Imperial College London

MEng Computing - Artificial Intelligence and Machine Learning

This document provides a definitive record of the main features of the programme and the learning outcomes that a typical student may reasonably be expected to achieve and demonstrate if s/he takes full advantage of the learning opportunities provided. This programme specification is intended as a reference point for prospective students, current students, external examiners and academic and support staff involved in delivering the programme and enabling student development and achievement.

Programme Information

Programme Title	Computing - Artificial Intelligence and Machine Learning
Award(s)	MEng
Programme Code(s)	G700
Awarding Institution	Imperial College London
Teaching Institution	Imperial College London
Faculty	Faculty of Engineering
Department	Department of Computing
Associateship	City and Guilds of London Institute (ACGI)
Main Location of Study	South Kensington Campus
Mode and Period of Study	4 academic years, full-time
Cohort Entry Points	Annually in October
Relevant QAA Benchmark Statement(s) and/or other external reference points	Honours Degrees in Computing and Master's Degrees in Computing
Total Credits	ECTS: 270-275 CATS: 540-550
FHEQ Level	Level 7
EHEA Level	2nd cycle
External Accreditor(s)	IET (Institution of Engineering and Technology) Accreditation received: 1991 Accreditation renewal: 2017 BCS (the Chartered Institute for IT) Accreditation received: 1993 Accreditation renewal: 2018

Specification Details

Student cohorts covered by specification	2018-19 and previous entry cohorts

Person responsible for the specification	Dr Damian Cerase, Teaching Quality Officer
Date of introduction of programme	
Date of programme specification/revision	February 2020

Programme Overview

Computing is a creative and wide-ranging subject that focuses on using sound underlying principles and logical thinking to design and build systems that really work. You will learn how modern computer and communications systems function, and how they can be used and adapted to build the next generation of computing applications. This course allows you to specialise in artificial intelligence and knowledge engineering, as well as the development of computational and engineering models of complex cognitive and social behaviours.

All of our Computing courses follow broadly the same structure for the first two years. Core modules give you an understanding of the basic concepts and principles of computing. We also provide a solid background in discrete mathematics (logic, sets, relations and grammars), which is the basic mathematics of computing, and classical mathematics and statistics relevant to applications engineering and management.

The central core of our courses has been designed to give you an overview of computing, an understanding of the basic concepts and principles, the ability to appreciate and to adapt to changes in technology, and practical experience in applied computing.

We place special emphasis on the fundamental principles underlying computing and on the engineering considerations involved in computing system design, implementation and usage. We will also introduce you to computing architecture and hardware, alongside the software that can exploit them.

You will attend laboratory and problem-solving classes, as well as completing project and design work throughout the course.

As the course progresses, you will study advanced techniques and modules, many of which draw on current research taking place in the Department.

At the end of your third year you will gain valuable skills and experience by completing an industrial placement.

Your study reaches Master's level in the final year, with a wide choice of optional modules and a substantial individual project on a subject of your choice.

Learning Outcomes

Knowledge and Understanding of:
- The major paradigms of high-level programming: declarative, imperative and object-oriented;
- Fundamental Computing concepts, including computer hardware, computer architecture, operating systems, programming, program design, fundamental algorithms, compilers, databases, networks and communications, human computer interaction, and many application areas such as e-commerce, graphics and artificial intelligence;
- The underlying mathematical foundations of Computing, including logic, discrete mathematics, computability, and complexity;

- Formal aspects of software engineering, including program specification, program reasoning and design methods;
- Continuous mathematics relevant to a wide range of application areas including computer graphics, operations research, optimisation, performance analysis and scientific computing;
- Practical aspects of software engineering and engineering design;
- Communication skills, including project specification, system design, teamwork, written and oral presentation and literature search;
- Moral and ethical issues, including professional conduct, law and plagiarism;
- In depth understanding of a broad range of research work in Department's areas of expertise;
- Ability to conduct research into the current state of the art in computing;

Intellectual Skills:
- Analyse computing system design problems of varying types and specify those problems, and proposed solutions, in a suitable formalism;
- Reason about program correctness and algorithm complexity;
- Construct abstract models of computer and communication systems for the purposes of functional and performance analysis;
- Analyse unseen problems and select tools and techniques most suitable for solving them;
- Design experiments for the purposes of testing and evaluation;
- Perform critical evaluation of alternative designs and solution techniques for a wide range of problems;
- Develop an understanding of the theory, practice and trends of more advanced computing topics;
- Understand current research work and undertake independent research;

