PROGRAMME SPECIFICATION

for the award of

BEng (Hons) Robotic Engineering

Managed by the Faculty of Technology, Design and Environment

delivered by the School of Engineering, Computing and Mathematics

Date approved:	29 June 2018
Applies to students commencing study in:	September 2019

1. RECORD OF UPDATES

Date amended*	Nature of amendment**	Reason for amendment**

SECTION 1: GENERAL INFORMATION

Awarding body:	Oxford Brookes University
Teaching institution and location:	Oxford Brookes University
Language of study:	English
Final award/s:	BEng (Hons)
Programme title:	Robotic Engineering
Interim exit awards and award titles available:	BEng (Ordinary degree) Named DipHE in Robotic Engineering DipHE CertHE
Brookes course code:	TBC
UCAS code:	TBC
JACS code:	H671 (Robotics)
HECoS code:	100170
Mode of delivery: (Mode of Study given in brackets)	Face to face/on-campus (full-time) Face to face/on-campus (part-time) Sandwich mode (full-time) Normally after year two Sandwich mode (part-time) Normally after year two
Duration of study:	Full-time degree courses are normally completed within three years of study (four years for sandwich mode). The maximum duration of study is eight years and includes any periods of approved and/or unapproved withdrawal.
Subject benchmark statement/s which apply to the programme:	Engineering AHEP3 QAA Engineering Benchmark Statement February 2015
Professional accreditation attached to the programme:	Institution of Mechanical Engineers (IMechE) (IEng for BEng, Graduates require no further academic study for Institution membership or for professional recognition). Subject to Accreditation in Spring 2019.
Apprenticeship Standard:	N/A
University Regulations:	The programme conforms to the University Regulations for 2019 entry as published/archived at: http://www.brookes.ac.uk/regulations/

SECTION 2: WHY STUDY THIS PROGRAMME?

Robots used to be science fiction, now they are science fact. The androids of science fiction movies are becoming a commercial reality. In years to come, robots are set to revolutionise the world in which we live, doing more and more for us. Some even believe the advent of conscious robots is near and for the first time, robots will actually think for us.

The BEng in Robotic Engineering has been designed specifically for students wanting to work in this exciting field. It offers the chance to learn how the robots and the computing that controls them actually works. There is extensive practical work involved. Your studies begin with learning the tremendous amount of inspired and creative work that humanity has invested in the subject so far. It ends with the opportunity to design and build a robot by joining our team of robot designers as they compete in national and international competitions.

In the first year it is not assumed that students have any prior knowledge of robots and there are practical sessions where you will actually make one. There is a module specifically about robots and even in your first weeks with us you will be handling, developing and controlling robots. In the second year, you will learn the complex process of design, where ideas are born and made real through a process of optimisation and analysis. In the third year you will study and design complete robotic systems. You can also join or contribute to our very successful Formula Student team, which is expanding their renowned success into the area of racing autonomous vehicles. In this international competition there are driverless cars that can now compete, a very challenging problem for final year robotics students to tackle. This approach to teaching and learning is excellent. It is the same approach we use for our world renowned Motorsports courses but simply applied to Robotics. For many, this excellent pedagogy is their reason for choosing Oxford Brookes.

The main exit award is the BEng (Hons) Robotic Engineering. This degree draws heavily on the School's long provision of degrees fully accredited by the Institution of Mechanical Engineers (IMechE) and the Institution of Engineering and Technology (IET). The course will be submitted for accreditation in Spring 2019, so that our first cohort to enter in September 2019 will be joining a degree that has been accredited from the very start.

The Department of Mechanical Engineering and Mathematical Sciences and the Department of Computing and Communication Technologies at Oxford Brookes offered world renowned courses in the areas of performance engineering design and motorsport, Artificial Intelligence (AI), machine learning and robotics. With the two schools now joined together to form the School of Engineering, Computing and Mathematics, this course in Robotic Engineering combines our expertise in both subject areas, producing a unique course that couples excellence in electro-mechanical engineering design with the computing threads of AI and machine learning to offer an exceptional course, producing its graduates at the forefront of their field.

