Template C4

Kingston University London

Programme Specification

Title of Course: *MSc Artificial Intelligence*

Date first produced	04/09/2024
Date last revised	25/08/2023
Date of implementation of current version	02/01/2025
Version number	2
Faculty	Faculty of Engineering, Computing and the Environment
School	School of Computer Science and Mathematics
Department	Department of Computer Science
Delivery Institution	

This Programme Specification is designed for prospective students, current students, academic staff and employers. It provides a concise summary of the main features of the programme and the intended learning outcomes that a typical student might reasonably be expected to achieve and demonstrate if they take full advantage of the learning opportunities that are provided. More detailed information on the learning outcomes and content of each modules can be found in the course VLE site and in individual Module Descriptors.

SECTION 1: GENERAL INFORMATION

Award(s) and Title(s): ***Up to 10 pathways***	MSc Artificial Intelligence
Intermediate Awards(s) and Title(s): ***There are 4 Intermediate awards for each pathway***	PGCert Artificial Intelligence PGDip Artificial Intelligence
Course Code ***For each pathway and mode of delivery***	PPARI1ARI20 PFARI1ARI20
UCAS code ***For each pathway***	

Award(s) and Title(s): ***Up to 10 pathways***	MSc Artificial Intelligence with Professional Placement
Intermediate Awards(s) and Title(s): ***There are 4 Intermediate awards for each pathway***	PGCert Artificial Intelligence PGDip Artificial Intelligence
Course Code ***For each pathway and mode of delivery***	N/A N/A
UCAS code ***For each pathway***	

RQF Level for the Final Award:	
Awarding Institution:	Kingston University
Teaching Institution:	
Location:	Penrhyn Road
Language of Delivery:	English
Modes of Delivery:	Full-time Part-time With Professional Placement
Available as:	Full field
Minimum period of registration:	Full-time - 1 year Part-time - 2 years With Professional Placement - 2 years
Maximum period of registration:	Full-time - 2 years Part-time - 4 years With Professional Placement - 3 years

Entry Requirements:	Kingston University typically uses a range of entry requirements to assess an applicant's suitability for our courses. Most postgraduate taught course requirements are based on having been awarded a relevant undergraduate degree and are normally coupled with minimum grades expectation of 2:2, specific courses in certain areas may have a stricter grade requirement. We may also use interview, portfolio and performance pieces to assess a person's suitability for some courses. We recognise that every person's journey to a postgraduate taught education is different and unique and in some cases we may take into account work experience and other non-standard pathways onto University level study. Additionally, all non-UK applicants must meet our English language requirements. Please see our course pages on the Kingston University website for the most up to date entry requirements.
Programme Accredited by:	Will be submitted for accreditation by BCS in due course, who require at least 2 cohorts.
QAA Subject Benchmark Statements:	QAA Subject Benchmark Statement https://www.qaa.ac.uk/quality-code/subject-benchmark-statements for Computing and Mathematics at master's level found here.
Approved Variants:	Compensation is not permitted in 30-credit modules at Level 7. All Level 7 30-credit modules must be passed with a mark of at least 50%.
Is this Higher or Degree Apprenticeship course?	

For Higher or Degree Apprenticeship proposals only	
Higher or Degree Apprenticeship standard:	N/A
Recruitment, Selection and Admission process:	N/A
End Point Assessment Organisation(s):	N/A

SECTION 2: THE COURSE

A. Aims of the Course

The MSc in Artificial Intelligence (AI) offers a comprehensive range of modules that cover cutting-edge algorithms, tools, and techniques in the field of AI. These modules are designed to align with the growing market opportunities in various areas, including big data, data mining, machine learning, deep learning and their direct application in Computer Vision, Natural Language Processing, and Cyber Security.
The principal aim of the course is:

- To provide students with a strong foundation in the theoretical aspects of AI technologies, enabling them to apply these algorithms to real-world data and develop intelligent systems ready for deployment.

