UNIVERSITY of BRADFORD

Faculty of Engineering and Informatics

Department of Computer Science

MSc Internet of Things Programme Specification

Academic Year	**2021/22**
Degree Awarding Body	**University of Bradford**
Final and interim awards at Level 7 FHEQ (Framework for Higher Education Qualifications in England)	**Degree of Master of Science** **Postgraduate Diploma** **Postgraduate Certificate**
Programme accredited by	**BCS The Chartered Institute for IT**
Programme admissions	**September**
Programme duration	**12 months full-time,** **24 months part-time**
QAA Subject benchmark statements	**Computing (2016),** **Master's degrees (2010)**
Date last confirmed by Faculty Board	**January 2021**

Please note: This programme specification has been published in advance of the academic year to which it applies. Every effort has been made to ensure that the information is accurate at the time of publication, but changes may occur given the interval between publishing and commencement of teaching. Any change which impacts the terms and conditions of an applicant's offer will be communicated to them. Upon commencement of the programme, students will receive further detail about their course and any minor changes will be discussed and/or communicated at this point.

Introduction

Over 50 billion devices around the globe are connected to the Internet. 75% of companies explore how to adapt their business operations to benefit from the Internet of Things (IoT) IoT is worth billions to the UK's economy, with efficiency benefits, innovation benefits and business creation benefits estimated to be close to 3% of UK gross GDP in 2020.

IoT is considered the base of the second digital revolution. IoT technologies allow everyday objects to communicate with each other over the Internet on a large scale, with enormous potential to change many aspects of our lives: Smart Cities, Industrial Internet of Things (IIoT), Self-Driving cars, Smart Grids, Smart Homes and Buildings, Smart Infrastructure, Smart Agriculture, Smart Health, Smart Mobility are some of the application areas continuing to drive the phenomenal growth of IoT to a mainstream technology.

> *"**A lack of Internet of Things skills and knowledge** among employees and management is viewed by the businesses as **the biggest obstacle to using the IoT more extensively.**" FROM "A QUIET REVOLUTION GATHERS PACE: THE INTERNET OF THINGS BUSINESS INDEX" (ECONOMIST INTELLIGENCE UNIT REPORT, 2013)*

Despite the growth of the industry over the last 7 years, there is still a shortage of professionally qualified IoT specialists. This postgraduate programme aims to deliver that precise need, preparing graduates with cutting edge knowledge and expertise in the

modern world of IoT and smart cyber physical systems. It will give graduates a unique advantage in the job market with expertise in:

- development of Smart Cyber Physical Systems.
- designing efficient communication and data management techniques.
- state-of-the-art data science techniques and Big Data processing tools for handling large, complex and real-time data.
- handling unique security and privacy challenges in IoT systems.
- understanding international issues related to the development of smart cities and other smart systems.
- developing IoT systems with consideration for human factors and fitness for interfacing with humans.
- research and development in IoT in the context of real-world projects.

On this MSc course, unique and challenging modules will focus on IoT programming, IoT application development stack, systems for big data analytics, statistical data analysis, data mining, privacy and security, advanced programming for mobile devices, and advanced IoT with data science. All modules are designed to encompass the overarching themes of IoT, delivering research-informed teaching in lectures, tutorials, and laboratory sessions.

Students will have the opportunity to work in state-of-the art labs including Internet of Things (IoT) Innovation Lab, Computing Enterprise Centre, and Ethical Hacking lab. You will also have excellent opportunity to carry out a dissertation project with national and international clients through these labs.

The teaching delivery team includes internationally renowned researchers and practitioners from all the relevant IoT areas, including sensors, communication, data engineering, data storage, big data analytics, cyber security and visualisation. We have secured multi-million-pound research funding in IoT related projects, ensuring you will be exposed to innovative knowledge and case studies through teaching content and the student projects linked to these projects.

Our IoT related projects are funded by European (European Union, European Space Agency), International (Newton, NASA) and UK research councils (Innovate UK) in the following topics:

- Smart cities (European Union)
- 5G (European Union)
- Big data (Innovate UK, EU)
- Visualisation (NASA, European Space Agency, NHS, Innovate UK)
- Digital Healthcare (Newton Fund)
- Cyber Security (Innovate UK, West Yorkshire Police)

Our teaching is research-led, and you will have opportunity to learn from these real-world, cutting-edge live projects. In addition, the researchers teaching this course work closely with two national centres located in Bradford: Digital Catapult Centre, and Digital Health Enterprise Zone (DHEZ) giving you access to the events and projects originating from these centres.