The degree also offers the opportunity for you to undertake a placement year and you are encouraged to do this. This allows you to gain valuable understanding from real life and to see much better the context of your studies.

SECTION 3: PROGRAMME LEARNING OUTCOMES

On successful completion of the programme, graduates will demonstrate the following Brookes Attributes:

3.1 ACADEMIC LITERACY

3.1.1 The application of basic IT, computing and mathematical tools, including physical relationships, that are fundamental to the design and modelling of Robotic Engineering structures and components.

3.1.2 The ability to apply basic engineering principles and the ability to work with analytic techniques for problem modelling and simulation.

3.1.3 Creative participation in the “Engineering Design Process”, at both the conceptual and detail levels.

3.1.4 Knowledge of manufacturing processes – including the fabrication of devices and the application of computers to manufacturing of Robotic components and assemblies including disassembly.

3.1.5 An understanding of good engineering practice and the properties, behaviour, fabrication and use of relevant materials and components in the Engineering Industry.

3.1.6 The ability to apply scientific and engineering principles to the solution of practical problems of Mechanical and Robotic Engineering systems and processes, with an appreciation and basic understanding of the relevant theory and analysis.

3.1.7 The ability to apply knowledge in order to analyse data and solve problems in a logical, practical and concise manner.

3.2 RESEARCH LITERACY

3.2.1 The ability to learn independently and apply that skill in order to extend the subject knowledge base or apply acquired knowledge to novel situations in Robotic Engineering.

3.2.2 Critically evaluate research and assess the quality and applicability of published research to particular contexts.

3.3 CRITICAL SELF-AWARENESS AND PERSONAL LITERACY

3.3.1 The ability to develop and use interpersonal communication, presentation and team working skills along with various other enterprise skills.

3.3.2 Organisational skills at both the personal level and in the areas of project management and the management of human resources.

3.3.3 The ability to communicate effectively using a range of personal presentation skills and techniques.

3.3.4 The ability to self-manage and organise their work.

3.4 DIGITAL AND INFORMATION LITERACY

3.4.1 The use and management of information technology within a Robotic Engineering design environment.

3.4.2 An understanding of a broad range of appropriate information technology skills and their application within a technical or commercial environment. Particularly CAD systems and data transfer between such systems.

3.4.3 The ability to work with and use models that simulate the behaviour of the physical world from which performance can be reliably predicted.

3.4.4 The ability to communicate effectively using traditional graphical techniques, reports, presentations and IT tools.

3.5 ACTIVE CITIZENSHIP

3.5.1 An understanding of critical factors in both the national and international Robotic Technology business environment such as marketing skills and financial awareness.

3.5.2 An understanding of the role of engineering and specifically the roles of Incorporated Engineers (IEng) and Chartered Engineers (CEng) in the global context of social, economic and ethical considerations.

SECTION 4: CURRICULUM CONTENT & STRUCTURE

4.1 PROGRAMME STRUCTURE AND REQUIREMENTS:

Year 1

eCSIS code	Banner code	Module Title	Credits	Level	Status	Coursework: Exam ratio
U04500	ENGR4001	Engineering Mathematics and Modelling I	30	4	Compulsory	30:70
U045X6	ENGR4012	Robotics & Electro-Mechanical Design & Practice I	30	4	Compulsory	100:0
U04514	ENGR4009	Introduction to Statics and Dynamics	15	4	Compulsory	30:70
U04600	TECM4001	Basic Electrical Engineering	15	4	Compulsory	100:0
U08500	ROBO4001	Introductory Robotics	30	4	Compulsory	100:0

Year 2

eCSIS code	Banner code	Module Title	Credits	Level	Status	Coursework: Exam ratio
U04530	ENGR5005	Engineering Mathematics and Modelling II	15	5	Compulsory	20:80
U045X2	ENGR5013	Engineering Simulation, Synthesis and Design	30	5	Compulsory	100:0
U045X3	TECM5001	Electric Machines and Drives	15	5	Compulsory	30:70
U04620	COMP5004	Control Technology	15	5	Compulsory	50:50
U08028	TECM5005	Software Development in C & C++	15	5	Compulsory	50:50
U08520	ROBO5001	Advanced Robotics	30	5	Compulsory	100:0

