

## Programme Specification

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### MSc Data Science (2019-20)

This specification provides a concise summary of the main features of the programme and the learning outcomes that a typical student might reasonably be expected to achieve and demonstrate if s/he takes full advantage of the learning opportunities that are provided.

Awarding Institution	University of Southampton
Teaching Institution	University of Southampton
Mode of Study	Full-time
Duration in years	1
Accreditation details	None
Final award	Master of Science (MSc)
Name of award	Data Science
Interim Exit awards	Postgraduate Certificate in Higher Education Postgraduate Diploma in Higher Education
FHEQ level of final award	Level 7
UCAS code	N/A
Programme code	6150
QAA Subject Benchmark or other external reference	Master's Degrees In Computing 2011
Programme Lead	Adriane Chapman (ac1n16)

### Programme Overview

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#### Brief outline of the programme

This programme prepares students to become data scientists. It gives them the opportunity to further their specialist knowledge in those subjects of Computer Science and Engineering that are crucial for mastering the vast and ever-so-complex information landscape that is characteristic to modern, digitally empowered organizations. This is typically linked to a number of core areas of expertise, from the ability to operate high-performance computing clusters and cloud-based infrastructures, to the know-how that is required to devise and apply sophisticated Big Data analytics techniques, and the creativity involved in designing powerful visualizations. The programme targets primarily students with a first degree in computing (or a closely related degree covering fundamental notions of programming or data analysis) and builds on successful pre-existing specialist masters at ECS.

The modules cover state-of-the-art techniques, technologies, and supporting tools, and expose students to their applications in meeting emerging business needs and ambitious societal problems. Application areas include:

data journalism, open government, finances, and social media. The programme will offer a range of options for students to choose from across these areas in order to allow them to build their own degree in a flexible way and to best match their strengths and interests. Given the broad and evolving nature of the Data Science field we may consider expanding the current scope of the programme into specialist methods and application scenarios in collaboration with colleagues from the Southampton Business School, Mathematics, or Computational Modelling.

In the first semester we start with a review of key topics in Data Science designed to resolve the inevitable variety of background knowledge and to build a cohort with a strong ethos of collaborative working. The course will introduce the core theoretical and technology components required to design and use a Data Science application, using open-source tools and openly accessible data sets. A second compulsory module in the first semester will cover the most important machine learning techniques, which are at the core of any attempt to analyse and reason about data. Finally, a new module on Data Visualization will introduce the most common types of visualization techniques and state-of-the-art technology used to build graphic elements into Data Science applications to present analytics results. Together this set of three compulsory modules in the first semester will ensure that students will be familiar with methods, techniques and tools that cover the entire data management lifecycle, from the collection and manipulation of the data to its analysis and use. This will also allow students to take an informed decision about their MSc project dissertation as by the beginning of the second semester they have already acquired the set of essential skills and knowledge that is needed to understand the full range of Data Science topics.

In the second semester the focus will be on the preparation of the MSc research project, aiming to enhance students' dissertation writing skills through the creation of a rigorous and peer reviewed project proposal. This is the fourth compulsory module of the programme. Finally, during the summer the MSc project gives students the chance to demonstrate their mastery of specialist techniques, relevant methods of enquiry, and their ability to design and deliver advanced applications, systems and solutions to a tight deadline, including the production of a substantial dissertation.

Your contact hours will vary depending on your module/option choices. Full information about contact hours is provided in individual module profiles.

### **Learning and teaching**

Learning and teaching methods are explained in the following sections covering programme learning outcomes.

### **Assessment**

Assessment methods are explained in the following sections covering programme learning outcomes.

## **Special Features of the programme**

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This is one of the few programmes in the UK that teaches the full spectrum of topics required to become a skilled data scientist in industry, academia, or government. Southampton is recognised to be internationally leading in many topics that are part of the curriculum, and specialist modules will be taught by staff involved in cutting-edge research. Students will be exposed to the most up to date insights and achievements in the field, while becoming acquiring solid knowledge and skills in understanding, using, and further developing state-of-the-art techniques and tools of industrial relevance. The students will be familiarized with a fully-fledged Data Science toolkit that will allow them to run projects and design applications in this space.