The course is ideal for students that wish to develop and apply computing skills in this domain that is widely used throughout industries and the public sector.
The modules are structured in a way that follows the typical roadmap of an AI project, ensuring a systematic approach to learning. Most importantly, elective modules are available to allow students to specialise and focus on specific areas of interest. The compulsory modules include Applied Data Programming, Ethics & Regulation in AI, and Machine Learning & Deep Learning. These modules provide a broad understanding of AI principles and applications. The elective modules include Cyber & AI Applications, Natural Language Processing, and Computer Vision. These modules offer students the opportunity to delve deeper into specialised areas within AI, depending on their chosen stream of study.

B. Intended Learning Outcomes

The programme outcomes are referenced to the QAA subject benchmarks for computing and mathematics and the Framework for Higher Education Qualifications (2024), and relate to the typical student. The course provides opportunities for students to develop and demonstrate knowledge and understanding specific to the subject, key skills and graduate attributes.

The programme learning outcomes are the high-level learning outcomes that will have been achieved by all students receiving this award. They must align to the levels set out in the 'Sector Recognised Standards in England' (OFS 2022).

Programme Learning Outcomes					
	Knowledge and Understanding On completion of the course students will be able to:		**Intellectual Skills** On completion of the course students will be able to		**Subject Practical Skills** On completion of the course students will be able to
A1	Explain and evaluate essential concepts, theories, principles, and practices of computer science that underpin Artificial Intelligence	B1	Analyse, abstract and decompose problems to design effective solutions or models.	C1	Create, develop and critically evaluate specifications for specialist computer systems involving AI and communicate these specifications to other computing professionals
A2	Evaluate key ethical, legal, social and commercial and other human factors that affect the design, development and deployment of Artificial Intelligence systems.	B2	Synthesise information and draw new conclusions from disparate and potentially incomplete sources.	C2	Use and modify established systems, AI models, techniques and tools to model, develop and build computer-based AI solutions
A3	Demonstrate a critical awareness of current developments and future trends in Artificial Intelligence.	B3	Analyse, evaluate and advise on the development of AI models to ensure they meet the needs of its current use and future development	C3	Collaborate and communicate effectively with other professionals/stakeholders to plan, design, implement, evaluate and deliver AI projects
A4	Evaluate security issues and evaluate risk in the context of Artificial Intelligence.	B4	Elicit, evaluate and model business, customer and user requirements, incorporating considerations such as sociological and commercial contexts.	C4	Create and implement software solutions involving AI using a variety of programming languages, environments and platforms
A5	Examine, appraise and identify appropriate ways that data and information can be stored and processed using Artificial Intelligence in ways appropriate to the context of different uses.	B5	Use different programming environments and justify the selection of one or more for a given context.	C5	Keep up-to-date in the Artificial Intelligence profession through relevant literature, research and using professional networks.
A6	Apply knowledge in a professional context, including understanding of	B6	Identify and develop appropriate methods and any relevant	C6	Relate academic theory to practice, develop and practise key

	their professional development and the structure of the placement organisation (with Professional Placement Only).		computer applications, to assist in the solution of problems.		personal and employability skills and show examples of the application of these skills.
		B7	Reflect critically on their experience during the professional placement, including research and information literacy, numeracy, management and leadership skills (with Professional Placement Only).		

In addition to the programme learning outcomes, the programme of study defined in this programme specification will allow students to develop the following range of Graduate Attributes:

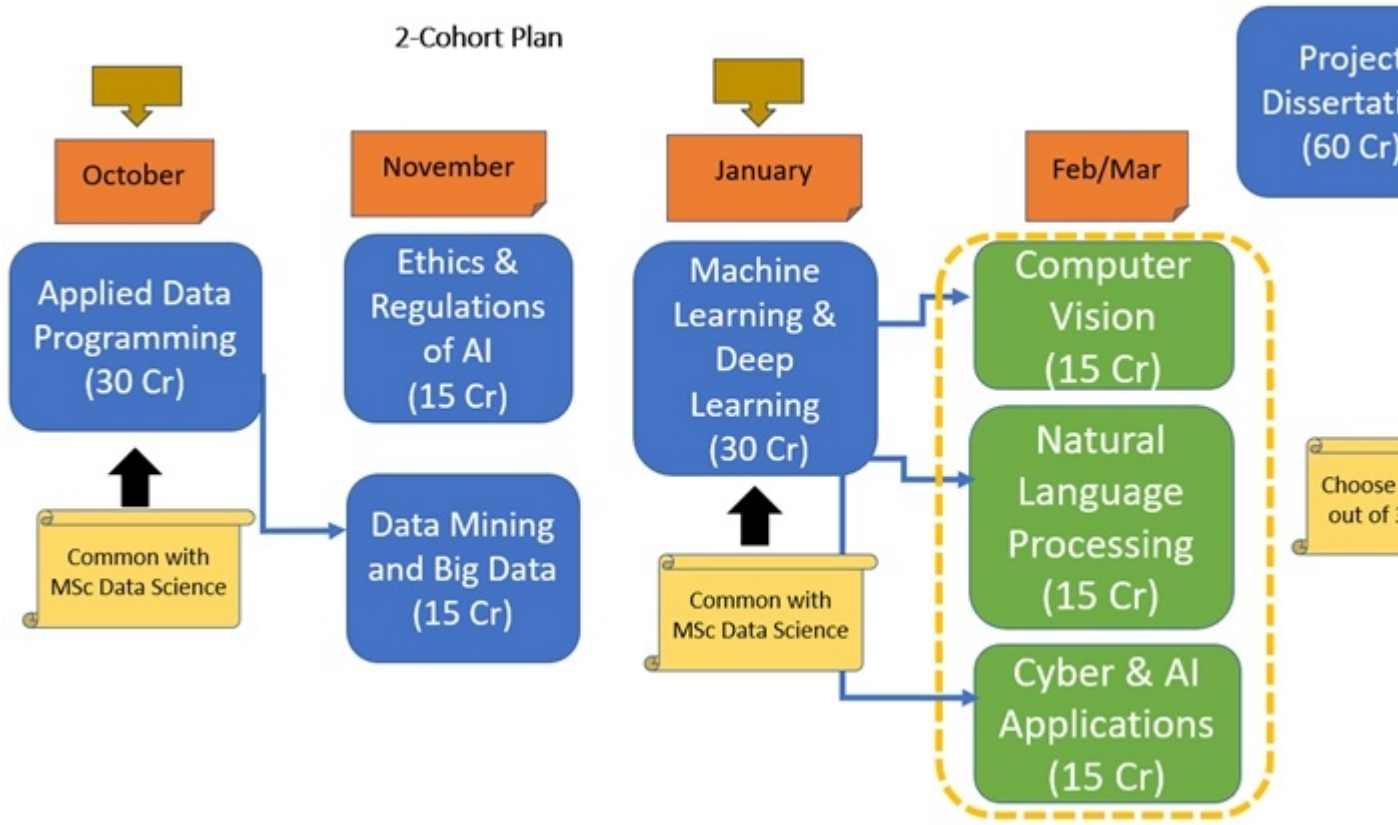
1. Creative Problem Solving
2. Digital Competency
3. Enterprise
4. Questioning Mindset
5. Adaptability
6. Empathy
7. Collaboration
8. Resilience
9. Self-Awareness

C. Outline Programme Structure

The programme is made up of four core taught modules in total worth 90 credits, two option modules (total: 30 credits) that have to be chosen worth 15 credits each and an individual project worth 60 credits. All students will be provided with the University Postgraduate Regulations. Full details of each module are provided in module descriptors and via the VLE.

The optional Professional Placement is undertaken following completion of the other modules, specifically in Year 2 – all deadlines for it are posted on the VLE. Students on placement complete a portfolio assessment which includes a reflection on how the theories they have learnt during their teaching year have helped them in their placement and demonstrate the ability to apply their teaching in a real-world situation.

Modules will run in the following order:



The project dissertation module's start and end dates are cohort-dependent. For the September cohort, students are enrolled in the module in January and are expected to