Optional Sandwich Year

eCSIS code	Banner code	Module Title	Credits	Level	Status	Coursework: Exam ratio
U04665		Professional Placement	0	5	Compulsory for Sandwich degrees	100:0

Year 3

eCSIS code	Banner code	Module Title	Credits	Level	Status	Coursework: Exam ratio
U04570	ENGR6001	Management, Ethics, Energy and Sustainability	30	6	Compulsory	50:50
U04591	ENGR6013	Engineering Project	30	6	Compulsory	100:0
U04595	ENGR6015	Advanced Digital Electronics	15	6	Compulsory	100:0
U04671	TECM6001	Sensors & Data Logging	15	6	Compulsory	50:50
U08089	COMP6011	Machine Learning	15	6	Compulsory	50:50
U08571	ROBO6002	Real-time Embedded Robotic Systems	15	6	Compulsory	100:0

4.2 PROGRESSION AND AWARD REQUIREMENTS

Exit award: BEng (Hons) in Robotic Engineering.

Progression

In order to achieve the expected depth of learning, progression is required as follows:

- For the award of BEng (Hons) Robotic Engineering, students must accrue 360 credits.
- For the award of BEng Robotic Engineering students must complete 120 credits at Level 4, 120 at Level 5 and 60 credits at Level 6.
- For the Named Diploma of Higher Education (Robotic Engineering) students are required to complete 120 credits at Level 4 and 120 credits at Level 5 making a total of 240 credits.
- For the Diploma of Higher Education, students must complete 240 credits in total, of which 90 must be at Level 5 or above.
- For the Certificate of Higher Education, students have to complete 120 credits in total of which at least 90 must be at Level 4.

4.3 PROFESSIONAL REQUIREMENTS

The BEng (Hons) in Robotic Engineering carries the highest possible level of professional recognition available to a degree award of its type granted by the Engineering Council. The BEng is subject to accreditation at the IEng level. The course will be submitted for accreditation at the next visit of the IMechE and the IET to the department in Spring 2019. Given the long history of successful accreditation of a broad portfolio of courses it is fully expected that the application will be successful. Accreditation by the IMechE grants graduates of the course exemption from any further academic requirements in their application for membership of the IMechE.

SECTION 5: TEACHING AND ASSESSMENT

The course is based around a spine of core double modules that develop the robotics theme from the start. Robotics is present in modules in every year. This spine of modules is supported by other modules that supply the analytical material necessary to be applied to the robotics core.

In the delivery of the course the course team make use of a modern, varied curriculum and you will learn not just from lectures but also from practicals, laboratory work and projects, seminars, computer based projects, guided independent learning, even visiting lecturers, industrial placement opportunities and competitions.

A degree is not just about working on your own and you can expect to undertake some assessed work in groups and to complete group projects, enhancing your skill as a team worker, just as your employer will ultimately want you to do. When you undertake group work you will receive guidance on how it is to be assessed and in particular how it is ensured that students receive marks that reflect the merit of their individual work and of their contribution...

The teaching methods used depend very much on the material being taught. Most people would expect maths to be assessed with exams and computer tests, and this is indeed the case. However, a subject like design can only properly be assessed by actually designing the artefact in hand. In this case a design portfolio is much more appropriate. During the course you can expect to be taught and assessed in the following ways.

- Preparation of your designs as real artefacts to be presented at opportunities such as our end-of-year Tech Show where students showcase their work to visitors from industry and the sector in general, or to be presented at competitions such as Formula Student, Robotic competitions or the IMechE design challenge.

- Laboratory work where you will experience first-hand the physical principles you are studying in lectures.

- Computer based tests undertaken against the clock where you get results very quickly.

- Design portfolios where, working in a group, you will prepare all the design specifications, drawings, analysis and computer simulations required to demonstrate that your proposed design will perform exactly as required by the design brief and meet the budget set.

