THE UNIVERSITY of EDINBURGH
College of Science & Engineering

Proposal for New Degree Programmes

Stage 2

Contents

THE UNIVERSITY OF EDINBURGH

PROGRAMME SPECIFICATION FOR [*INSERT NAME OF PROGRAMME OF STUDY, e.g.* M.A. Honours in Ancient History *or* M.Sc. in Public Health][1]

PROGRAMME SPECIFICATION

Grey text has been added to provide guidance. Please delete as you add your own text, remove italics, and change the font colour to black.

OVERVIEW	
Awarding Institution	University of Edinburgh
Teaching Institution	University of Edinburgh
Programme accredited by	N/A
Final Award	MSc / PGDip / PGCert
Programme Title	High Performance Computing / High Performance Computing with Data Science
UCAS Code	N/A
Relevant QAA Subject Benchmarking Group(s)	**Computing**
Postholder with overall responsibility for QA	EPCC MSc Programmes Director EPCC MSc Programmes Officer

[1] The information contained in this Programme Specification should be used as a guide to the content of a degree programme and should not be interpreted as a contract.

Date of Production/revision	February 2019

EXTERNAL SUMMARY

200-250 Words

High Performance Computing:

High Performance Computing (HPC) is the use of powerful processors, networks and parallel supercomputers to tackle problems that are very computationally or data-intensive. You will learn leading-edge HPC technologies and skills to exploit the full potential of the world's largest supercomputers and multicore processors. This is a well-established programme that has been successful in training generations of specialists in parallel programming. High Performance Computing is a key area supporting most areas of scientific research and industry.

You will study at EPCC, the UK's leading supercomputing centre and a Centre of Excellence within the University's College of Science and Engineering. EPCC is a major provider of HPC training in Europe with an international reputation for excellence in HPC education and research. Our staff have a wealth of expertise across all areas of HPC, parallel programming technologies, and data science.

This MSc programme has a strong practical focus and provide access to leading-edge HPC systems such as the UK national supercomputing service, currently ARCHER (118,000 processing cores), expected to be replaced during the 2019/20 academic year.

High Performance Computing with Data Science:

Data Science involves the manipulation, processing and analysis of data to extract knowledge, and High Performance Computing (HPC) provides the power that underpins it. High Performance Computing (HPC) is the use of powerful processors, networks and parallel supercomputers to tackle problems that are very computationally or data-intensive. You will learn leading-edge HPC technologies and skills to exploit the full potential of the world's largest supercomputers and multicore processors. This is a well-established programme that has been successful in training generations of specialists in parallel programming. High Performance Computing is a key area supporting most areas of scientific research and industry.

You will learn the multidisciplinary skills and knowledge in both HPC and data science to unlock the knowledge contained in the increasingly large, complex and challenging data sets that are now generated across many areas of science and business.

You will study at EPCC, the UK's leading supercomputing centre. EPCC is the major provider of HPC training in Europe with an international reputation for excellence in HPC education and research.

Our staff have a wealth of expertise across all areas of HPC, parallel programming technologies and data science.

This MSc programme has a strong practical focus and provide access to leading-edge HPC systems such as the UK national supercomputing service, currently ARCHER (118,000 processing cores), expected to be replaced during 2019/20 academic year.

EDUCATIONAL AIMS OF THE PROGRAMME

These programmes draw on EPCC's experience and expertise in the fields of HPC and Data Science, providing students the opportunity to study in a practical way at the supercomputing centre which hosts and manages the UK national supercomputing service.

Both programmes:

- Equip students with an understanding of HPC architectures and technologies.
- Equip students with expertise in advanced tools and techniques for HPC software development.
- Enable students to apply this knowledge in order to exploit modern parallel and multicore computing systems in key scientific and commercial application areas.
- Enable students to develop skills in problem-solving, project management, independent and critical thinking, team work, professionalism and communication.
- Enable students to develop as HPC practitioners, able to apply current and emergent technologies in both industry and research.

MSc in HPC:

- Teach the leading-edge programming techniques required to exploit the power of the world's largest parallel supercomputers.

MSc in HPC with Data Science:

- Teach the core data analysis tools and techniques required to extract knowledge from large datasets using HPC platforms.

