Programme Title: BSc(Eng) Internet of Things Engineering

Programme Specification (UG)

Awarding body / institution:	QMUL and Beijing University of Posts and Telecoms (BUPT)
Teaching institution:	QMUL and BUPT
Name of final award and programme title:	BSc(Eng) Internet of Things Engineering
Name of interim award(s):	
Duration of study / period of registration:	4 years
QMUL programme code / UCAS code(s):	H6NI
QAA Benchmark Group:	Engineering, but benchmarks subsumed by UKSPEC
FHEQ Level of Award :	Level 6
Programme accredited by:	Institution of Engineering and Technology
Date Programme Specification approved:	
Responsible School / Institute:	School of Electronic Engineering & Computer Science

Schools / Institutes which will also be involved in teaching part of the programme:

Collaborative institution(s) / organisation(s) involved in delivering the programme:

Beijing University of Post and Telecommunications (BUPT)

Programme outline

This programme comes as a response to the increasing research and commercial interest for autonomous and intelligent applications that are based on the principles of the Internet of Things (IoT). This is a comprehensive programme covering all four layer structure which is needed for building complete IoT applications, such as smart grid, smart city, smart home, industrial automation, telemetry, etc.

The programme focuses on computer science's foundation and support, combined with other disciplines, such as microelectronics, communication networks and economics management. It emphasises on the necessary fundamental and practical knowledge for creating, designing, implementing, maintaining, and managing IoT systems. At the same time, it will keep pace with information industry's development in terms of course construction, and constantly adapting to social changes.

In addition to the technology, the programme will also include the key skills aspects already incorporated into the other JP programmes that were specifically commended by the QAA.

Programme Title: BSc(Eng) Internet of Things Engineering

Aims of the programme

The programme sets out provide graduates with:
- a solid fundamental knowledge about telecommunication and computer sciences;
- an understanding of network design and network planning principles for IoT;
- a knowledge of theory, methodology and techniques for IoT network assessment and evaluation;
- a good overall understanding of computer and telecoms network development skills.

This new interdisciplinary programme will provide graduates with a broader employment scope, covering the field of telecoms, computer science and related management.

What will you be expected to achieve?

At the end of his/her degree, each student should be able to demonstrate the following abilities:
• the ability to recall factual knowledge and the ability to apply it in familiar and unfamiliar situations;
• the ability to apply scientific, mathematical and software 'tools' to a familiar or unfamiliar situation;
• the ability to use Information Technology as a key tool pervading all aspects of Internet of Things;
• the ability to understand practical issues concerning real systems (whether hardware or software);
• the ability to recognise insufficient existing knowledge and the ability to search for the necessary scientific, mathematical and software 'tools' relevant to that particular issue;
• the ability to work as part of a team;
• the ability to manage time effectively;
• the ability to appreciate the financial background against which decisions are made in industry;
• the ability to show a certain level of reflection on the role of engineering in society;
and the following skills:
• the perceptive skills needed to understand information presented in the form of technical circuit-diagrams, flow-charts and high-level languages;
• the practical skills needed to implement a piece of hardware or software and to use laboratory test equipment;
• the analytical skills needed to verify the correct behaviour of a hardware or software system or component and to be able to identify faults;
• the design skills needed to synthesise a design (in hardware and/or software) from a specification (including the choice of the best option from a range of alternatives), to implement the design and to evaluate the design against the original specification;
• the written and oral communication skills needed to present information, in particular written information, effectively;
• the critical reasoning skills needed to appraise a particular topic;
• the ability to research and troubleshoot complex issues in such system systematically and communicate their conclusions clearly to specialist and non-specialist audiences.

Context-based aims and objectives:

• To be able to identify and apply the key communications principles (e.g. Shannon equations, queuing theory and information theory) for communications between devices, sensors, actuators and machines at any time in anywhere;
• To be able to use mathematics and statistics to systematic analysis hardware and software IoT systems e.g. use of complex numbers, matrix algebra, differential equations and transform theory to analysis and design the medium access and network routing protocols;
• To be able to apply relevant signal and information processing techniques to analyse and extract sensor information into useful representation for IoT applications;
• To be able to develop, provide and maintain IoT services, infrastructure and products for society, within the constraints imposed by economic, legal, social, cultural and environmental considerations;
• To be able to discuss the current and emerging concept e.g. cloud computing, Web and services middleware, for development of interaction IoT application;
• To be able to identify issues and requirements in the practice of IoT engineering activities, such as ethical issues and safety (e.g. hearing damage prevention);
• To be able to demonstrate the use of appropriate design methodology, programming tools and techniques necessary for structuring IoT applications;

Programme Title: BSc(Eng) Internet of Things Engineering

• To be able to apply essential business management skills for managerial careers in IoT industry and other technology-driven companies at the global level.