**Please note:** As a research-led University, we undertake a continuous review of our programmes to ensure quality enhancement and to manage our resources. As a result, this programme may be revised during a student's period of registration; however, any revision will be balanced against the requirement that the student should receive the educational service expected. Please read our [Disclaimer](#) to see why, when and how changes may be made to a student's programme.

Programmes and major changes to programmes are approved through the University's [programme validation process](#) which is described in the University's [Quality handbook](#).

## Educational Aims of the Programme

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The aims of the programme are to enable you to:

- 1) Develop original ideas and solve complex problems in new or unfamiliar environments, based on advanced knowledge of the principles and methodologies of data science
- 2) Integrate knowledge and handle complexity in this area of computer science and information engineering, formulating sound judgements with incomplete or limited data
- 3) Communicate your conclusions and the underpinning knowledge and rationale clearly and unambiguously to specialist and non-specialist audiences
- 4) Develop your independent learning skills as required for continued professional development

## Programme Learning Outcomes

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### Knowledge and Understanding

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On successful completion of this programme you will have knowledge and understanding of:

- A1. Key concepts of data science
- A2. Advanced concepts in specialist areas of data science, including data manipulation and analysis, as well as data visualization and use
- A3. State of the art techniques, technologies, and tools used in these areas, including a core data scientist programming toolkit
- A4. Methods of software design, development and testing used in the specialist areas mentioned under A2
- A5. Applicable methods of research and enquiry within the discipline

### Teaching and Learning Methods

A1 to A5: Most modules consist of a combination of lectures, small group teaching, practical work, directed reading, and coursework assignments. At the end of the taught part of the course you will undertake an individual project associated with a research group in ECS. Small group teaching, including all practical work and the individual project accommodate different learning styles.

### Assessment Methods

Testing of the knowledge base is through a combination of unseen written examinations and assessed coursework in the form of problem solving exercises, laboratory reports with literature review components, design and programming exercises, and individual and small-group projects.

## Subject Specific Intellectual and Research Skills

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On successful completion of this programme you will be able to:

- B1. Conceptualize and design advanced and specialized data science solutions using the methods and tools taught in the program
- B2. Test, evaluate, and maintain such solutions
- B3. Analyse problems to determine appropriate algorithms, methods, techniques, and software tools which could be used to solve them
- B4. Find, understand, and explain literature related to the main areas of the data science, including textbooks, scientific publications, software documentation and industry white papers, standards, as well as ethical, legal, and environmental guidance
- B5. Formulate, implement, and evaluate a research project expanding on the methods, techniques, programming tools, and application scenarios taught in the program

### Teaching and Learning Methods

B1 to B4: Most modules consist of a combination of lectures, small group teaching, practical work, directed reading, and coursework assignments. At the end of the taught part of the course you will undertake an individual project associated with a research group in ECS. Small group teaching, including all practical work and the individual project accommodate different learning styles. One-on-one tutorial can support full-class lectures, when required.

B4: The project preparation module and the MSc dissertation include a strong literature and peer review component.

B5: The project dissertation will be supervised by a primary and a secondary supervisor from ECS, using similar methods as for MSc Computer Science.

### Assessment Methods

B1 to B5: Testing of the subject-specific intellectual and research skills is through a combination of unseen written examinations and assessed coursework in the form of problem solving exercises, laboratory reports with literature review components, design and programming exercises, and individual and small-group projects.

In addition, B4 will be assessed as part of the project preparation module, using assessment criteria related specifically to literature survey and peer review skills.

B5 focuses on assessing research, method design, as well as programming skills.

## Transferable and Generic Skills

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On successful completion of this programme you will be able to:

- C1. Use conventional and electronic indexing and search methods to find technical information
- C2. Present technical information concisely in written and verbal forms to a range of audiences
- C3. Work in a small group on a given task, managing your own contribution and the overall task
- C4. Work independently on a significant research project, managing time and risk in an effective manner
- C5. Recognise legal and ethical issues of concern to business, professional bodies, and society, including but not limited to information security, and follow relevant guidelines to address these issues

### **Teaching and Learning Methods**

A number of courses have a significant coursework element. This can range from method design work through to presentations resulting from directed reading. The individual project includes independent research, project management, including time and risk management, literature search and review, and report writing.