- Tutorials where you will bring along your answers to set problems and receive help where you have got stuck. The most effective way for you to learn is for you to show an expert what you tried to do and for them to show you how to recognise where you went wrong, that’s what happens in the tutorials.

- Seminars where you will present your own research and ideas about a problem set by teaching staff. In the seminar you will participate in discussions led by teaching staff and hear what your fellow students thought about the same problem you have considered. There is never a right answer to a real world problem and in the seminars you will gain insights that would never otherwise have occurred to you.

- Presentations in which you will present your work to your colleagues and learn how to deal with their questions.

- In-module assignments are commonly used where you will undertake a discrete project on a module-specific topic. This might be about how to produce a program to learn from human interaction or to analyse a fundamental principle associated with sustainability. Whatever the topic, you will become an expert.

- Your final year dissertation is a major undertaking and students usually choose an area that they want to work in after graduation. You will study one-to-one with your supervisor, an expert in the field, and produce a presentation and report at a very high standard. Our best students in the

dissertation publish their work in scientific journals. The dissertation report is something students often take to interviews and it acts as an exemplar of their skills.

- Lectures, yes there are traditional lectures too and also some exams.

Developing your portfolio
Students are encouraged to keep their assessed work and to use it as the course develops to enhance their approach to work as the course evolves. The work can be of assistance in applying for jobs, for example, reports, posters or short videos assessed as part of a module can be used to showcase you understanding and ability to a prospective employer.

All the assessment set on the course is aimed at developing your ability to meet the learning outcomes of the course. The learning outcomes of the course define what each graduate should be able to do and can be found in Section 3 above. These are central to the design of the course and the course team employed considerable effort to ensure that they meet the needs and expectations of the organisations that will ultimately be responsible for recruiting graduates from the programme. In this way the entire assessment regime has an overall purpose and acts together to ensure that graduates have exactly the skill set employers are looking for. Section 4 above shows the breakdown of exam vs. coursework that apply to each module.

All modules feature 'formative assessment' which involves the feeding back of assessed work with comments and strategies for improvement so that students can learn as they progress. This can take the form of computer based assessments or, for example, in the design module, regular meetings with teaching staff to present the design work so far and receive comments and guidance in response. As with the first year, the major spine of the courses consisting of the two modules in Design and Practice together with Mathematics and Modelling are supported by other single modules that are analytical in nature. For example material covered in Electrical Machines and Drives will clearly be of direct use in the design of a robotic system.

Students experience between 16 and 22 hours of teaching per week and this varies throughout the course and even week-to-week. In addition to direct contact time, students are expected to undertake a considerable amount of individual directed study. A typical module might involve 36 hours of contact but all involve up to 150 hours of effort in total. In general this is accomplished on four and a half days a week with Wednesday afternoons kept clear for sport and other activities whenever possible.

2. SECTION 6: ADMISSION TO THE PROGRAMME

6.1 ENTRY REQUIREMENTS

Students entering Year 1 of the courses will normally hold one of the following qualifications:

(i) A level grades (typically a minimum of BBB grades or 120 point) in three subjects, one of which must be Mathematics. In addition, normally Physics (or Engineering Science) is highly desirable, but candidates with alternative subjects will be given consideration.
(ii) A BTEC Certificate or Diploma in an Engineering discipline, typically with at least five distinctions in the final year of study including mathematics;
(iii) An HND course (typically with at least four distinctions including mathematics) with adequate mathematics and Engineering Science content; or
(iv) A qualification equivalent in standard to these qualifications, that is recognised by the University.

Admission with Credit (Accreditation of Prior Learning)

Applicants with relevant prior learning are welcome to apply and start the course with exemption from specific modules or the whole of Stage I. Specific examples include:

(i) Students with a very good HND in an Engineering subject are usually exempted all of Stage I and are admitted directly to Stage II. Normally these students will have achieved at least five distinctions over their second year units, with all other second year units being at Merit level.

(ii) Students who have completed parts of degree courses elsewhere will be given credit appropriate to the amount of study successfully completed. Such students will normally be expected to have achieved consistent marks/grades within the 2:1 band at their previous Higher Education Institution.

