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**	Cybersecurity and Artificial Intelligence
2	**Programme Code**	COMT141
3	**JACS Code**	I120, I400
4	**Level of Study/**	Postgraduate
5a	**Final Qualification**	Master of Science (MSc)
5b	**QAA FHEQ Level**	Masters
6a	**Intermediate Qualification(s)**	Postgraduate Diploma (PGDip), Postgraduate Certificate (PGCert)
7	**Teaching Institution** (if not Sheffield)	Not applicable
8	**Faculty**	Engineering
9	**Department**	Computer Science
10	**Other Departments providing credit bearing modules for the programme**	None
11	**Mode(s) of Attendance**	Full-time
12	**Duration of the Programme**	1 year
13	**Accrediting Professional or Statutory Body**	British Computer Society (BCS) National Cyber Security Centre (NCSC)
14	**Date of production/revision**	February 2024

15. Background to the programme and subject area

Computer Science is the fundamental discipline of the information and communication age. Cybersecurity now permeates every aspect of life, ranging from business and medicine to science, engineering and the humanities, requiring skilled personnel to harness and exploit the growing power of computing devices, while at the same time protecting the security of the ever-increasing data flows generated on a day-to-day basis.

The MSc in Cybersecurity and Artificial Intelligence is suited to graduates in computer science or related areas (as well as graduates with significant computer software or system experience) who wish to acquire industrially relevant skills in cybersecurity and artificial intelligence, while studying in a research-led teaching environment. The programme is designed to provide specialist skills and knowledge for students with a desire to work in, or further develop their abilities in industries that rely or will rely on cybersecurity and modern machine learning/AI techniques.

The learning and teaching methods ensure a mix of working styles; students will work both independently and as part of a team, developing both their confidence and capability in making authoritative decisions. The nature of the programme encourages the development of a network of peers who share enthusiasm for the field, and who bring an understanding of the wider context and applicability of the subject in the wider world.

The content of the programme reflects a range of expertise and research excellence of the Department. It harnesses four AI modules from our existing successful MSc in Artificial Intelligence and supplements these modules with four bespoke cybersecurity modules (with a project at the interface of the two topics). Teaching is informed by the research activity of staff, which has an international reputation for the quality of its research. In the 2021 Research Excellence Framework (REF), 99% of our research was rated in the top two categories, meaning it is classed as world-leading or internationally excellent. The Department is rated 8th nationally for the quality of our research environment. The Department's Industrial Advisory Board plays an important role in advising the Department on its teaching provision, with particular emphasis on the suitability of its degree programmes as training and development for careers in computer science and software engineering.

We anticipate that some of MSc graduates from this programme may also wish to pursue PhDs in cybersecurity and so the programme forms part of our overall strategy for research development.

The programme is accredited by the British Computer Society (BCS), as partially meeting the educational

requirements for Chartered Engineer (CEng/IEng) and Chartered Information Technology Professional (CITP) registration. In addition, it is certified by the National Cyber Security Centre (NCSC).

See the Department of Computer Science website: http://www.shef.ac.uk/dcs for more information.

16. Programme aims

The aims of the programme are:

1. To develop knowledge of fundamental and leading-edge topics in cybersecurity and AI.
2. To deepen the student's knowledge of selected areas of cybersecurity and artificial intelligence, through the completion of group and individual project work.
3. To provide immediately employable graduates with an industrially relevant mix of knowledge and practical skills.
4. To provide research-led training, thus providing a solid foundation for graduates to pursue a research degree or an industrial career in research and development.
5. To immerse students in an academic environment that rewards innovation, fosters a sense of community and encourages students to direct their own learning.