submit it by mid-September. Similarly, for the January cohort, students are enrolled in the module in June and are expected to submit it by mid-January.
Consistent with all PG courses in the School of Computer Science and Mathematics (CSM), modules will be delivered in Block Delivery Mode to offer students high flexibility in balancing their work and other commitments. Each 30-credit and 15-credit module will be delivered over two and one week(s) respectively, with classes scheduled for five days a week, six hours a day.
The three elective modules should function as practical applications of the machine learning and deep learning concepts introduced in the 30-credit core module CI7520. Additionally, students are expected to extend the topics covered in the taught modules and treat the Dissertation module (CI7000) as an exemplary AI project. This project should not only demonstrate students' domain knowledge but also showcase their practical skills.
The target of our course extends well beyond covering the main theories of contemporary AI applications. Our primary goal is to prepare our graduates for the industry by focusing extensively on real-world commercial applications and full enterprise architecture. In the current industry, there are AI research-oriented staff who understand AI theory very well but struggle to commercially implement or integrate it into an enterprise platform due to a lack of understanding of system engineering and architecture principles. Conversely, there are very good software engineers who understand best software practices but struggle to efficiently integrate AI components due to a lack of understanding of AI theory. As a result, they use AI as a black-box component without being able to efficiently customise it to meet application needs, which affects the performance, reliability, efficiency, operational cost, and other aspects of the final product.
While each of the modules covers some aspects of software engineering practice and architecture frameworks, an integrated approach is crucial. Therefore, we are introducing a compulsory one-and-a-half-day intensive workshop titled “Developing an AI-Driven Cloud-Based Enterprise System,” which will be offered twice a year. Students are expected to enrol in the workshop during the early stages of their dissertation project. The main aim is to provide a comprehensive understanding of the development of AI-driven cloud-based enterprise systems while highlighting essential systems engineering and architectural principles.

MSc Artificial Intelligence

Level 7							
MSc Artificial Intelligence							
Core modules	**Module code**	**Credit Value**	**Level**	**Teaching Block**	**Pre-requisites**	**Full Time**	**Part Time**
Applied Data Programming	CI7340	30	7	TB1		1	1
Big Data and Data Mining	CI7524	15	7	TB1		1	2
Ethics and Regulation of Artificial Intelligence	CI7522	15	7	TB1		1	2
Machine Learning and Deep Learning	CI7520	30	7	TB2		1	1
Project Dissertation	CI7000	60	7	TB1 and TB2		1	2
Optional Modules							

Computer Vision	CI7523	15	7	TB2		1	2
Cyber Security and Artificial Intelligence Applications	CI7526	15	7	TB2		1	2
Natural Language Processing	CI7525	15	7	TB2		1	2

Level 7 information

Students can start in September or January.
Students exiting the programme with 60 credits are eligible for the award of PgCert in Artificial Intelligence.
Students exiting the programme with 120 credits are eligible for the award of PgDip in Artificial Intelligence.

MSc Artificial Intelligence with Professional Placement

Level 7							
MSc Artificial Intelligence with Professional Placement							
Core modules	**Module code**	**Credit Value**	**Level**	**Teaching Block**	**Pre-requisites**	**Full Time**	**Part Time**
Applied Data Programming	CI7340	30	7	TB1		1	1
Big Data and Data Mining	CI7524	15	7	TB1		1	2
Ethics and Regulation of Artificial Intelligence	CI7522	15	7	TB1		1	1
Machine Learning and Deep Learning	CI7521	30	7	TB2		1	1
Professional Placement	CI7900	120	7	TB3		2	2
Project Dissertation	CI7000	60	7	TB1 and TB2		1	2
Optional Modules							
Computer Vision	CI7523	15	7	TB2		1	2
Cyber Security and Artificial Intelligence Applications	CI7526	15	7	TB2		1	2
Natural Language Processing	CI7525	15	7	TB2		1	2

D. Principles of Teaching, Learning and Assessment

Students on postgraduate courses in the School of CSM come from diverse social, cultural and educational backgrounds and their past learning experiences are varied. The School's broad strategy of aiming for problem-centred teaching and accessible, relevant (authentic) artefact-based assessment (assessment of learning by doing/creating) was created in recognition of this. The course adopts the University's Inclusive Curriculum Design Principles to cater for this diversity and define the approaches to learning, teaching and assessment (LTA), pastoral care and employability with the following broad principles:

1. An inclusive curriculum with the student at the heart of the learning process encouraging choice in their focussed topics for investigation within the prescribed module assignment formats (where practical) and sharing experiences and perspectives within the course through discussion and presentation of results.
    - Module descriptors adopt problem-centred approaches which in turn facilitate an inclusive learning environment.
    - Curricula and approaches to LTA allow for expression of cohorts' experiences and perspectives, ultimately for sharing and shaping understanding together. Modules and the dissertation challenge students' epistemological and ontological approaches to the study of Artificial Intelligence, including software and its legal, social and ethical aspects and the impact on society to develop approaches to critical evaluation of current and future knowledge.
    - Teaching sessions are problem-centred, predominantly workshop-based, and necessarily interactive to make best use of the intensive weeks of study interspersed with directed study. Workshops and the use of the VLE (or other cohort-inspired networking tools) allow students to investigate and share their understanding of new concepts, techniques and technologies. This approach is also designed to enhance their practical competency and confidence when dealing with a range of requirements.
    - The delivery is research informed, taking advantage of CSM's diverse research portfolio, dynamically updated in accordance with advances in the field.
    - Modules incorporate opportunities to explore current developments in the field, in practice and applied settings incorporating student perspectives, real world situations, problem solving and task based learning. Content includes the opportunity for students to personalise the topics being explored and allow them to adapt summative assessments towards their personal interests and motivations, where practical in module assignments as well as the dissertation.
    - Teaching teams draw on the academic strengths and research interests of staff and use invited speakers and experts from research and industry to bolster the curriculum. This offers students up-to-date learning experiences from experts in these areas.
    - Students complete their MSc by conducting an individualised capstone research project, designed in collaboration with the Artificial Intelligence team.
2. Assessment for learning (rather than solely of learning) enabling an inclusive student perspective in their design and application, permitting a degree of individual choice and direction for assessed tasks work.

- All assessments have been designed at level 7, as appropriate for the Artificial Intelligence MSc, to be inclusive, accessible, artefact-based and authentic to the field.
- Students' induction at the start of the course includes an introduction to the language of UK HEI assessment and the tools used to measure the quality of their academic performance.
- The assessment strategy aims to incorporate an element of choice within a carefully designed framework of assessments that align with the diversity of a Artificial Intelligence professional's needs, and thus encourages students to be personally involved in their assessments. For example, students will have opportunities to choose to focus on different industries and contexts reflecting their specialism or areas of interest in coursework assignments.
- Students have formative tasks and feedback available within the workshops preceding all assessments. Teaching sessions adopt a range of activities (including practical tasks, case studies, group discussion, role play) to enrich the learning experience in a problem-centred, predominantly workshop-based setting, which directly supports the formulation of summative assessments.
- Feedback on both formative tasks and summative work enables students to learn from assessment experiences, reflect alongside directed study and feed-forward that learning to future assessments, most critically to the final dissertation project.

3. An approach to the personal tutor system appropriate to the Artificial Intelligence MSc, which provides opportunities for students to personalise their experience and track their academic and personal skills development.
    - The Course Leader is the nexus of the postgraduate personal tutor system and normally acts as the formal Personal Tutor, supported day-to-day during intensive week-block teaching by the course's module leaders. The personal tutors take the lead on academic advise and pastoral support. This is also complemented by the Individual Project Supervisor who also develops a complementary relationship with their supervisees. The personal tutor and project supervisor are the major touchpoints for the investigation of students' current future skills and a point of guidance for their development.
    - Students will have a Dissertation Supervisor from the Artificial Intelligence team and in cases where that is the Course Leader, an independent Personal Tutor will also be appointed so that all students have the opportunity for independent pastoral and academic advice.
    - The Course Leader and/or Personal Tutor will meet with Artificial Intelligence students regularly to provide guidance on assessment and personal development choices, discuss progress on the course, career plans, goals, development and recognition of personal and graduate attributes.

The assessment during the Professional Placement year will include a reflective practice piece of work supported by evidence of achievement, and the employer's appraisal. The performance and attendance will be regularly monitored through the placement year. The marking of the placement is "pass" or "fail".