In certain exceptional cases it may be possible to give credit for Level 5 modules as well as for Level 4 but it will not normally be possible to gain credit for Honours modules at level 6 as an accredited BEng requires the student to have completed the final two years full time education sequentially on the same programme at the same institution.

6.3 JOB ROLE/EMPLOYER PROFILE.

Students wanting to work in industry will find themselves well prepared for roles in design, analysis, R&D, testing, technical sales, production, business analysis and simulation. Such roles might be in companies manufacturing robots, developing software for robotic systems, defence, automotive, racing, materials, aerospace or government and the civil service.

Further Study
Students who want to pursue further study at the Masters or PhD level will find the accreditation, together with the sound platform of analytical skills mean they are well prepared in fields such as Robotics, Mechanical Engineering, Computing, Cybernetics and Gaming.

SECTION 7: PREPARATION FOR EMPLOYMENT

Students are prepared for employment in a number of different ways. Firstly, the very design of the curriculum follows the journey from understanding and analysing the work of others and the evolution of current practice through to the synthesis of new design ideas in response to a need. From here students extend their knowledge to state-of-the-art analysis techniques in the robotics field. This is exactly the process followed by other very successful accredited programs within the School that lead to excellent employment in their own fields, for example, motorsport.

The School has implemented a policy whereby every module features a short section dealing with employability, specifically how the material learned in that module is used in industry or postgraduate research.

In addition the module Management, Ethics, Energy and Sustainability includes material covering employment, CV preparation and a consideration of the employment and career development process. Particular elements of the curriculum that support and prepare students for employment include:

Practical Curriculum elements
The curriculum includes a very significant amount of practical work and having hands-on experience of industry standard equipment is a big advantage. In the first year students have a whole day a week dedicated to practical work. This continues into the second and third year where laboratory work continues to support academic studies. Students who participate in our Formula Student team or the Robotics competitions gain extensive practical work and can attend interviews with the huge advantage of having actually turned design ideas into reality and successfully confronted excellent competition.

Computing literacy
The use of computer in general is all pervasive but in the area of robotics it is a core technology. It's not just using them, its programming them, and extracting performance from them at the limit. Students of the course use computers from beginning to end. You will become an expert through constant exposure to high performance programming and to the latest computer hardware. Complex robots have dozens of computers all working together so there is the all important area of coordination and communication between them to consider too.

Business context
All business organisations need to turn a profit. Students are taught the fundamentals of business. The intent is not to produce business graduates, but rather to produce graduates who are expert in the field of robotic engineering but who also understand business. In this way, graduates of the course are all the

more employable because they don't need the business orientation that graduate schemes sometimes have to supply.

Industrial placement
Nothing makes a better preparation for employment than actually getting work experience before applying for your first role after graduation. That is exactly what you get if you undertake a work placement. The Faculty has a full-time Placement Manager whose job is to help students find and secure a placement. The scheme is very successful and generally speaking, students who want to do a placement, get one. The experience not only enhances employability but helps students to put their final year studies into better context. Some students even do a project based in the placement company, all of which, again, support employment opportunities. You also get paid.

Industrial lecture series
The School hosts a series of industrial lectures where former students, Industrial Advisory Board members and other representatives from industry give presentations about what they and their organisation do. This is a great way to get first-hand information from people who have done what our graduates want to do. Many of these presenters are Brookes alumni or from companies that have expressed a preference in employing Brookes graduates.

Competitions
The School participates in the Formula Student competition every year. The Formula Student car is fitted with advanced electronic systems and we are moving into the complex field of driverless racing cars. Autonomous road vehicles are set to replace the existing fleet and this competition offers students a chance to put ideas into practice and compete with the best universities from around the world. We also expect our robotic students to develop robots to compete in one of the many competitions available. Drawing on our excellent Formula Student experience, the first cohorts of students will be expected to start our assault on a major international robotic competition as well as assisting our Formula Student team. This effort will initially be focused on the IMechE Design Challenge competition which is nationally recognised for its high quality of competition.