Practical Skills:
- Design and develop programs of varying levels of complexity using a number of different programming languages and paradigms, for example object oriented programming, logic programming, functional programming and imperative programming;
- Use many computing tools and techniques, such as database, web-based and graphic tools and techniques;
- Analyse computing problems and devise appropriate solutions to them;
- Give technical presentations;
- Prepare technical reports;
- Conduct detailed literature searches;
- Plan, conduct and write up a programme of development conducted in a team;
- Plan, conduct and write-up a programme of research and development conducted as an individual;
- Design high quality user interfaces;
- Apply mathematical knowledge to Computing problems of a numerical nature;

Transferable Skills:
- Communicate effectively through oral presentations, computer presentations and written reports;
- Program in the major computer programming paradigms;
- Use the World Wide Web effectively;
- Integrate and evaluate information from multiple and diverse sources;
- Work within and contribute to a team, apply management skills such as co-ordination, project design and evaluation and decision processes as applied in software engineering;
- Manage resources and time;

- Learn independently with open-mindedness and critical enquiry;
- Learn effectively for the purpose of continuing professional development;
- Apply research skills to develop an in depth understanding of a new or emerging topic, and then extend the state of the art in that topic;

The Imperial Graduate Attributes are a set of core competencies which we expect students to achieve through completion of any Imperial College degree programme. The Graduate Attributes are available at: www.imperial.ac.uk/students/academic-support/graduate-attributes

Entry Requirements

Academic Requirement	Grade Requirement	Normally a minimum of **A*AA** overall
	Subject Requirements	**A*** in Mathematics **A** in two further accepted A-levels (Further Mathematics is highly recommended. Other useful A-levels include: Ancient Language, Biology, Chemistry, Computing, Economics, Electronics, English Literature, History, Law, Modern Language, Philosophy, Physics, Politics and Psychology) (or a comparable qualification recognised by the College).
	Excluded Subjects	ICT, Business Studies and General Studies
International Baccalaureate (IB)	Grade Requirement	Minimum 39 points
	Subject Requirements	**7** in Mathematics at higher level **6** in one further relevant subject at higher level (for example Physics, Computer Science, Chemistry, Economics, Biology)
English Language Requirement		Standard requirement IELTS score of 6.5 overall (minimum 6.0 in all elements)
Admissions Tests		Candidates may be asked to undertake an admissions test set by the College in order to provide additional information for the Admissions Tutor in support of an application.
Interview		Selected candidates only

The programme's competency standards document can be found at:
http://www.imperial.ac.uk/computing/prospective-students/courses/competence/

Learning & Teaching Strategy

Scheduled Learning & Teaching Methods	- Lectures - Tutorials - Practical work - Laboratory work

	• Group work • Practical exercises
Project Learning Methods	• Independent research project
Placement Learning Methods	• Industrial placement

Assessment Strategy	
Assessment Methods	• Individual projects • Group projects • Reports • Presentations • Written examinations • Laboratory-based examinations • Coursework • Laboratory work • Programming tests

Academic Feedback Policy

Feedback will be provided on coursework within two weeks of submission. This will be in the form of, for example:

- Personal discussion;
- Discussions in small-group tutorials;
- Marked-up coursework, laboratory exercises or tests;
- Verbal presentation, e.g. during or after lectures;
- Written class-wide summaries;
- Interactive problem solving sessions;
- Model answers to coursework;

In lieu of feedback on examinations, selected examination questions are routinely set as unassessed problems in the following year, with model answers provided.

Re-sit Policy

In line with College policy, students who are unsuccessful in any of their examinations may usually be allowed an opportunity to re-sit at the discretion of the Board of Examiners.

Students in the Faculty of Engineering who have marginally failed a year may be offered the chance to undertake a Supplementary Qualifying Test (SQT) at the discretion of the Board of Examiners in order to progress into the next year.