C1 to C3: Most modules include small group teaching, practical work with lab partners, directed reading and coursework that requires literature review. The project preparation module includes project management and the delivery of a project plan via a presentation. Small group teaching, including all practical work, and the individual project accommodate different learning styles.

C4: The MSc project, as well as some coursework includes independent research and report writing.

C5: These skills will be covered in the compulsory taught modules.

### **Assessment Methods**

Coursework is generally assessed through written reports or computer code. The individual project is assessed by a dissertation of 15,000 words. The project preparation module is assessed via a literature review, as well as written and presentation versions of the project plan.

### **Subject Specific Practical Skills**

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On successful completion of this programme you will be able to:

- D1. Use specialist software tools for data storage, analysis and visualization

### **Teaching and Learning Methods**

D1: Practical work involving the use of such tools and programming exercises

### **Assessment Methods**

D1: Coursework in form of reports and programmed code, as well as MSc dissertation

## Programme Structure

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The programme structure table is below:

Information about pre and co-requisites is included in individual module profiles.

Where optional modules have been specified, the following is an indicative list of available optional modules, which are subject to change each academic year. Please note in some instances modules have limited spaces available.

### Part I

#### Typical course content

The programme consists of eight taught modules, each worth 7.5 ECTS credit points (15 CATS) and an individual research project worth 30 ECTS credit points (60 CATS). Three compulsory modules cover data analysis and use. Another compulsory module prepares you for your individual research project. Four optional modules can be selected from a wide range of topics (including advanced topics of data processing and manipulation, data mining, and data use and applications) to tailor the programme to your strengths and interests.

#### Programme details

The programme runs over three semesters. The first semester consists of three compulsory modules and one optional module. The second semester consists of the compulsory Project Preparation module and three optional modules. All modules are at level 6 or 7 but at most 15 ECTS (30 CATS) can be taken at level 6. As there are a large number of optional topics, students will be given generic and bespoke advice to help them make an appropriate selection, based on their background and interests. Following the first two semesters of the taught component of the programme, the students will undertake a research project which will be assessed by a degree dissertation.

There are two variations of Machine Learning in semester 1, COMP6245 and COMP6246. One of these should be taken. COMP6245 'Foundations' has a deeper focus on the mathematical foundations of machine learning and aims to serve as a launching point for further study. The practical parts of 'Foundations' focus on understanding how to implement machine learning techniques and understanding how those techniques work. COMP6246 'Technologies' has a technological focus, and allows students to get hands-on experience with modern machine learning techniques. Students studying 'Technologies' will be taught how to use machine learning libraries and tools, and will be expected to achieve a conceptual understanding of how the different techniques work, as well as an understanding of their advantages and disadvantages. COMP6245 and COMP6246 are mutually exclusive; it is not possible to take both modules. Note that some semester 2 modules have COMP6245 or COMP6246 as a prerequisite (see the module specifications). For 'Foundations' it is assumed that students have prior knowledge of linear algebra (including matrix operations), Calculus (including partial differentiation), probability and statistics. For 'Technologies' students should be comfortable with basic linear algebra and the fundamental concepts of Calculus.

Most modules are shared with our Master of Engineering programmes in Computer Science and our specialist MSc programmes. It should be noted that it may not be possible to run some optional modules if the number of students registered on the module is very small. It should also be noted that optional module choice can be restricted by the University Timetable, which varies from year to year: some optional modules may clash with other optional or

compulsory modules. Please be aware that many modules are shared between different cohorts; the class size depends on cohort size, which varies from year to year.

Examinations are held at the end of Semester 1 (January) and at the end of Semester 2 (May/June). Students who have successfully completed 30 ECTS (60 CATS) or 60 ECTS (120 CATS) at the level of the award may exit with a Postgraduate Certificate or Postgraduate Diploma, respectively.

The following describes the regular pattern of study of a full-time student, completing the programme within 12 calendar months:

Semester 1:

Four modules, including three compulsory modules and one optional module. Examinations are held in January.