17. Programme learning outcomes

Knowledge and understanding:	
K1	Have a sound knowledge and critical understanding of gathering, organising and evaluating information needed to formulate and solve problems.
K2	Have a deep academic understanding of several advanced, research-led cybersecurity subject areas, covering fundamental technologies, malware and other threats, secure software development, and commercially and industrially relevant architectures for security. This understanding is gained by following the four taught cybersecurity modules.
K3	Have a deep academic understanding of several advanced, research-led Artificial Intelligence subject areas, covering fundamental machine learning approaches and application to specific areas of cybersecurity relevance. This understanding is gained by following the four taught AI modules.
K4	Develop understanding of how AI and Cybersecurity can be combined beneficially to enhance or contribute to some aspect of cybersecurity. For example, how to use AI to solve cybersecurity problems or how the cybersecurity of AI systems may be addressed. The project dissertation plays the major part in developing this understanding.

Skills and other attributes:	
S1	Be able to function in a computer-based learning environment, making full use of email, the internet and electronic media.
S2	Be able to conceive, design and write correct working computer programs relevant to cybersecurity and AI.
S3	Have written communication skills, including the ability to comprehend, summarise, synthesize and properly cite research-level material as part of an integrated argument.
S4	Have oral communication skills, specifically the ability to present and defend a substantial piece of work, to engage with enquirers and respond effectively to questions, and the ability to communicate to a non-specialist audience.
S5	Have team working skills, demonstrating personal responsibility, interpersonal communication skills, and the ability to plan to meet deadlines.
S6	Have research skills, demonstrating an ability to identify material from multiple published sources, relevant to a chosen topic, and from it synthesize theories, principles or designs pertinent to practical problem-solving.
S7	Be able to demonstrate initiative, self-motivation, and research ability fostered through the completion of an individual project.

18. Teaching, learning and assessment

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

Learning is student-centred, that is, the Department fosters an environment with many opportunities for individual and group learning, but the responsibility for learning rests with the student, who must be personally organised and self-motivated to make the most of the programme. Students are assigned to a personal tutor; they meet regularly to discuss progress and learning issues. Academic and technical advice may be sought from lecturers, teaching assistants and supporting staff (initially, via email). Teaching is offered through induction procedures, formal lectures, seminars, computer laboratories, problem-solving classes and project supervision.

Induction procedures in which students are provided with an introduction pack and participate in tutorial sessions. Contents of the pack include the MSc Student Handbook, and a departmental map enabling students to familiarise themselves with the layout of the department and the main computing facilities. During intro week, students participate in orientation activities introducing them to the resources available via the departmental web site and local intranet. Learning outcomes *K1* and *S1* are supported through this.

Lectures are 50-minute formal presentations to a large class of students by a lecturer, who is responsible for the delivery of the module concerned. 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. The learning outcomes *K1-K3* are supported mainly through this mode.

On-line materials. We aim to adopt a flipped classroom approach where appropriate, particular for parts of the cybersecurity modules. Our HEFCE Catalyst grant will fund the development of online materials to facilitate this endeavour. As for lectures, the purpose 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. We will mix video, audio and slide content. Materials will generally be made available in small chunks, supported by on-line quizzes and problem sheets. Where a flipped classroom approach is adopted we will use problem classes, lab classes and seminars to support further understanding. The academic responsible for the module will also maintain a Q&A blog (with a general assumption that all discourse is public).

W**e envisage significant provision of links to externally freely available resources.**

Seminars are longer 90- to 110-minute informal presentations to a class of students by a lecturer, researcher, industrial partner or student, describing an area of their current research or business. There is typically more opportunity to structure the session internally with questions, problem solving and other kinds of interactive or shared learning experience, in which the students may also participate in the teaching. **The learning outcomes *K4*, *S5* and *S6* are directly promoted through this mode, with indirect support for *S4* and *K1-K3.***

Computer laboratories are 50-minute or 110- minute sessions, supervised by teaching assistants (and sometimes attended by the responsible lecturer) in which students work at a computer, to learn and practise a specific practical skill such as computer programming. The learning outcomes *S1* and *S2* are promoted mainly through this mode, with indirect support for *K1-K3.*

Problem-solving classes are 50-minute or 110- minute sessions, 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 practically with material presented in lectures and start to apply this knowledge. The learning outcomes *K1-K4* are supported through this mode.