Please note that the following information is only applicable to students who commenced their Level 4 studies in 2017/18, or 2018/19

In each year of undergraduate study, students are required to study modules to the value of at least 10 credits, which align to one or more of the following themes:

- networking
- multi- and inter-disciplinarity
- international perspectives
- enterprising perspectives.

These modules will be identified through the Module Directory, and / or by your School or Institute as your studies progress.

Academic Content:	
A 1	[US1] Knowledge and understanding of scientific principles and methodology necessary to underpin their education in their engineering discipline, to enable appreciation of its scientific and engineering context, and to support their understanding of historical, current and future developments and technologies. This LO is covered in many modules across all years of study to provide a solid foundation, reinforce understanding and to appreciate the application of scientific principles.
A 2	[US2] Knowledge and understanding of mathematical principles necessary to underpin their education in engineering discipline and to enable them to apply mathematical methods, tools and notations proficiently in the analysis and solution of engineering problems. This LO is mainly covered in year 1 and year 2 modules to provide a solid foundation, reinforce understanding and appreciate of mathematical principles in IoT related engineering problems. For examples: "Computer Fundamentals and Programming" and "Discrete Mathematics", they emphasise the importance of mathematical on algorithm design, design effective Mathematical model to solve complex problem. This LO is covered in many modules with particular emphasis being given in years 1 and 2 through modules such as: B"Advanced Mathematics 1 & 2", "Linear Algebra" and "Advanced Mathematics 2". Further specialist topics are then addressed in modules such as "Probability Theory and Stochastic Statistics" and "Signals and Systems".
A 3	[EA1] Understanding of engineering principles and the ability to apply them to analyse key engineering processes. This LO is covered in many modules across all years of study to provide a solid foundation for systematic analysis of the IoT engineering and processes. For examples in "Communication and Networks" the use of wireless communication and mathematics principles to analyse the energy efficiency of the networks for IoT applications; and in "Middleware", the key concepts such as client server and P2P are covered in the lectures so that students could develop ideas for middleware in the context of new technologies.
A 4	[EA3] Ability to apply quantitative methods and computer software relevant to the engineering discipline, in order to solve engineering problems. Quantitative methods and computer software are used in many modules to solve IoT related engineering problems. For example in "Communication and Networks", probability distributions is used in evaluating the system performance in given IoT scenarios, and also in BBC6521 "Project", students are required to apply quantitative methods or computer software to solve defined problems that related to IoT.

A5	[EA4] Understanding of a systems approach to engineering problems and to work with uncertainty. This LO is covered in many modules for students to apply systematic approach to solve IoT related engineering problems. For example in "Embedded Systems" takes a system approach to explain and design a microprocessor system that related to IoT application. "Middleware" required students to develop and design a software application using system approach. Meanwhile in "Project", students typically follow a top-down approach, devising a functional specification derived from requirements capture, before proceeding to an implementation and subsequent evaluation.
A6	[D2] Understand customer and user needs and the importance of considerations such as aesthetics. Understand customer and user needs are important aspects in IoT Engineering degree programme. And they are mainly covered in software related modules. Specific examples include "Software Engineering" where students are required to understand the user requirements and needs and develop during the software development process; "Cloud Computing" where students need to have implement user requirements to target customer needs when developing cloud application. In "Project" and "Engineering Environment (IoT)", students need to establish the user/customer needs by carrying out requirement analysis and/or literature survey.
A7	[P6] Awareness of appropriate codes of practice and industry standards. This LO of appropriate codes of practice and industry standards related to IoT engineering discipline is covered in number of modules. For examples in "Communication and Networks" and "Cryptography and Cyber Security" various related standards will be covered in the lectures.
A8	[P7] Awareness of quality issues. The awareness of quality issues are covered explicitly in number of modules. For examples, the quality issues is introduced through "Computer Fundamentals and Programming" and "Personal Development Plan 3" modules where students are required to demonstrate an awareness of quality issues, and consider the quality issues in the Design and Build product development in "Engineering Environment(IoT)". "Middleware" also covers this LO during the design of middleware application.