Semester 2:

Four modules, including Project Preparation and three optional modules. Examinations are held in May/June.

Summer/Semester 3:

You will undertake a research project lasting 3 to 4 months, which is assessed by a 15,000 word dissertation.

The programme structure, including the compulsory and optional modules for each semester, is summarised below. Semester 2 modules may have a semester 1 pre-requisite, which can be checked in the module specifications, hence the choice of semester 1 options can affect the options available in semester 2.

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SEMESTER 1 - select one optional module

COMP6234 - compulsory

COMP6235 - compulsory

COMP6245 or COMP6246 - compulsory

COMP6202 - optional

COMP6203 - optional

COMP6231 - optional

COMP6244 - optional

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SEMESTER 2 - select three optional modules

ELEC6211 - compulsory

COMP3211 - optional

COMP6207 - optional

COMP6208 - optional

COMP6212 - optional

COMP6214 - optional

COMP6215 - optional

COMP6216 - optional

COMP6217 - optional

COMP6237 - optional

COMP6239 - optional

COMP6241 - optional

COMP6247 - optional

COMP6248 - optional

MATH6157 - optional

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SUMMER

COMP6200 - core

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Code	Module Title	ECTS	Type
COMP6234	Data Visualisation	7.5	Compulsory
COMP6235	Foundations of Data Science	7.5	Compulsory
ELEC6211	Project Preparation	7.5	Compulsory

### Part I Compulsory Optional

You must select only one variation of Machine Learning (MSc).

Code	Module Title	ECTS	Type
COMP6245	Foundations of Machine Learning (MSc)	7.5	Compulsory
COMP6246	Machine Learning Technologies (MSc)	7.5	Compulsory

### Part I Core

Code	Module Title	ECTS	Type
COMP6200	MSc Project	30	Core

### Part I Optional

Select one semester 1 module (7.5 ECTS/15 CATS) and three semester 2 modules (22.5 ECTS/45 CATS) from the following:

Code	Module Title	ECTS	Type
COMP3211	Advanced Databases	7.5	Optional
COMP6208	Advanced Machine Learning	7.5	Optional
COMP6241	Advanced Topics in Human-Systems Interaction	7.5	Optional
COMP6207	Algorithmic Game Theory	7.5	Optional
MATH6157	Applied Statistical Modelling	7.5	Optional
COMP6244	Cloud Applications	7.5	Optional
COMP6212	Computational Finance	7.5	Optional



COMP6237	Data Mining	7.5	Optional
COMP6248	Deep Learning	7.5	Optional
COMP6202	Evolution of Complexity	7.5	Optional
COMP6231	Foundations of Artificial Intelligence	7.5	Optional
COMP6203	Intelligent Agents	7.5	Optional
COMP6239	Mobile Applications Development	7.5	Optional
COMP6214	Open Data Innovation	7.5	Optional
COMP6247	Reinforcement and Online Learning	7.5	Optional
COMP6215	Semantic Web Technologies	7.5	Optional
COMP6216	Simulation Modelling for Computer Science	7.5	Optional
COMP6217	The Science of Online Social Networks	7.5	Optional

## Progression Requirements

The programme follows the University's regulations for [\*Progression, Determination and Classification of Results : Undergraduate and Integrated Masters Programmes\*](#) and [\*Progression, Determination and Classification of Results: Postgraduate Master's Programmes\*](#) as set out in the University Calendar: <http://www.calendar.soton.ac.uk/sectionIV/sectIV-index.html>

## Support for student learning

There are facilities and services to support your learning some of which are accessible to students across the University and some of which will be geared more particularly to students in your particular Faculty or discipline area.