Project supervision is a regular meeting held with an individual or group project supervisor, who may also be the student's personal tutor. During the 20-50 minute session, students report on their progress to the supervisor, who highlights further areas of investigation, helps with technical problems, advises about the content and structure of technical reports and generally encourages the students to organise their time effectively. The learning outcomes *S4-S7* and *K4* are directly promoted through this mode, with *S2* and *S3* supported indirectly.

The transition from teaching to self-motivated learning is encouraged through specialist teaching materials such as lecture handouts or copies of lecture slides, which are typically supplied via the Department of Computer Science website. Set course texts and more general background materials are available through the University libraries, at bookshops and also via the Internet. Students are responsible for obtaining textbooks and printing any material downloaded over the Internet. Active learning is fostered and promoted through engagement in practical work, such as exercises, assignments and projects. Additionally, students are expected to undertake

private study.

Exercises are short tasks, either writing computer programs or working out solutions to other kinds of set problem, which are typically reviewed at the end of the session. Learning outcomes *K1-K4* and *S1-S3* may be supported this way.

Assignments are offered over several weeks, typically involving the design and implementation of a software system to perform a given task, or the researching of a body of information leading to the writing of a discursive essay on a given topic. Learning outcomes *K1-K4* and *S2-S4* are supported by this.

Projects are undertaken individually or in groups over one or two semesters. Projects typically solve a larger problem, possibly for an industrial client, possibly with a research dimension, and require good personal and organisational skills and good presentation skills. Learning outcome *K4* and *S2-S7* are supported by this; indirectly, *S1* and *K1-K3* are reinforced.

Private study makes up more than half of the time allocated to each module. Students are expected to read around the topics of each module and follow directed reading from recommended course texts and online sources. Private study will include further investigations prior to exercises or projects and consolidates the lecture notes.

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

Modules may be assessed by examination, by an individual or group project, or by some combination of examination and a practical assignment. Learning outcomes K1-K4 and S2-S4 may be assessed by examination or coursework. Learning outcome S1 is not formally assessed, but is a skill acquired as a side-effect of working in a computer-based learning environment. Learning outcomes S4-S7 are assessed by individual and group project work.

Examinations are typically 2-hour question papers. Examinations test the knowledge learning outcomes K1-K4 but also provide evidence of practical skill S3, and evidence of engagement in S2.

Assignments are pieces of continuously assessed coursework, which students complete individually or in groups as directed. Assignments both develop and assess the practical skills S2-S4 (and S5 for group assignments).

A **project** is completed during the summer. Students select a topic, research the background literature, prepare a survey/analysis report at the interim assessment stage, and apply this knowledge in a practical, problem-solving project which is expected to contain some degree of original contribution. The final assessment stage is by dissertation and presentation (including a software demonstration, if appropriate), assessed independently by two examiners. A viva voce examination may be held to form a common view in cases of insufficient evidence or divergent opinions. The learning outcomes S3-S4, S6, and S7 are directly assessed, together with specialist areas of knowledge from K1-K4. Practical skills in S1-S4 may be assessed indirectly.

19. Reference points

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

University Strategic Plan
http://www.sheffield.ac.uk/strategicplan

Teaching and Learning Strategy of the Department of Computer Science.

Discussions with members of the Department of Computer Science Industrial Liaison Board (consisting of representatives from major companies in the IT industry, as well as more specialist consultancies and companies).

Discussions with a variety of local and national commercial and Governmental organisations.

Departmental annual student course evaluations and student feedback via the Staff-Student Committee.

External

Subject Benchmark Statements
https://www.qaa.ac.uk/the-quality-code/subject-benchmark-statements

The UK Engineering Council Standards and Routes to Registration (SARTOR) document, 3rd Edition, 1997.

The draft UK Standards for Professional Engineering Competence (UK-SPEC), 2003.
Accreditation requirements of the British Computer Society (BCS)

The workload fits comfortably within the guidelines laid down by the University, of 10 hours per credit awarded, and is monitored by external examiners.