The College's Policy on Examination Re-sits and SQTs is available at:
https://www.imperial.ac.uk/about/governance/academic-governance/academic-policy/exams-and-assessment/

Further information regarding re-sits for BEng, MEng, BSc and MSci degrees in the Faculty of Engineering can be found in the relevant Academic Regulations available at:
https://www.imperial.ac.uk/about/governance/academic-governance/regulations/

Mitigating Circumstances Policy
Students may be eligible to apply for mitigation if they have suffered from serious and unforeseen circumstances during the course of their studies that have adversely affected their ability to complete an assessment task and/or their performance in a piece of assessment. The College's Policy on Mitigating Circumstances is available at: https://www.imperial.ac.uk/about/governance/academic-governance/academic-policy/exams-and-assessment/

Assessment Structure

Rules of Progression
Year One In order to pass the first year and qualify to progress to the second year, the candidate must achieve: • A minimum of 40% in each module; • A minimum of 40% overall. **Year Two** In order to pass the second year and qualify to progress to the third year, the candidate must achieve: • A minimum of 40% in each module; • A minimum of 40% overall. **Year Three** To qualify for the fourth year students must normally obtain an overall mark of at least 40% in the third year, including at least 40% in the group project. Students who fail to achieve this will normally be required to transfer to the BEng degree and complete an individual project.

Marking Scheme
Final Degree Classifications The marks for all components of the four years of the course are aggregated into an overall mark. The class of Honours awarded depends on this overall mark, with the proviso that candidates must have achieved at least 40% overall in the fourth year and normally at least 40% in their individual project. The Pass Mark for all undergraduate modules is 40%. The MEng degree mark is calculated with the year weightings 1:2:2:4. In addition to these requirements, candidates are normally expected to successfully complete the MEng degree programme in four continuous years. Third – a student must achieve an aggregate mark of 40% Lower Second – a student must achieve an aggregate mark of 50% Upper Second – a student must achieve an aggregate mark of 60% First - a student must achieve an aggregate mark of 70%

Module Weightings		
Year	Module Title	Module Weighting %
1 (11.1%)	Reasoning About Programs	7.05%
	Databases 1	8.82%
	Architecture	8.82%
	Mathematical Methods	8.82%
	Logic	8.82%
	Programming 1 (Haskell)	10.11%
	Programming 2 (Java)	13.00%
	Discrete Structures	7.05%
	Graphs and Algorithms	7.05%
	Laboratory 1	0.00%
	Computing Topics	4.70%
	Ethics in Computing 1	0.58%
	Presentation Skills	0.58%
	Hardware	8.82%
	Programming 3 (C)	5.77%
	Year 1 Extracurricular	0.00%
2 (22.2%)	Compilers	8.23%
	Software Engineering - Design	8.23%
	Networks and Communications	8.23%
	Operating Systems	8.23%
	Models of Computation	8.23%
	2nd Year Computing Group Project	10.58%
	Probability and Statistics	8.23%
	Laboratory 2	23.52%
	Advanced Laboratory 2	0.00%
	An Introduction to Law for Computer Scientists	0.00%
	Introduction to Prolog	0.00%
	Introduction to Artificial Intelligence	8.23%
	Algorithms 2	8.23%
	Year 2 Extracurricular	0.00%
3 (22.2%)	3rd Year Software Engineering Group Project	25.88%
	Machine Learning	10.58%
	Electives (AT LEAST 5 from group A and NO MORE THAN 1 from group B)	10.58% each
	Year 3 Extracurricular	0.00%
4 (44.4%)	Computing Industrial Placement	0.00%
	Individual Project MEng	45.47%
	Electives (AT LEAST 9 ECTS from group C and 4.5 ECTS from groups D and E. NO MORE THAN 12 ECTS from group E)	7.79% each
	Year 4 Extracurricular	0.00%

Indicative Module List									
Code	Title	Core/ Elective	Year	L&T Hours	Ind. Study Hours	Place- ment Hours	Total Hours	FHEQ Level	ECTS
CO112	Hardware	Core	1	27	73	0	100	4	4
CO113	Architecture	Core	1	27	73	0	100	4	4
CO120.1	Programming 1 (Haskell)	Core	1	31	169	0	200	4	8
CO120.2	Programming 2 (Java)	Core	1	13.5	186.5	0	200	4	8
CO120.3	Programming 3 (C)	Core	1	52	148	0	200	4	8
CO130	Databases 1	Core	1	27	73	0	100	4	4
CO140	Logic	Core	1	27	85.5	0	112.5	4	4.5
CO141	Reasoning About Programs	Core	1	27	85.5	0	112.5	4	4.5
CO142	Discrete Structures	Core	1	49.5	50.5	0	100	4	4
CO145	Mathematical Methods	Core	1	32	68	0	100	4	4
CO150	Graphs and Algorithms	Core	1	See module leader			100	4	4
CO161	Laboratory 1	Core	1	176	0	0	N/A	4	0
CO163	Computing Topics	Core	1	11	64	0	75	4	3
CO164	Ethics in Computing 1	Core	1	4	0	0	N/A	4	0