PROGRAMME OUTCOMES

Knowledge and Understanding	Students successfully completing the programme should be able to:

	Both programmes: • apply modern programming tools and techniques when writing code; • implement the processes by which high quality software is developed; • develop and execute parallel applications on leading-edge supercomputers; • evaluate the pros and cons of different programming models for modern computer systems; • apply knowledge of how computers work, from hardware up through system software to applications, to develop efficient parallel programs. **MSc in HPC** • experiment with different approaches to a programming problem to arrive at the most efficient solution on a given hardware platform. **MSc in HPC with Data Science** select the most appropriate approach to extract knowledge from large, complex data sets.
Graduate Attributes: Skills and abilities in Research and Enquiry	Graduates from the programme will be able to: • analyse the performance of software in relation to the hardware on which it runs; • explore alternative approaches to a given problem, and integrate different approaches; • quickly assimilate existing work of relevance to a given problem.
Graduate Attributes: Skills and abilities in Personal and Intellectual Autonomy	Graduates will have proven ability to: • plan complex software development and validation tasks by themselves; • deploy their logical, analytical and problem solving skills to develop solutions to technical problems; • show initiative in taking on industrial and academic software development roles; • critically evaluate their own and others' work and ideas.

Graduate Attributes: Skills and abilities in Communication	Graduates will have proven ability to: • communicate effectively through a variety of oral, visual, written, diagrammatic and on-line media; • communicate technical content to a range of different audiences; • work effectively as part of a development team.
Graduate Attributes: Skills and abilities in Personal Effectiveness	Graduates will have proven ability to: • make effective use of learning materials, and acquire and apply knowledge from a variety of sources; • work effectively on large projects, both individually and as part of a team; • organize their workload and manage their time when working independently, and complete complex tasks under deadline pressure.
Technical/practical skills	Graduates will have proven ability to: **Both programmes:** • design and implement software for HPC systems using more than one programming language (e.g. C, C++, Fortran, Python); • master new programming languages and technologies quickly as the need arises; • make well-informed and sensible decisions when designing software for HPC systems; • design and conduct experiments and evaluate their results. **MSc in HPC** • analyse the performance characteristics and limitations of modern parallel HPC systems, including processor technologies such as manycore CPUs and GPU accelerators. **MSc in HPC with Data Science** • apply a range of data analysis tools to practical problems and evaluate their effectiveness.

PROGRAMME STRUCTURE AND FEATURES

Course structure: The programmes are taken as part-time intermittent study with the following timescales depending on intended award:

- Postgraduate Professional Development (PPD): Up to 50 credits taken over up to 24 months.
- Postgraduate Certificate (PGCert): 60 credits taken over up to 24 months
    - Compulsory courses for PGCert in HPC: Practical Introduction to HPC, Message-passing Programming, Threaded Programming, plus 20 credits from a selection of courses.
    - Compulsory Courses for PGCert in HPC with Data Science: Practical Introduction to Data Science, Practical Introduction to HPC, Message-passing Programming, Threaded Programming
- Postgraduate Diploma (PGDip): 120 credits taken over up to 48 months
    - Compulsory courses for PGDip in HPC: Practical Introduction to HPC, Message-passing Programming, Threaded Programming, Programming Skills, Software Development, plus 60 credits from a selection of optional courses.
    - Compulsory Courses for PGDip in HPC with Data Science: Practical Introduction to Data Science, Practical Introduction to HPC, Message-passing Programming, Threaded Programming, Programming Skills, Software Development, plus 40 credits from a selection of optional courses
- Master of Science (MSc): 180 credits (to include 120 taught credits and a 60 credit dissertation project) taken over up to 72 months:
    - Compulsory courses for MSc in HPC: Practical Introduction to HPC, Message-passing Programming, Threaded Programming, Programming Skills, Software Development, Project Preparation, Dissertation (High Performance Computing) plus 50 credits from a selection of optional courses.
    - Compulsory Courses for PGDip in HPC with Data Science: Practical Introduction to Data Science, Practical Introduction to HPC, Message-passing Programming, Threaded Programming, Programming Skills, Software Development, Project Preparation, Dissertation (High Performance Computing with Data Science) plus 30 credits from a selection of optional courses

For further details of compulsory and optional course choices, consult the *Degree Programme Table* at http://www.drps.ed.ac.uk/index.php. DPT attached as Appendix 1.

Entry requirements: A UK 2:1 honours degree, or its international equivalent, in a relevant subject. You must also be a competent programmer, for example in C, C++, Python, Fortran, or Java.

We will also consider your application if you have equivalent work experience.