The University provides:

- library resources, including e-books, on-line journals and databases, which are comprehensive and up-to-date; together with assistance from Library staff to enable you to make the best use of these resources
- high speed access to online electronic learning resources on the Internet from dedicated PC Workstations onsite and from your own devices; laptops, smartphones and tablet PCs via the Eduroam wireless network. There is a wide range of application software available from the Student Public Workstations.
- computer accounts which will connect you to a number of learning technologies for example, the Blackboard virtual learning environment (which facilitates online learning and access to specific learning resources)
- standard ICT tools such as Email, secure filestore and calendars.
- access to key information through the MySouthampton Student Mobile Portal which delivers timetables, Module information, Locations, Tutor details, Library account, bus timetables etc. while you are on the move.
- IT support through a comprehensive website, telephone and online ticketed support and a dedicated helpdesk in the Hartley Library.

- Enabling Services offering support services and resources via a triage model to access crisis management, mental health support and counselling. Support includes daily Drop In at Highfield campus at 13.00 – 15.00 (Monday, Wednesday and Friday out of term-time) or via on-line chat on weekdays from 14.00 – 16.00. Arrangements can also be made for meetings via Skype.
- assessment and support (including specialist IT support) facilities if you have a disability, long term health problem or Specific Learning Difficulty (e.g. dyslexia).
- the Student Services Centre (SSC) to assist you with a range of general enquiries including financial matters, accommodation, exams, graduation, student visas, ID cards
- Career and Employability services, advising on job search, applications, interviews, paid work, volunteering and internship opportunities and getting the most out of your extra-curricular activities alongside your degree programme when writing your CV
- Other support that includes health services (GPs), chaplaincy (for all faiths) and 'out of hours' support for students in Halls and in the local community, (18.00-08.00)
- A Centre for Language Study, providing assistance in the development of English language and study skills for non-native speakers.

The Students' Union provides

- an academic student representation system, consisting of Course Representatives, Academic Presidents, Faculty Officers and the Vice-President Education; SUSU provides training and support for all these representatives, whose role is to represent students' views to the University.
- opportunities for extracurricular activities and volunteering
- an Advice Centre offering free and confidential advice including support if you need to make an academic appeal
- Support for student peer-to-peer groups, such as Nightline.

Associated with your programme you will be able to access:

- The tutorial system – you will have a personal tutor whom you can meet on request for advice on your programme and choice of options, or for pastoral support
- The ECS Student Advisory Team who provide additional pastoral support
- ECS computer workstations, with a range of manuals and books
- Specialist project laboratories, including infrastructure for large-scale data analysis
- Personal email account and Web access, including the use of online collaboration tools
- Helpdesk (programming advisory)
- Post-graduate demonstrators who provide additional support for your design projects
- A Web site for each taught module, including a summary of the learning objectives, teaching materials and related reading.

## Methods for evaluating the quality of teaching and learning

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You will have the opportunity to have your say on the quality of the programme in the following ways:

Completing student evaluation questionnaires for each module of the programme

- Acting as a student representative on various committees, e.g. Staff: Student Liaison Committees, Faculty Programmes Committee OR providing comments to your student representative to feedback on your behalf.
- Serving as a student representative on Faculty Scrutiny Groups for programme validation
- Taking part in programme validation meetings by joining a panel of students to meet with the Faculty Scrutiny Group

The ways in which the quality of your programme is checked, both inside and outside the University, are:

- Module and programme reports which are monitored by the Faculty according to university guidelines
- Programme validation, normally every five years.
- External examiners, who produce an annual report
- A national Research Assessment Exercise (our research activity contributes directly to the quality of your learning experience)
- Institutional Review by the Quality Assurance Agency

Further details on the University's quality assurance processes are given in the [Quality Handbook](#).

## Career Opportunities

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Data scientists help organisations handle and manage the large amounts of data being produced, released and opened up online thanks to digital technologies. With the ability to generate insights from huge datasets, data scientists can discover stories and phenomena that may otherwise remain hidden, potentially creating opportunities for an organisation to improve, economise or investigate further. Harvard Business Review described the role as ‘The Sexiest Job of the 21st Century’ due to the rare combination of qualities and skills that a trained data scientist possesses.

What jobs does a data scientist do?

Data science has seen an unparalleled expansion in virtually every sector of the economy. As the data-driven economy continues to grow, increasing numbers of organisations require skilled professionals who are capable of handling large datasets to produce valuable insights. Additionally, positions requiring managers who can utilise the resulting analysis to make impactful decisions are becoming increasingly common.