Disciplinary Skills - able to:	
B1	[US3] Ability to apply and integrate knowledge and understand of other engineering disciplines to support study of their own engineering discipline. This LO is mainly covered in year 3 and year 4 modules to apply and integrate engineering principles to support the study of IoT engineering related discipline. For examples the use of engineering mathematics in "Machine Learning" and "Environment Environment(IoT)" to provide the appreciation of other engineering principles and apply to IoT related engineering problems and scenarios.
B2	[EA2] Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modelling techniques. This is covered in many modules to identify, classify and describe the performance of different systems and protocols for IoT. One example is in "Communication and Networks", the performance of different modulation techniques to different IoT scenarios are analysed, and another example is in "Cloud Computing" which the performances of different cloud infrastructures will be analysed and classified.
B3	[D1] Investigate and define a problem and identify constraints including environmental and sustainability limitation, health and safety and risk assessment issues. This LO is covered by many modules across all 4 years. For examples, the environmental and sustainability limitations are explicitly considered within "Personal Development Plans". Furthermore, students are required to provide environmental and risk assessment reports along with their project final report. Various legal risks are covered in "Internet of Things Engineering Practice" and "Engineering Environment (IoT)".
B4	[D3] Identify and manage cost drivers. Cost drivers are covered in number of modules from year 2 onward. For examples, "Product Development and Management" includes the planning and developing suitable and competitive IoT products and"Engineering Environment(IoT)" explicitly cover how to manage the cost drivers and budget in IoT applications.
B5	[D4] Use creativity to establish innovative solutions. This LO is covered in many modules in IoT Engineering degree scheme to solve and present the innovative solutions related to IoT scenarios. For examples, in "Embedded Systems" students are required to creatively design interactive hardware systems using Keil uVision. More specifically, "Project" are explicitly required the students to use creativity to produce their own solution to a given scenario.

Programme Title: BSc(Eng) Internet of Things Engineering

B 6	[D5] Ensure fitness for purpose for all aspects of the problem including production, operation, maintenance and disposal. This LO is covered in several modules. For instance, In a software context, "Software Engineering" considers the complete software life cycle, including re-usability. Fitness-for-purpose is also implicitly covered in all student project activities, such as "Engineering Environment(IoT)". Environmental impact, including disposal, is a core element of "Project".
B 7	[D6] Manage the design process and evaluate outcomes. This LO covered in many modules in IoT Engineering degree scheme. More specific examples are "Software Engineering" where students are required to monitor the development process to avoid any slippage. Meanwhile "Project" requires students to plan a complex project using tools such as Gantt charts, coping with uncertainly, whilst meeting deadlines. Students must also evaluate their solutions, reflecting on the final outcome.
B 8	[P1] Knowledge of characteristics of particular materials, equipment, processes, or products. This LO is covered in many modules including those specifically related to IoT Engineering discipline. For examples, in "Sensors and Radio Frequency Identification" the architecture of readers and transponders covered in lectures; in "Embedded Systems", various features of different microprocessors and how to choose a proper interfaces or connections for different applications are discussed.
B 9	[P8] Ability to work with technical uncertainty. This LO is covered in number of modules. It is first introduced in "Introduction to Electronic Systems" and "Physics C". It is then apply into more practical environment in "Project" where students required to conduct risk assessment exercises in technical uncertainly. "Middleware" also covers partially this LO in the aspect of resilience issues.
B 10	Ability to produce a coherent technical presentation in written or oral form; This is explicitly addressed in "Personal Development Plans" and "Project".
B 11	Present a coherent argument; covered in a number of modules culminating in the Final Year Project viva in "Project". After the presentation the student is cross-examined to assess aspects such as focal knowledge, context awareness and the appropriateness of the assessment methodology
B 12	Acquire and apply knowledge in a rigorous way to new and unfamiliar situations. This is undertaken in many core technical modules and also business module, where complex situations are explored. Realistic case studies are presented and students use skills and knowledge they have acquired to determine the best course of action.
B 13	Use quantitative data in analysis and synthesis in engineering problems. This is addressed in many modules including: "Communication and Networks" and "Machine Learning".

