG1063	40	C		1 & 2
Thermodynamics 1	ENG1066	10	C		2
MEng Year 2					
Analogue Electronics 2	ENG2004	10	C		2
Digital Electronics 2	ENG2020	10	C		1
Electrical Circuits 2	ENG2023	10	C		1
Electronic Design Project 2	ENG2025	10	C		2
Embedded Processors 2	ENG2029	10	C		2
Engineering Electromagnetics 2	ENG2031	10	C		2
Power Electronics 2	ENG2045	10	C		1
Mechanics of Structures 2A	ENG2081	10	C		1
Introductory Programming 2	ENG2083	10	C		1
Dynamics 2	ENG2084	10	C		2
Engineering Mathematics 2	ENG2086	20	C		1
MEng Year 3					
Communication Systems 3	ENG3014	10	C		1
Control 3	ENG3015	10	C		2
Electromagnetic Compatibility 3	ENG3023	10	C		2
Electronic Circuit Design 3	ENG3024	10	C		2
Electronic System Design 3	ENG3026	10	C		1
Engineering Career Skills	ENG3027	10	C		1 & 2
Simulation of Engineering Systems 3	ENG3036	10	C		1
Dynamics 3	ENG3039	10	C		1
Power Engineering 3	ENG3041	10	C		2
Real Time Computer Systems 3	ENG3043	10	C		1
Team Design Project EE3	ENG3049	10	C		1 & 2
Adv. Programming & Software Eng. 3	ENG3091	10	C		2
MEng Year 4					
Control 4	ENG4042	20	C		1
Integrated Systems Design Project 4	ENG4085	20	C		1
Robotics Team Design Project 4	ENG4XXX	20	C		1 & 2
Robotics 4	ENG4118	20	C		2
Introduction to Machine Learning & Artificial Intelligence in Engineering	ENG4200	10	C		1

Plus 30 credits of options from:					
Cyber Security Fundamentals (H)	COMPSCI4062	10		O	2
Robotics Foundations (H)	COMPSCI4076	10		O	1
Computational Social Intelligence (H)	COMPSCI4080	10		O	1
Biosensors & Diagnostics 4+	ENG4036	20		O	2
Digital Communication 4	ENG4052	20		O	2
Digital Signal Processing 4	ENG4053	20		O	1
Vibration 4	ENG4137	20		O	2
Autonomous Vehicle Guidance Sys 4*	ENG4175	10		O	2
Biophysics of Cells & Systems 4+	ENG4181	10		O	1
Navigation Systems 4	ENG4184	10		O	1
Radar & Electro-Optic Systems 4	ENG4185	10		O	2
Power Electronics & Drives 4	ENG4187	10		O	1
Ultrasound Technology & Apps 4	ENG4193	10		O	1
Elements of Law for Engineers	LAW1011	10		O	2
Social Robotics 4H	PSYCH4086	10		O	1
MEng Year 5					
Advanced Control 5	ENG5009	10	C		2
Individual Project 5	ENG5041P	60	C		1
Robotics Team Design Project 5	ENG5XXX	20	C		2
Advanced Artificial Intelligence & Machine Learning	ENG5XXX	10	C		2
Plus 20 credits of options from:					
Human Computer Interaction Design & Evaluation (M)	COMPSCI5057	10		O	2
Conversational Interfaces (M)	COMPSCI5094	10		O	2
Autonomous Guidance Vehicle Sys M*	ENG5017	10		O	2
Fault Detection, Isolation & Recovery	ENG5031	10		O	2
Real Time Embedded Programming	ENG5220	20		O	2
Dynamics 5	ENG5299	10		O	2
Advanced Ultrasonics	ENG5316	10		O	2
Biorobotics	ENG5XXX	10		O	2

Notes

* ENG5017 cannot be taken in Year 5 if ENG4175 has already been taken in Year 4

+ ENG4181 Biophysics of Cells & System 4 is a pre-requisite for ENG4036 Biosensors & Diagnostics 4

Regulations

This programme will be governed by the relevant regulations published in the University Regulations. These regulations include the requirements in relation to:

(a) Award of the degree
(b) Progress
(c) Early exit awards
(d) Entry to Honours (For undergraduate programmes, where appropriate)

https://www.gla.ac.uk/myglasgow/apg/policies/uniregs/

13. Programme Accredited By:

Accreditation will be sought from the Institution of Engineering and Technology (IET) and the Institution of Mechanical Engineers (IMechE)

14. Location(s):

Glasgow

15. College:

College of Science and Engineering

16. Lead School:

Engineering [REG30300000]

17. Is this programme collaborative with another institution:

No

18. Awarding Institution(s):

University of Glasgow

19. Teaching Institution(s):

University of Glasgow

20. Language of Instruction:

English

21. Language of Assessment:

English

22. Relevant QAA Subject Benchmark Statements (see Quality Assurance Agency for Higher Education) and Other External or Internal Reference Points:

This Programme Specification is informed by the QAA Benchmark Statement for Engineering

https://www.qaa.ac.uk/docs/qaa/subject-benchmark-statements/subject-benchmark-statement-engineering.pdf

It is also informed by the Engineering Council Publication “UK Standard for Professional Engineering Competence (UK-SPEC)”

https://www.engc.org.uk/engcdocuments/internet/Website/UK-SPEC%20third%20edition%20(1).pdf

and the requirements of the Institution of Engineering and Technology (http://www.theiet.org/) and the Institution of Mechanical Engineers (http://www.imeche.org.uk/)

23. Additional Relevant Information (if applicable):

Support for students is provided by the Postgraduate/Undergraduate Adviser(s) of Studies supported by University resources such LEADS (www.gla.ac.uk/myglasgow/leads/), Counselling & Psychological Services (www.gla.ac.uk/services/counselling/), the Disability Service (www.gla.ac.uk/services/studentdisability/) and the Careers Service (www.gla.ac.uk/services/careers/).

24. Online Distance Learning:

No

25. Date of approval:	