E. Support for Students and their Learning

Postgraduate students are supported by:

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    - A detailed induction programme in the first week of enrolment which includes mathematics and programming background diagnostics and support for students with diverse academic backgrounds. For example:
        - Students' programming experience is explored during induction. Diagnostic self-assessment and self-directed learning materials for introductory Python have been developed within the in-house Nooblab system to prepare students unfamiliar with Python for the CI7520 module.
        - A mathematics and statistics "refresher" course is available following induction, as for other CSM postgraduate programmes.
    - Students Academic Success Centre (SASC), which supports students in their academic skills, English language, assessment and feedback interpretation, through daily drop-ins as well as online through the VLE (Canvas). For CSM students in particular (but open to all) SASC incorporates:
        - Programming Aid for drop-in software development support; and
        - MathsAid for mathematics and statistics support (Both are run by CSM academic staff or postgraduate & PhD students)
        - Advice on generic study skills is also available on the VLE (Canvas), to which all students have access; this includes advice on writing, oral communication, numeracy, problem-solving and career management, amongst others.
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    - The Course Leader-led Personal Tutor Scheme aims to help students in their studies, with a combination of staff and peer support. It is recognised that students studying the MSc Artificial Intelligence come from a variety of backgrounds, including those who are in employment, returning to study after a break, recent graduates from Kingston University and other UK institutions and international students. These various experiences and backgrounds contribute to the peer support built into the Personal Tutor Scheme. At the beginning of the year and throughout, tutors and students will discuss: available resources to help students getting started at Kingston University and transitioning from undergraduate to postgraduate study; maths aid, employability, CV and cover letter writing, and 'skills gap analysis'; academic progress during studies, including formative and summative feedback and how this can be used to feed-forward to improve performance; and preparation for the research project.
    - Students are encouraged to discuss academic and pastoral concerns with their Course Leader. All academic staff operate a system of open office support hours during which students can consult with their lecturers. Additional assistance is also available through the Union of Kingston Students, the Dyslexia and Disability Support Office, and the Careers & Employability Service.

- Elected/appointed Student Representatives who can report to the Student Voice Committee meetings with feedback from students on the course specific to the modules and the course in general.

F. Ensuring and Enhancing the Quality of the Course

The University has several methods for evaluating and improving the quality and standards of its provision. These include:

- External examiners
- Student Voice Committees (SVC)
- Annual Monitoring and Enhancement
- Internal Subject Review undertaken at subject level
- Student evaluation including MEQs
- Moderation policies
- Feedback from employers

G. Employability and work-based learning

The course, MSc in Artificial Intelligence (AI), encompasses a diverse range of modules covering contemporary fields within AI. The compulsory modules establish the foundational theories and provide hands-on implementations, while each elective module opens pathways to related projects, research, and subsequent job opportunities. All module titles were already approved by the Industrial Advisory Board (IAB).

The compulsory modules cover essential aspects such as machine learning, deep learning, and the ethical and regulatory considerations that AI scientists must adhere to. Additionally, they introduce the "Data Mining and Big Data", a subject that has been in high demand in market.

The elective modules offer specialized topics including computer vision, natural language processing, and Cyber Security with AI. The AI research conducted at Kingston University showcases not only diversity but also renowned quality, particularly in areas such as computer vision, image processing and cyber security.

Job opportunities within AI-related fields have experienced an unprecedented surge, and studies indicate that this trend is likely to continue for at least the next decade. Furthermore, as various AI systems may replace numerous current jobs, individuals with deep knowledge and expertise in AI, particularly computer scientists, are expected to secure employment more easily than those in other disciplines. Lastly, it is worth noting that the School of Computer Science and Mathematics (CSM) adopts the block delivery mode for this course, providing high flexibility for students to balance their work and other commitments.

Recent graduates from CSM's postgraduate courses have found employment with large organisations such as IBM, Hewlett Packard, Capgemini, JDA Software, Thomson Reuters, GlaxoSmithKline, Axa, BAA, British Telecom, Ernst & Young, Marks & Spencer, Waitrose, Virgin Media, NHS Institute for Innovation and Improvement as well as a host of smaller companies. Graduates also pursue careers in academia joining universities such as Kingston University's PhD programmes in digital imaging, network security, and user experience.