This course is also strongly aligned with the strategic academic themes of the University giving students benefit of the inter-disciplinary research carried out in the university:

Programme's Focus Themes	Related University Strategic Theme(s)
IoT for Healthcare	Advanced Healthcare
IoT for Smart Cities	Sustainable Societies
IoT for Industry 4.0	Innovative Engineering

Programme Aims

The programme is intended to:

- Enable graduates to develop deep knowledge and expertise in the modern world of IoT and smart cyber physical systems.
- Provide industry with graduates able to develop solutions to address challenges in developing complex IoT and smart cyber physical systems.
- Prepare graduates to carry out research in IoT systems.

Admission Requirements

We take into consideration a number of factors when assessing your application. It's not just about your grades; we take the time to understand your personal circumstances and make decisions based on your potential to thrive at university and beyond.

Academic admission requirements

Applicants are expected to possess a good Honours degree (normally 2:2 or above) in computer science, computer engineering, informatics or other computer-related subjects from an approved degree-awarding body.

In addition, for students whose first language is not English, a test of written and spoken English normally needs to have been passed at grade 6.0 for IELTS or 550 for TOEFL (or 250 for the computer-based test) or above. If you do not meet the IELTS requirement, you can take a University of Bradford pre-sessional English course. See the Language Centre for more details: www.brad.ac.uk/courses/other/pre-sessional-english-language-programme.

Please note: The information above relates to the contemporary recruitment cycle at time of publication and therefore may now be out of date. The current entry requirements are published online at www.bradford.ac.uk/courses/pg/internet-of-things.

The University of Bradford has always welcomed applications from disabled students, and these will be considered on the same academic grounds as are applied to all applicants. If applicants have some form of disability, they may wish to contact the Disability Service before they apply at www.bradford.ac.uk/disability/before.

Recognition of Prior Learning

Applications are welcome from students with non-standard qualifications or mature students (those over 21 years of age on entry) with significant relevant experience.

If applicants have prior certificated learning or professional experience which may be equivalent to parts of this programme, the University has procedures to evaluate and recognise this learning in order to provide applicants with exemptions from specified modules or parts of the programme.

Programme Learning Outcomes

To be eligible for the award of **Postgraduate Certificate** at FHEQ level 7, students will be able to:

1. Demonstrate a systematic understanding and critical awareness of discipline knowledge in IoT systems development.
2. Demonstrate an understanding of advanced techniques applicable to their research and development projects on IoT applications.
3. Demonstrate ability of evaluating existing methodologies in the literature and proposing new methodologies for addressing challenges of IoT systems development.
4. Communicate the results and conclusion on IoT systems development clearly to specialist and non-specialist audiences.
5. Demonstrate the independent learning ability required for continuing professional development.
6. Demonstrate ethical implications of technological advancement and usage with regard to the Internet of Things.

Additionally, to be eligible for the award of **Postgraduate Diploma** at FHEQ level 7, students will be able to:

7. Deal with complexity in IoT projects for design, development and deployment.
8. Demonstrate originality in the application of principle and knowledge on IoT stack and analytics, together with a practical understanding of applying IoT stack and analytics to generate new knowledge in the discipline.

Additionally, to be eligible for the award of **Degree of Master** at FHEQ level 7, students will be able to:

9. Demonstrate skills to select, design, plan and manage a self-directed and managed research-informed original project, demonstrating a critical analysis and evaluation of relevant material and the ability to apply relevant skills and research methodologies in the production of an advanced report.

Learning and Teaching Strategy

The programme utilises a range of learning methods to offer a personalised, research-led, and digitally rooted learning experience with a holistic, international focus. At the centre of this strategy is the focus on problem-solving through the use of creative, analytical,

logical and innovative thinking, and through networking and communicating effectively with peers.