Attributes:	
C 1	[S1] Knowledge and understanding of commercial and economic context of engineering processes. The LO of the awareness of the commercial and economic aspects of engineering is covered across 3 modules, particularly "Engineering Environment(IoT)" and "Product Development and Management". "Cloud Computing" also addresses this LO as part of the design and implementation processes for cloud computing application under cost and time constraints. Additionally, "Project" contains the budgetary constraints, requiring students to justify expenditure and operate within a commercially constrained environment.
C 2	[S2] Knowledge of management techniques that may be used to achieve engineering objectives within that context. The knowledge of management techniques and develop the students' management skills in term of team working, team playing and communications are explicitly covered in "Cloud Computing". Other modules also incorporate this LO explicitly, for example "Software Engineering" requires students to work as a team to develop an artefact.
C 3	[S3] Understanding of the requirement for engineering activities to promote sustainable development. This LO is covered in number of modules in IoT Engineering degree scheme. For examples in "Cloud Computing" where the energy efficiency aspects of cloud infrastructure and data centres will be discussed and assessed in the exam. And also "Personal Development Plans" integrates part of this LO in the coursework.
C 4	[S4] Awareness of the framework of relevant legal requirements governing engineering activities, including personnel, health, safety, and risk (including environmental risk). This LO is covered by number of modules, specifically in "Personal Development Plan 3" and "Project", where students are required to prepare documentation related legal requirements such as Risk Assessment and health and safety Assessment.

C 5	[S5] Understanding of the need for a high level of professional and ethical conduct in engineering. The understanding of high level of professional and ethical conduct in engineering is covered in many modules. For examples, in "Personal Development Plans 2 and 3" where Engineering Ethics will be covered specifically in the lectures. And also, students in "English Language and Study Skills 1 & 2" and "Communication Skills 1 & 2" are required to team up and present aspects related to social issues and ethics.
C 6	[P3] Understanding of contexts in which engineering knowledge can be applied (e.g. operations and management, technology development, etc). This LO is covered in number of modules. For examples in "Middleware" and "Cloud Computing" underpin the students understanding of how middleware and cloud computing fits into IoT applications such as smart cities and disaster monitoring.
C 7	[P4] Understanding use of technical literature and other information sources. This LO is covered in many modules to develop the skills of technical literature reading and finding. For examples in "Embedded Systems" requires students to refer to the design user manual of common microprocessors in labs; and in "Wireless Sensor Networks", students are required to literature for selecting appropriate sensors for particular IoT applications.
C 8	[P5] Awareness of nature of intellectual property and contractual issues. The awareness of nature of intellectual property and contractual issues are covered in number of modules. For examples in "English Language and Study Skills 1 and 2" require students to practice professional writing and to avoid plagiarism; Meanwhile in "Cloud Computing" students learn about the security and privacy restrictions that cloud computing applications need to comply with in term of intellectual property and contractual issues.

How will you learn?

All taught courses involve lectures, problem solving coursework, laboratory work, case study and independent study. Lectures are used to introduce principles and methods and also to illustrate how they can be applied in practice. Coursework allows students to develop their skills in problem solving and to gain practical experience. Laboratory work provide students with the guidance and help while solving a problem using a wide range of tools and techniques. This allows students to learn-by-doing in order to complement the lectures. QM Graduate Attributes are available for all JP students to identify students' attributes and develop students' knowledge, skills and behaviour that employers' value.

How will you be assessed?

The assessment of the taught course units takes place through a written examination and practical coursework. Some courses also include in-class tests as a component in assessment.

The final year project is examined on the basis of a written report, a formal oral presentation, and a demonstration of the piece of software or hardware developed by the student. In addition to the final year project, other modules introduce projects and group working skills.

Examinations must contribute at least 70% of the overall marks to satisfy IET Accreditation.

How is the programme structured?

Please specify the structure of the programme diets for all variants of the programme (e.g. full-time, part-time - if applicable). The description should be sufficiently detailed to fully define the structure of the diet.