					Ind.	Place-			
Code	Title	Core/ Elective	Year	L&T Hours	Study Hours	ment Hours	Total Hours	FHEQ Level	ECTS
CO165	Presentation Skills	Core	1	6	0	0	N/A	4	0
CO191	Advanced Programming	EX1	1	18	0	0	N/A	4	0
CO701	Programming Competition Training	EX1	1	N/A				4	0
CO211	Operating Systems	Core	2	See module leader			100	5	4
CO212	Networks and Communications	Core	2	See module leader			100	5	4
CO220	Software Engineering - Design	Core	2	See module leader			100	5	4
CO221	Compilers	Core	2	See module leader			100	5	4
CO240	Models of Computation	Core	2	See module leader			100	5	4
CO245	Probability and Statistics	Core	2	See module leader			100	5	4
CO261	Laboratory 2	Core	2	See module leader			525	5	21
CO261C	Advanced Laboratory 2	Core	2	See module leader			N/A	5	0
CO271	2nd Year Computing Group Project	Core	2	See module leader			175	5	7
CO273	An Introduction to Law for Computer Scientists	Core	2	See module leader			N/A	5	0
CO276	Introduction to Prolog	Core	2	See module leader			N/A	5	0

Indicative Module List									
Code	Title	Core/ Elective	Year	L&T Hours	Ind. Study Hours	Place- ment Hours	Total Hours	FHEQ Level	ECTS
CO202	Algorithms 2	Core	2	27	73	0	100	5	4
CO231	Introduction to Model-based Artificial Intelligence	Elective (A)	2	See module leader			100	5	4
CO233	Computational Techniques	Elective (A)	2	See module leader			100	5	4
CO701	Programming Competition Training	EX2	2	N/A				5	0
CO362	3rd Year Software Engineering Group Project	Core	3	See module leader			250	6	10
CO395	Introduction to Machine Learning	Core	3	See module leader			125	6	5
CO303	Systems Verification	Elective (B)	3	See module leader			125	6	5
CO304	Logic-Based Learning	Elective (B)	3	See module leader			125	6	5
CO315	Computer Vision	Elective (B)	3	See module leader			125	6	5
CO317	Graphics	Elective (B)	3	See module leader			125	6	5
CO318	Custom Computing	Elective (B)	3	See module leader			125	6	5
CO322	Communicating Computer Science in Schools	Elective (B)	3	See module leader			125	7	5
CO331	Network and Web Security	Elective (B)	3	See module leader			125	6	5

			Indicative Module List						
Code	Title	Core/ Elective	Year	L&T Hours	Ind. Study Hours	Place-ment Hours	Total Hours	FHEQ Level	ECTS
CO332	Advanced Computer Architecture	Elective (B)	3	See module leader			125	6	5
CO333	Robotics	Elective (B)	3	See module leader			125	6	5
CO337	Simulation and Modelling	Elective (B)	3	See module leader			125	6	5
CO338	Pervasive Computing	Elective (B)	3	See module leader			125	6	5
CO339	Performance Engineering	Elective (B)	3	See module leader			125	6	5
CO343	Operations Research	Elective (AB	3	See module leader			125	6	5
CO347	Distributed Algorithms	Elective (B)	3	See module leader			125	6	5
CO382	Type Systems for Programming Languages	Elective (B)	3	See module leader			125	6	5
CO572	Advanced Databases	Elective (B)	3	See module leader			125	6	5
EE3-24	Embedded Systems	Elective (C)	3	See module leader					
-	Business School Modules	Elective (C)	3	Variable				6	6
-	Horizons Modules	Elective (C)	3	Variable				6	6
CO701	Programming Competition Training	EX3	3	N/A				6	0
CO401	MEng Computing Individual Project	Core	4	See module leader			625	7	25