From analysing social data at top companies like Facebook and LinkedIn, to working in areas such as financial services, clinical trials and climate change, there is a wide range of potential jobs available. Graduates from our MSc program are employed worldwide in development, analyst, and consultancy roles in leading companies at the forefront of information technology as well as in many data intensive industries. The program provides an excellent opportunity for entry into the data sciences or similar fields – such as big data, open data, and careers in the following industries would all be suitable:

- Established companies with large quantities of organisational or customer-oriented data looking to spot trends in sales, marketing or operations.
- Start-up companies based around new opportunities to take advantage of the booming data-driven economy;
- Government departments looking to utilise increased amounts of open data to gain crucial insights that can affect policy at the highest levels;
- Research and consultancy companies looking to analyse data and feed these discoveries back to the wider community, as well as to provide training and specialist services to clients.

A data scientist’s prospects

The demand for staff working with big data is predicted to rise by 92% over the 5 years from January 2013 [<http://www.sas.com/reg/gen/uk/eskills-big-data-report>], with the positions advertised in 2013 seeking developers (43%), architects (10%), consultants (10%), analysts (7%) and administrators (5%) [<http://www.e-skills.com/research/research-themes/big-data-analytics/>]. In the UK, big data positions offer a median salary of £55,000 – 24% higher than that for IT staff in general [<http://www.e-skills.com/research/research-themes/big-data-analytics/>]. There are also academic possibilities for doctoral study and academic careers, as there are for entrepreneurial careers.

ECS runs a dedicated careers hub with is affiliated with more than 100 renowned companies such as IBM, ARM, Microsoft, Samsung, and Google. Visit our careers hub for more information.

## External Examiner(s) for the programme

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Name: Professor John Domingue - Open University

Students must not contact External Examiner(s) directly, and external examiners have been advised to refer any such communications back to the University. Students should raise any general queries about the assessment

and examination process for the programme with their Course Representative, for consideration through Staff: Student Liaison Committee in the first instance, and Student representatives on Staff: Student Liaison Committees will have the opportunity to consider external examiners' reports as part of the University's quality assurance process.

External examiners do not have a direct role in determining results for individual students, and students wishing to discuss their own performance in assessment should contact their Personal Academic Tutor in the first instance.

**Please note:** This specification provides a concise summary of the main features of the programme and the learning outcomes that a typical student might reasonably be expected to achieve and demonstrate if s/he takes full advantage of the learning opportunities that are provided. More detailed information can be found in the programme handbook.

## Appendix 1:

Students are responsible for meeting the cost of essential textbooks, and of producing such essays, assignments, laboratory reports and dissertations as are required to fulfil the academic requirements for each programme of study. In addition to this, students registered for this programme also have to pay for:

### Additional Costs

Type	Details
Stationery	You will be expected to provide your own day-to-day stationary items, e.g. pens, pencils, notebooks, etc). Any specialist stationary items will be specified under the Additional Costs tab of the relevant module profile.
Textbooks	<p>Where a module specifies core texts these should generally be available on the reserve list in the library. However due to demand, students may prefer to buy their own copies. These can be purchased from any source.</p> <p>Some modules suggest reading texts as optional background reading. The library may hold copies of such texts, or alternatively you may wish to purchase your own copies. Although not essential reading, you may benefit from the additional reading materials for the module.</p>
Approved Calculators	Candidates may use calculators in the examination room only as specified by the University and as permitted by the rubric of individual examination papers. The University approved models are Casio FX-570 and Casio FX-85GT Plus. These may be purchased from any source and no longer need to carry the University logo.
Printing and Photocopying Costs	In the majority of cases, coursework such as essays; projects; dissertations is likely to be submitted on line. However, there are some items where it is not possible to submit on line and students will be asked to provide a printed copy.

In some cases you'll be able to choose modules (which may have different costs associated with that module) which will change the overall cost of a programme to you. Details of such costs will be listed in the Module Profile. Please also ensure you read the section on additional costs in the University's Fees, Charges and Expenses Regulations in the University Calendar available at [www.calendar.soton.ac.uk](http://www.calendar.soton.ac.uk).