Most modules are shown with a value of 15 credits. This is to simplify the procedure to fit the QM system. EBU modules are actually 44 contact hours instead of 33 so should count for more than 15 credits; BBx modules use Chinese credits that do not map exactly to QM credits. The exception is Personal Development Plan (PDP) which is 1.8. Engineering Environment is a mix of QM and BUPT modules that does not have any specific credits but counts 5% towards the award of Honours and exists in all JP modules, with a slightly different mix depending on programme; PDP counts towards Engineering Environment but does not have any real credits by itself, although it is shown on the transcript.

In addition there are more modules than in a degree in London in order to satisfy Chinese requirements - the module load is not symmetrical across semesters as the technical modules are balanced with the Chinese compulsory modules not shown. All modules are taught in English and every module must be passed for a degree to awarded (Chinese regulations) - so are all shown as core.

Programme Title: BSc(Eng) Internet of Things Engineering

JP programme has two parts: technical content and compulsory courses. The degree is awarded on the basis of the technical content, but the compulsory part must be passed to get a degree to comply with Chinese MoE requirements.

Only modules shown on the QM transcript counting towards the award of Honours are included; Chinese compulsory courses are not shown in detail, nor are short summer semester modules, but these must all be passed for the award of the degree so a pass/ fail module is included to allow that to be handled at QM.

Academic Year of Study FT - Year 1

Module Title	Module Code	Credits	Level	Module Selection Status	Academic Year of Study	Semester
Personal Development Plan 1	EBC3001	5	3	Study only	0	Semesters 1 & 2
English Language and Study Skills 1	BBC3915	15	3	Core	0	Semester 1
Advanced Mathematics 1	BBC4911	15	4	Core	0	Semester 1
Linear Algebra	BBC4913	15	4	Core	0	Semester 1
Computer Fundamentals and Programming	BBC3502	15	3	Core	0	Semester 1
English Language and Study Skills 2	BBC3924	15	3	Core	0	Semester 2
Introduction to Electronic Systems	BBC4102	15	4	Core	0	Semester 2
Advanced Mathematics 2	BBC4921	15	4	Core	0	Semester 2
Physics C	BBC4924	15	4	Core	0	Semester 2

Academic Year of Study FT - Year 2

Module Title	Module Code	Credits	Level	Module Selection Status	Academic Year of Study	Semester
Personal Development Plan 2	EBC4001	5	4	Study only	1	Semester 1
Discrete Mathematics	BBC4114	15	4	Core	1	Semester 1

Programme Title: BSc(Eng) Internet of Things Engineering

Module Title	Module Code	Credits	Level	Module Selection Status	Academic Year of Study	Semester
Signals and Systems	EBU4375	15	4	Core	1	Semester 1
Introduction to Internet of Things	BBC5200	15	4	Core	1	Semester 1
Data Structures	BBU4208	15	4	Core	1	Semester 1
Introductory Java Programming	EBU4201	15	4	Core	1	Semester 2
Probability Theory and Stochastic Statistics	BBC4941	15	4	Core	1	Semester 2
Product Development and Management	EBU5607	15	5	Core	1	Semester 2
Database Systems	EBU5503	15	5	Core	1	Semester 2
Digital Circuit Design	EBU4202	15	4	Core	1	Semester 2
Communication Skills 1	BBC4106	5	4	Core	1	Semester 1
Communication Skills 2	BBC4107	10	4	Core	1	Semester 2

Academic Year of Study FT - Year 3

Module Title	Module Code	Credits	Level	Module Selection Status	Academic Year of Study	Semester
Personal Development Plan 3	EBC5001	5	5	Study only	2	Semesters 1 & 2
Communication and Networks	EBU5212	15	5	Core	2	Semester 1
Machine Learning	CBU5201	15	5	Core	2	Semester 1
Cryptography and Cyber Security	EBU6010	15	6	Core	2	Semester 1
Operating systems	EBU5204	15	5	Core	2	Semester 1

Programme Title: BSc(Eng) Internet of Things Engineering

Module Title	Module Code	Credits	Level	Module Selection Status	Academic Year of Study	Semester
Middleware	EBU6501	15	6	Core	2	Semester 1
Software Engineering	EBU6304	15	6	Core	2	Semester 2
Embedded Systems	EBU5477	15	5	Core	2	Semester 2
Wireless Sensor Networks	BBC6406	15	6	Core	2	Semester 2
Sensors and Radio Frequency Identification (RFID)	EBU6408	15	6	Core	2	Semester 2