		Indicative Module List								
Code	Title	Core/ Elective	Year	L&T Hours	Ind. Study Hours	Place- ment Hours	Total Hours	FHEQ Level	ECTS
CO464	Computing Industrial Placement	Core	4	See module leader			1125	7	45
CO404	Separation Logic: Scalable Reasoning about Programs	Elective (D)	4	See module leader			125	7	5
CO406	Concurrent Processes	Elective (D)	4	See module leader			125	7	5
CO433	Advanced Robotics	Elective (D)	4	See module leader			125	7	5
CO474	Machine Arguing	Elective (D)	4	See module leader			125	7	5
CO493	Probabilistic Inference	Elective (D)	4	See module leader			125	7	5
CO496	Mathematics for Machine Learning	Elective (D)	4	See module leader			125	7	5
CO424	Reinforcement Learning	Elective (D)	4	See module leader			125	7	5
CO417	Advanced Computer Graphics	Elective (D)	4	See module leader			125	7	5
CO491	Knowledge Representation	Elective (D)	4	See module leader			125	7	5
CO416	Machine Learning for Imaging	Elective (D)	4	See module leader			125	7	5
CO460	Deep Learning	Elective (D)	4	See module leader			125	7	5
CO499	Modal Logic for Strategic Reasoning in AI	Elective (D)	4	See module leader			100	7	5
CO332	Advanced Computer Architecture	Elective (E)	4	See module leader			125	6	5

		Indicative Module List								
Code	Title	Core/ Elective	Year	L&T Hours	Ind. Study Hours	Place- ment Hours	Total Hours	FHEQ Level	ECTS
CO337	Simulation and Modelling	Elective (E)	4	See module leader			125	6	5
CO408	Privacy Engineering	Elective (E)	4	See module leader			125	7	5
CO410	Scalable Systems and Data	Elective (E)	4	See module leader			125	7	5
CO422	Computational Finance	Elective (E)	4	See module leader			125	7	5
CO438	Complexity	Elective (E)	4	See module leader			125	7	5
CO440	Software Reliability	Elective (E)	4	See module leader			125	7	5
CO447	Advanced Computer Security	Elective (E)	4	See module leader			125	7	5
CO467	Principles of Distributed Ledgers	Elective (E)	4	See module leader			125	7	5
CO468	Probabilistic Programming	Elective (E)	4	See module leader			125	7	5
CO470	Program Analysis	Elective (E)	4	See module leader			125	7	5
CO471	Advanced Issues in Object Oriented Programming	Elective (E)	4	See module leader			125	7	5
CO475	Software Engineering for Industry	Elective (E)	4	See module leader			125	7	5
CO477	Computational Optimisation	Elective (E)	4	See module leader			125	7	5
CO484	Quantum Computing	Elective (E)	4	See module leader			125	7	5

					Indicative Module List					
Code	Title	Core/ Elective	Year	L&T Hours	Ind. Study Hours	Place-ment Hours	Total Hours	FHEQ Level	ECTS
CO490	Natural Language Processing	Elective (E)	4	See module leader			125	7	5
ELEC97105	Self-Organising Multi-Agent Systems	Elective (F)	4	See module leader					
CO322	Communicating Computer Science in Schools	Elective (F)	4	See module leader			125	7	5
-	Business School Modules	Elective (F)	4	Variable				6	6
-	Horizons Modules	Elective (F)	4	Variable				6	6
CO701	Programming Competition Training	EX4	4	N/A				7	0

Supporting Information
The Programme Handbook is available at: http://www.imperial.ac.uk/computing/current-students/computing/ug-handbook/
The Module Handbook is available at: http://www.imperial.ac.uk/computing/current-students/computing/ug-handbook/
The College's entry requirements for undergraduate programmes can be found at: http://www.imperial.ac.uk/study/ug/apply/requirements
The College's Quality & Enhancement Framework is available at: www.imperial.ac.uk/registry/proceduresandregulations/qualityassurance
The College's Academic and Examination Regulations can be found at: http://www.imperial.ac.uk/about/governance/academic-governance/regulations/
Imperial College is an independent corporation whose legal status derives from a Royal Charter granted under Letters Patent in 1907. In 2007 a Supplemental Charter and Statutes was granted by HM Queen Elizabeth II. This Supplemental Charter, which came into force on the date of the College's Centenary, 8th July 2007, established the College as a University with the name and style of "The Imperial College of Science, Technology and Medicine". http://www.imperial.ac.uk/admin-services/secretariat/college-governance/charters/
Imperial College London is regulated by the Office for Students (OfS) https://www.officeforstudents.org.uk/