Progression requirements: To obtain an MSc degree, students must qualify in their second year for entry to third and fourth year as Honours years. This normally requires passes at 50% or above in 80 credits' worth of the taught courses, together with an overall average of 50% on the taught component

Exit awards: The final degree classification for PGCert and PGDip students is based equally on performance across the taught programme. The MSc is classified based on the average of the taught component (120 credits) and dissertation components (60 credits) independently Degrees are classified according to the University's postgraduate standard marking scale with boundaries at 70% (distinction), 60% (merit), 50% (pass: MSc) and 40% (pass PG Cert and PGDip).

Mode of study: Part-time (Intermittent)

Language of study: English

TEACHING AND LEARNING METHODS AND STRATEGIES

This section should include the following:

EPCC courses are characterised by a strong practical focus taught by experienced practitioners in the field. On-campus courses generally have three hours of teaching per week, split either as two hours of lectures and one hour of practical/tutorial or one hour lecture and two hours of practical/tutorial. Online courses would adopt a similar model, with tutorials taking place in time-zone specific slots to make live-access easier for as many students as possible and Collaborate recordings available to students unable to be in the Collaborate Room live. Message/discussion boards such as those within Learn or a Slack channel would be also used to facilitate further intra-class discussion and to allow questions to be answered more in keeping with the timescales required by part-time students.

All students will be given access to appropriate computer systems for practical programming examples. These will be the same systems as used by on campus students, which currently include Cirrus (a 10,000 CPU-core Tier-2 HPC service) and ARCHER (a 100,000 CPU-core Tier-1 national HPC service).

TEACHING AND LEARNING WORKLOAD

Please indicate the typical workload for a student on this programme for each year of study

Start Year	**Time in scheduled teaching (%)**	**Time in independent study (%)**	**Time on placement (%)**
Year 1	20	80	*0*

Year 2	20	80	
Year 3	5	95	
			Add rows as necessary

ASSESSMENT METHODS AND STRATEGIES

Assessment would be undertaken via mixed-mode across the courses of the programme. The programmes' practical focus means many courses would require coding and reports as either significant or partial assessment opportunities.

The following courses will be assessed by such mixed coursework: programming and code submissions with reports, with varying balances depending on the course, and some presentations:

- Message-passing Programming (10 credits, compulsory – usually taken in Semester 2 of year 1 or 2)
- Threaded Programming (10 credits, compulsory – usually taken in Semester 2 of year 1 or 2)
- Programming Skills (10 credits, compulsory – usually taken in Semester 1 of year 1 or 2)
- Software Development (10 credits, compulsory – usually taken in Semester 1 of year 1 or 2)
- Parallel Design Patterns (10 credits, optional – usually taken in Semester 1 of year 2 or later, up to year 5)*
- Performance Programming (10 credits, optional – usually taken in Semester 1 of year 2 or later, up to year 5)*
- Project Preparation (10 credits, compulsory – usually taken in Semester 2 of year 2-5 – final year before progression to MSc)

  *Most students would be expected to take at least one of these two courses and at least one of the two courses marked ** below

The following courses will be assessed via 80-100% exam with at least one opportunity for formative feedback during the Semester (if multiple opportunities possibility of some marks attached to the formative attempts):

- Design and Analysis of Parallel Algorithms (10 credits, optional – usually taken in Semester 1 of year 2 or later, up to year 5)**
- Advanced Parallel Techniques (10 credits, optional – usually taken in Semester 1 of year 2 or later, up to year 5)**

  **Most students would be expected to take at least one of these two courses along side one of the two courses marked *, above.

The following courses will likely be assessed via blended assessment (50% exam, 50% coursework):

- Practical Introduction to High Performance Computing (20 credits, compulsory – usually taken in Semester 1 of year 1 or 2) – n.b. this course is currently 100% coursework, but there is the intention to alter this for 2020/21 at next year's board of studies.
- Practical introduction to Data Science (20 credits, compulsory for HPC with Data Science, optional for HPC – usually taken in Semester 1 of year 1 or 2) – n.b. this course is currently 100% coursework, it is not yet confirmed that this course will definitely move to the blended assessment model, but it considered a strong possibility and this will be considered and changes submitted to the Board of Studies for approval next year.

Design and Analysis of Parallel Algorithms and Advanced Parallel Techniques (both 10 credit optional courses, but most students are expected to

ASSESSMENT METHOD BALANCE

Please indicate the typical assessment methods for a student on this programme for each year of study. Additionally please complete the Assessment matrix.