Academic Year of Study FT - Year 4

Module Title	Module Code	Credits	Level	Module Selection Status	Academic Year of Study	Semester
Cloud Computing	EBU7501	15	7	Core	3	Semester 1
Smart Infrastructure and Data Architecture	EBU6504	15	6	Core	3	Semester 1
Internet of Things Engineering Practice	BBC6201	15	6	Core	3	Semester 1
Engineering Environment (IoT)	EBC6012	15	6	Core	all years	Semesters 1-3
Chinese Compulsory Topics	BBF7000	0		Core	all years	Semesters 1-3
Project	BBC6521	30	6	Core	3	Semesters 1 & 2

What are the entry requirements?

Pass the minimum entry requirements for BUPT. As a national key university, all entrants to BUPT must score above the top line in the Chinese national entrance examinations. In addition, BUPT's requirement is much higher than that and the level is approximately equivalent to the top 2-3% of the population in China of that age group.

Queen Mary University of London

Programme Title: BSc(Eng) Internet of Things Engineering

How will the quality of the programme be managed and enhanced? How do we listen to and act on your feedback?

The Staff-Student Liaison Committee (SSLC) provides a formal means of communication and discussion between QM and BUPT and JP students. The committee consists of student representatives from each year in JP together with appropriate representation from staff within the QM and BUPT. It is designed to respond to the needs of students, as well as act as a forum for discussing programme and module developments. SSCLs meet twice a semester.

The JP operates an Academic Committee which is responsible under the contract and MoE licence for all matters relating to the delivery of taught programmes at school level including monitoring the application of relevant QM policies and reviewing all proposals for module and programme approval and amendment before submission to Taught Programmes Board. Student views are incorporated in this Committee's work in a number of ways, such as through student membership, or consideration of student surveys.

The JP operates an Annual Programme Review of the taught undergraduate provision. The process is normally organised with the Director and co-Director of JP who responsible for the completion of the school's Annual Programme Reviews. Schools/ institutes are required to produce a separate Annual Programme Review for undergraduate programmes using the relevant Undergraduate Annual Programme Review process. Students' views are considered in this process through analysis of the module evaluations and SSLC comments. In addition BUPT conducts a biannual review of all programmes.

What academic support is available?

Induction and pastoral support is provided through BUPT. Students are organised into "classes" of 30 as in the usual Chinese model. Each class has a tutor who provides pastoral support. One male and one female tutor sleep on campus every night so there is 24/7 access to pastoral support.
Feedback mechanisms from students are: (i) directly to the lecturers (ii) to their tutor (as described above) and (iii) through an SSLC that meets twice a semester. Because of the large numbers of students, a separate SSLC is held for each cohort.

For every module, whether taught by QM or BUPT, formal office hour or tutorial slots are provided. In addition QM staff can give advice and supervision remotely using a variety of techniques including Skype, Microsoft Teams and Zoom conferencing system.

How inclusive is the programme for all students, including those with disabilities?

This module will be delivered to BUPT JP students at BUPT campus. The learning outcomes for the module are clearly stated in the module descriptor. The teaching is expected to be delivered in person at BUPT campus. The lectures will not be recorded but all electronic materials will be available on QMPlus, including the reading list. The SensusAccess tool will be used if necessary.

A specific disabled students support that complies with Chinese law is applied to this programme since the students are physically in China.

Programme-specific rules and facts

The Special Regulations for the JP apply to this programme.

Links with employers, placement opportunities and transferable skills

There is an industrial advisory committee consisting of senior staff from the Chinese Telecommunications industry. An Industrial Liaison officer is part of the JP team to develop links with industry and industrial projects, to ensure that projects are appropriate and to monitor their progress. A good industrial project provides excellent experience for an engineering undergraduate. There is a compulsory internship for all year 3 summer students and frequent invited industry lectures to year 3 and 4 students.

Programme Title: BSc(Eng) Internet of Things Engineering

To date the JP has a record of 100% employment or PG education with most JP graduates (>80%) go on to PG education.

Programme Specification Approval

Person completing Programme Specification:	Matthew Tang
Person responsible for management of programme:	Michael Chai
Date Programme Specification produced / amended by School / Institute Learning and Teaching Committee:	
Date Programme Specification approved by Taught Programmes Board:	

Queen Mary University of London