Students' employability skills are developed throughout the course, through activities that are embedded within the syllabus and from the University's Careers and Employability Service. During induction week students are encouraged to reflect on and identify what they have previously learned, whether academically or in terms of transferable skills, and how these may be relevant to their choice of subject discipline and employment opportunities. They are also encouraged to explore the job market and possible career paths at an early stage of the course, and to consider attributes that employers look for in graduates above and beyond essential academic skills. The students are then encouraged to continue to build on the key skill attributes learnt from their previous education and experiences, and focus on the importance of the following KU graduate attributes that are particularly relevant to Artificial Intelligence: Creative and original thinking, being inventive and experimental, finding original solutions to problems, influencing change, being more resilient and self-aware and able to consider their actions in the context of the wider community. As the course progresses, students are further encouraged to develop clearer ideas about career options and are offered assistance and guidance in the preparation of a CV and for job applications and interviews. For students already in employment the course offers an opportunity to enhance their knowledge and to develop their practical, intellectual and key skills to assist them in their career development, obtaining recognition for current and acquired skills.

Work-based learning, including sandwich courses and higher or degree apprenticeships

Additional support is available for students undertaking a placement.

- While the responsibility for finding and securing a professional placement rests ultimately with the students, those who are intending to undertake a placement are supported by a comprehensive structured programme of activities and events designed to help them. This starts with an additional separate day of induction at the start of the course (over and above the induction for other students) – introducing some of the fundamentals of career development and job-hunting, as well as the place of the professional placement module within the academic structure. After induction students follow, over a few months, a scheduled programme of assignments (built into the module structure in Canvas) including personal awareness/development portfolio, CV writing, and commercial awareness research, combined with webinars and workshops on such things as building a personal brand in LinkedIn as well as networking events. This is supported by placements and careers' teams who, in addition to helping source potential placement job opportunities and expanding the University's pool of employer contacts, work with students to help them utilise the resources available and complete the assignments. In addition, staff from the University's Careers and Employability team introduce all of their facilities and resources and also work with the students in one-to-one sessions e.g. for cv review. As well as acting as consultants, support staff also visit the students in timetabled sessions for 'maximum exposure' and students who have completed the placement in the past are also invited back for presentations and Q & A sessions.

- The appropriateness of placement positions is vetted by the Course Leader and while out on placement students are supported by a placement tutor who monitors progress and visits the students on site.
- The aim from start to finish is to ensure that students have a successful and rewarding placement experience which develops their knowledge and skills and prepares them for higher levels of employment.

All students will be benefiting from the Future Skills programme that the University is rolling out as a part of the Town House Strategy. These skills include problem solving, communication skills, digital skills, critical thinking, analytical skills, adaptability, imitativeness, resilience, building relationships and creativity. Post-graduate students come with many of these skills with them, so there will be great opportunities for peer-based work and sharing and the development of these skills across the cohort. The development of these skills will be built into the degree programme coherently as the future skills programme rolls out into post-graduate study. In the beginning, they will be discussed during Personal Tutor meetings and supervision of the Individual Project. Students are encouraged to have an industrial client as the focus for their projects, and this offers an ideal common area for discussion.

H. Other sources of information that you may wish to consult

The British Computer Society (The Chartered Institute for IT) https://www.bcs.org
The Institute for Mathematics and its Applications https://ima.org.uk
QAA Subject Benchmark Statement https://www.qaa.ac.uk/quality-code/subject-benchmark-statements for Computing and Mathematics at master's level.

I. Development of Course Learning Outcomes in Modules

This table maps where course learning outcomes are **summatively** assessed across the modules for this course. It provides an aid to academic staff in understanding how individual modules contribute to the course aims, a means to help students monitor their own learning, personal and professional development as the course progresses and a checklist for quality assurance purposes.

Module Code		Level 7										
		CI7522	CI7523	CI7524	CI7525	CI7526	CI7340	CI7521	CI7520	CI7000	CI7340	CI7900
Knowledge & Understanding	A1		S	S		S	S			S		
	A2	S	S		S					S		
	A3	S		S		S	S			S		
	A4		S		S				S	S		
	A5	S		S		S	S		S			
	A6											S

Intellectual Skills	B1		S				S		S	S		
	B2	S		S			S			S		
	B3		S		S	S			S	S		
	B4	S		S	S				S	S		
	B5				S	S	S			S		
	B6		S	S		S	S					
	B7											S
Practical Skills	C1		S				S		S	S		S
	C2		S		S	S				S		S
	C3				S		S		S	S		S
	C4		S		S	S	S					
	C5	S		S					S	S		S
	C6	S		S		S	S					S

Students will be provided with formative assessment opportunities throughout the course to practise and develop their proficiency in the range of assessment methods utilised.