(Attached)

Please note the below assumes a student taking 60 credits per year over three years for the MSc, whereas in fact a student may take fewer credits that over up to 6 years as the programme is part-time intermittent.

Start Year	**Assessment by written exams (%)**	**Assessment by practical exams (%)**	**Assessment by coursework (%)**
Year 1	Up to 66.67% (40/60 credits depending on course choices/path)	0	33.33% or more (depending on credit load/course choices)
Year 2	Up to 66.67% (40/60 credits depending on course choices/path)	0	33.33% or more (depending on credit load/course choices)
Year 3	0	0	100%
Total	All students would be expected to take a minimum of 30 credits assessed via exam with the majority of students taking 40 credits assessed via examination.		Students may take a maximum of 80 taught credits assessed via coursework plus the 60 dissertation credits.

CAREER OPPORTUNITIES

Graduates from EPCC's on-campus MSc programmes are in high demand from a wide range of companies ranging from multinationals to SMEs both within the UK, Europe, and internationally as well as a strong demand from within academia both as researchers within HPC, computational science fields, data science, and professionally for HPC services and centres underpinning research.

Initial graduate destinations for on-campus students over recent years include: ARM, Intel, Amazon, MathWorks, NCR, Avaloq, Global Surface Intelligence, Boston Ltd, ECMWF, Leonardo, STFC, ICHEC, and, EPCC itself. Many students also go on to further study opportunities, with 8 current University of Edinburgh PhD students being graduates of the programme.

The online versions of the MSc programmes are targeted at audiences unable to attend a full-time and/or on campus MSc, thus it is anticipated to be a career development opportunity for those working in the field: such as the research software engineer community, computational scientists, or for those attempting to retain to access those areas.

OTHER ITEMS

This section ca include other distinctive features of the programme, e.g.

- Especially in first years regular online-specific and joint on-campus/online SSLC meetings to see what works and doesn't work for online vs on-campus so that improvements can be made.
- No overseas placement opportunity unless students take a dissertation project with a partner in their home country.

ABOUT THE PROGRAMME

ADDITIONAL REQUIREMENTS

PRSB Accreditations (where relevant)	*Please note accreditations awarded or planned*
Admissions requirements **Before completing this section please contact a member of the Recruitment and Admissions team for further guidance.**	Discussed with Shannon Hersage in draft form as part of wider assessment of on-campus programmes requirements in September and October 2018. Same as on-campus programmes. Good 2:1 degree in science/computer science or engineering related subject. Competent and keen programmer in one of C, C++, Fortran, Java or Python. Significant work experience may be accepted in place of formal qualifications. Standard English language requirements.
To be completed by R & A Team	*Please select to confirm that a member of the R & A section have consulted on the Admissions requirements.* ☒
Work experience/work based learning opportunities	Students may undertake a dissertation project with an industrial partner for experiential learning opportunities.

CONSULTATION

Student body	Discussed with existing on-campus part-time students (and previous graduate)
External Review/Critical Friend	*In addition to the consultation process at Stage 1 please provide a full summary of the consultation undertaken and the impact this has had on the development of the programme*

ADDITIONAL DOCUMENTS	
Memorandum of Agreement (if applicable)	
Award letter (if applicable)	
DPT (please use your current template)	

APPROVAL

Programme Title:	
Programme Proposer:	

STAGE 1: SCHOOL BOARD OF STUDIES REVIEW AND APPROVAL

Confirmation of approval of the proposal at the School Board of Studies should be entered below.

Date of BoS:
Convener Name:
Comment and Approval (BoS Minute): *Please provide either a link to the minutes of the Board or a copy of the relevant text from the minutes.*

STAGE 2: HEAD OF SCHOOL REVIEW AND APPROVAL

Head of School: *Please print name*
Comment and Approval:
Signature:

STAGE 3: COLLEGE CURRICULUM APPROVAL BOARD REVIEW AND OUTCOME

Date of CCAB:
Convener Name:

Stage 2 Outcome (please select as appropriate)	
Proposal approved ➧ Proceed to *New Programme Request & DPT creation*	☐
Proposal approved with conditions	☐
Proposal rejected with recommendations	☐
Proposal rejected	☐
Comment:	

DOCUMENT CHECKLIST	
Document	**Completed**
DPT	☒
Memorandum of Agreement (if applicable)	☐
Assessment Matrix	☒
Award letter (if applicable)	☐