20. Programme structure and regulations

The programme is offered over 12 months, starting in mid-September each year, and finishing the following September. The teaching year is divided into two semesters of 15 weeks, plus a 12-week project period during the summer. The first 12 weeks of each semester are devoted to teaching, with the remaining 3 weeks devoted to examinations. The programme is fully modular, delivered in multiples of 15 credits. Masters students study for 180 credits in a year (120 = 8 x 15 credits of taught modules and a 60-credit dissertation).

This comprises eight 15-credit **core** modules:

COM6509 Machine Learning and Adaptive Intelligence (promoting K1, K3)

COM6012 Scalable Machine Learning (promoting K1, K3)

COM6115 Text processing (promoting K1, K3, K4)

COM6513 Natural Language Processing (promoting K1, K3, K4)

COM6014 Fundamental Security Properties and Mechanisms (promoting K1-K4)

COM6015 Development of Secure Software (promoting K1, K2)

COM6016 Cyber Threat Hunting and Digital Forensics (promoting K1, K2)

COM6017 Security of Control and Embedded Systems (promoting K1, K2).

and a 60-credit project-based module:

COM6013 Cybersecurity and Artificial Intelligence Dissertation Project (supporting K1-K4, S3, S4, S6, S7).

All modules support S1 and S2.

S3 is developed specifically in the Security of Control and Embedded Systems module and the project dissertation.

S4 is developed via project presentation and also podcast development.

Team skills (S5) are developed specifically via the Security of Control and Embedded Systems module (whose assessment is in part group based) but also in part by modules (e.g. Fundamental Security Properties and Mechanisms may involve lab work in pairs or larger groups).

S6 and S7 are supported by the project dissertation and presentations (but also by the taught modules, with demonstration of wider reading often required for assessments).

Students who obtain 180 credits in total are awarded the degree of MSc. Exit awards of PG Diploma and PG Certificate can also be awarded to students who have obtained the appropriate number of credits as stated in the University regulations.

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/regs

21. Student development over the course of study

Students entering the programme will typically have a Computer Science background (or relevant industrial experience) and are expected to have A-level mathematics, but they are likely to be new to cybersecurity and machine learning. The modules ensure that all students have a common academic grounding, and emphasize fundamental principles, concepts and techniques.

Student choice is served through the provision of a wide variety of possible project topics designed to enable students to design a programme in accordance with their developing interests and career aspirations.

Students' development over the course of their study is measured through assessment of performance in each module, and across the programme as a whole, and monitored via regular meetings with a personal tutor who also offers pastoral care.

Masters students are required to complete an individual research-based dissertation of 15,000 – 20,000 words. This enables students to apply appropriate research techniques to a real problem combining the fields of

cybersecurity and artificial intelligence, and to engage at an in-depth level with an area of the subject which is of particular interest to them. The project topic must combine aspects of cybersecurity and AI.

Students may develop their own dissertation topics, in consultation with staff, or select from a list of possible topics generated by academic staff and industrial clients.

PG Diploma and PG Certificate students do not complete a dissertation project. PG Certificate students will have successfully completed fewer modules than MSc or PG Diploma students and are therefore expected to have an appreciation of some learning outcomes (K1-K4) rather than a thorough understanding of them.

22. Criteria for admission to the programme

Candidates should hold a 2.1 at degree level and should additionally either be graduates in computer science (or a related area), or else demonstrate significant computing-related experience. A-level Mathematics (or equivalent) is also required.

Students whose first language is not English must hold an approved English language qualification.

23. Additional information

The Department of Computer Science is housed in the modern, purpose-built Regent Court building and has its own dedicated computing facilities. The Department is internationally recognised for its teaching and research (in the 2021 Research Excellence Framework (REF), 99% of our research was rated in the top two categories, meaning it is classed as world-leading or internationally excellent). It has particular research strengths in the fields of natural language processing, speech technology, machine learning, robotics, computer graphics and software verification and testing.

The Department of Computer Science MSc Student Handbook governs all local aspects of academic student life, with regard to services offered, computer etiquette, and local regulations.

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.