The teaching delivery team includes internationally renowned researchers and practitioners from all the relevant IoT areas, including sensors, communication, data engineering, data storage, big data analytics, mobile application development, cyber security and visualisation. We have secured multi-million-pound funding in IoT related projects, ensuring you will be exposed to innovative knowledge and case studies. Our teaching is research-led, and you will have opportunity to learn from these live, real-world projects.

Formal lectures will facilitate your acquisition of knowledge and understanding, discipline specific skills, and apply this learning to industry practices. Laboratory sessions, using three state-of-the-art, purpose-built laboratories run in conjunction with the theoretical components, give you the opportunity to enhance your understanding of particular topics. The unique teaching content and delivery on the course is extremely well supported with state-of-the-art, special purpose labs including IoT Innovation lab, Ethical Hacking lab and Computer Enterprise Centre. These will also help to develop discipline-specific skills and personal transferable skills.

In addition, the research and development carried out in these labs and the case studies from the publicly funded high profile projects, ensures that the content is fresh and pioneering. We also integrate knowledge and experience from Industrial partners through both our Industry Advisory Board and these research projects through challenging case studies, lab-based activities and invited talks, ensuring that research findings are at the heart of our curriculum. This new programme will also involve invited external speakers from various industry sectors. This ensures you will be exposed to the very latest and future developments.

In addition to the standard technology-enhanced learning approaches, we embed technologies to deliver key concepts in an interactive environment that enhances your experience in developing IoT products. For example, extensive use of simulation for product design and use of cloud and big data testbeds to support hands-on learning.

Assessment Strategy

Assessment for this programme is designed to develop research and development skills in the area of IoT in addition to more generic professional transferable skills such as critical thinking, team working, communication, leadership and decision- making. The overarching theme of the assessment on the programme is to support learning by offering you plenty of opportunities to receive feedback through formative assessment components, and by linking the assessments to real-world use cases and problems. The assessment strategies include group/collaborative work, individual assignments, examinations, research paper/report writing, and lab- based exercises. The final project/dissertation provides a significant opportunity to demonstrate your capability and skill in IoT systems development.

Curriculum

The programme has two stages: the taught programmes stage which takes place during the first two semesters (or four semesters for the part-time route), and the project/dissertation stage. The taught programmes stage is organised on a modular basis. All modules are assessed at FHEQ Level 7.

The programme has modules in the Autumn and Spring periods providing grounding and advanced study of the field. The final two semesters allow students the opportunity to develop, through sustained major project work, advanced knowledge and understanding of internet of things.

The curriculum may change subject to the University's programme monitoring and review procedures.

Programme structure

Module Code	Module Title	Module Type	Credit	Study Period
COS7039-B	Internet of Things (IoT)	Core	20	Autumn (Sem1)
COS7025-B	Mobile Application Development	Core	20	Autumn (Sem1)
COS7006-B	Big Data Systems and Analytics	Option	20	Autumn (Sem1)
COS7009-B	Software Development	Option	20	Autumn (Sem1)
COS7046-B	Big Data Visualisation	Option	20	Autumn (Sem1)
COS7043-B	Advanced IoT (Data Science for IoT)	Core	20	Spring (Sem2)
COS7048-B	MSc Group project	Core	20	Spring (Sem2)
COS7045-B	Advanced Machine Learning	Option	20	Spring (Sem2)
ENB7007-B	Risk Assessment and Management	Option	20	Spring (Sem2)
COS7004-E	Dissertation	Core	60	Spring & Summer (S2-3)

Students will be eligible to exit with the award of **Postgraduate Certificate** if they have successfully completed 60 credits and achieved the award learning outcomes.

Students will be eligible to exit with the award of **Postgraduate Diploma** if they have successfully completed at least 120 credits and achieved the award learning outcomes.

Students will be eligible for the award of **Degree of Master** if they have successfully completed at least 180 credits and achieved the award learning outcomes.

Assessment Regulations

This Programme conforms to the standard University Postgraduate Assessment Regulations which are available at the following link: www.bradford.ac.uk/regulations.

Minor Modification Schedule

Version Number	Brief Description of Modification	Date of Approval
4	Revised curriculum structure based on BCS accreditation visit, and student/industry feedback	**March 2020**
5	Revised presentation updated formatting and specification made accessible. Updated text to accommodate January starts.	**January 2021**
6	Annual changes for 2021 academic year	**June 2021**