UNIVERSITY of BRADFORD

Faculty of Engineering and Digital Technologies

https://www.bradford.ac.uk/courses/pg/satellite-systems-engineering/

MSc Satellite Systems Engineering Programme Specification

Academic Year:	**2023-24**
Degree Awarding Body:	**University of Bradford**
Partner(s), delivery organisation or support provider (if appropriate):	
Final and interim award(s):	MSc Satellite Systems Engineering Postgraduate Diploma Satellite Systems Engineering Postgraduate Certificate Satellite Systems Engineering
Programme accredited by (if appropriate):	
Programme duration:	1 year
QAA Subject benchmark statement(s):	Engineering
Date last confirmed and/or minor modification approved.	

Introduction

October 1957 is the day that marked the beginning of the Space Age: the first man-made satellite, Sputnik, was launched into space by the Soviet Union and transmitted a signal to Soviet scientists on the ground for three weeks. More than 60 years on, space missions have been extended from purely scientific exploration to now providing indispensable navigation, environmental monitoring, communication, and TV systems worldwide.

Satellites have been one of the government's eight great technologies since 2010. It is one of the UK's fastest growing sectors and a vital part of the UK's economy, with a projected annual income of over £16.4 billion and employing over 45,000 people in diverse and

exciting roles as scientists, engineers, entrepreneurs, and innovators in the UK. The global space economy is projected to grow to £490 billion by 2030.

The critical role that space plays in our daily lives has often been taken for granted. Satellites orbiting at a distance above 160 km from the Earth connect us with our friends, families, and colleagues, monitor the climate and forecast the weather, enable road and ocean navigation, support homeland security and disaster relief and many more. By gathering CO_2 emission data efficiently and routinely on a global scale, satellites can hold countries to their emissions promises made at COP26 summit.

Artificial intelligence (AI) is also gaining momentum and is impacting our daily lives. For example, Twitter, Facebook, Instagram have all used AI to enhance customer experience, improve their products, fight cyberbullying, and delete offensive comments. AI is identified as one of the most sought-after skills in many business sectors. It has become increasingly important in future satellite systems and space science development. Apart from applying AI to analyse data gathered by satellites, satellite payloads *and* design can also exploit AI to support the operation of large satellite constellations, including relative positioning, communication, and end-of-life management.

The goal of this MSc course is to respond to the fast-growing satellite, telecommunications, and AI applications industries and equip students with readily employable specialist knowledge and transferable skills needed to enhance their careers or to start a new career in these sectors of industry.

In this exciting course, students will acquire both technical and non-technical skills. Among the technical skills, students will learn the space dynamics to understand how a constellation of satellites can orbit the earth. In addition, students will also study the different principles, functions, components, and applications of the three pillars of satellite systems, namely communications, earth observation, and navigation, as well as the ground system that communicate with the satellites. How AI and machine learning can be applied to satellite system design and different satellite applications will be investigated. Theoretical knowledge will be further consolidated through practical group projects to design and implement different satellite payloads for communications, earth observation, and navigations (possibly with intelligent functions) on miniaturised satellites, or to design and implement a satellite ground station to receive satellite signals. Apart from group projects, students can further enhance their theoretical knowledge, practical experience, use of specialist software and simulation packages such as Matlab, CST, Weka, TensorFlow, Python with PyCharm, Arduino programming through research-based individual MSc projects. Students will have the opportunity to conduct MSc projects created and supervised by staff from Airbus and/or the Satellite Applications Catapult. Students will also learn ethical and responsible use of satellite systems and AI for the good of humanity. Furthermore, how satellite systems improve the quality of lives in a global context will be studied and discussed through formal lectures and group discussions. Students will also acquire technical signals (supported by both software and hardware-based laboratories) in radio frequency engineering, wireless communication systems, and digital signal processing systems.

Transferable soft skills such as interpersonal, communications, team working, analytical and problem solving, project management and entrepreneur skills are embedded into small

group projects within the 20-credit modules. In addition, communications, presentation, and project management skills will be further consolidated through individual MSc projects.

The University of Bradford has a long and established track record in satellite research and applications that started in the1980s. It is a member of the European Space Agency funded Satellite Network of Experts, and pioneered and developed the Automated Solar Activity Prediction system for space weather prediction in collaboration with NASA and the European Space Agency. The university academic team has extensive experience and expertise in RF engineering, antenna design, satellite imaging, satellite integration with terrestrial mobile networks. They will be supported by industry experts to deliver this exciting programme. Students will benefit from state-of-the-art facilities provided by the Bradford-Renduchintala Centre for Space AI including a teaching lab, a project lab, a cleanroom, and nano and pico satellite engineering models together with a suite of software platform and packages.

The programme is endorsed by the Satellite Applications Catapult. The Catapult will co-supervise up to two 3–6-month student placement(s) each year to support the programme (with a cash contribution of up to £18k per annum, paid as stipend directly to the student). In addition, students from this programme will have access to the Catapult's Internship programme, which will offer MSc graduates the opportunity to apply for a graduate placement at the Catapult for up to 18 months (up to £40k per annum, paid directly to the intern). Similarly, Airbus also supports this MSc programme, providing possibility for placements for students who select projects proposed by Airbus. Seminars featuring invited speakers from relevant industries will be held to better equip students for a career in industry as well as enhancing their innovation and entrepreneurship skills.

Students will further be able to develop their employability skills via timetabled careers sessions delivered by the Faculty Link Career Consultant. These sessions will focus on supporting students in their placement/graduate applications. Students will also be able to access various services provided by Career and Employability Services through their platform 'Handshake' e.g., events (fairs and webinars/workshops), jobs and one-to-one appointments (CVs, interviews and assessment centres preparations, online selection tests etc.)

Programme Aims

The programme is intended to:

1. provide telecommunication and satellite/space professionals, physicists, mathematicians, graduate analysts, AI technologists with specialist and transferable knowledge and skill sets needed to enhance their careers or to start a new career in the satellite/space/telecom/RF industry.
2. provide students with specialist understanding of artificial intelligence (AI), relevant AI tools and its applications in satellite systems and missions.
3. provide students with specialist understanding of the different functions, components, and architecture of the three pillars of satellite systems, namely communications, Earth observation, and navigation.
4. provide students with hands-on experience to design satellite payloads and to programme using nano and pico satellite engineering models for potential satellite missions.

5. Develop students' skills in entrepreneurship and innovation.
6. equip students with the advanced technical skills and associated tools and skills to be readily employable in this exciting and growing area.

Programme Learning Outcomes

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

1. Apply knowledge and new insights of key engineering principles underpinning satellite system design.
2. Exercise initiative and personal responsibility, which may be as a team member or leader to meet professional and technical objectives.
3. Demonstrate critical understanding of and apply a high level of professional and ethical conduct in engineering, evidencing business and management practices relevant to engineering and IT professionals.
4. Communicate effectively outcomes of practical work, draw conclusions from and present the results to specialist and non-specialist audiences.
5. Demonstrate self-directed and independent learning, as well as originality of thought to generate innovative system designs to fulfil new needs.

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

6. Evidence the consideration of the key design parameters, constraints (e.g. regulatory, technical, computational resources) and applications requirements for intelligent and/or satellite systems to deliver different services for communications, earth observation and navigation.
7. Select, apply and/or combine advanced engineering methods and/or software tools to help generate innovative and optimized solutions.
8. Critically appraise the vulnerabilities and ethics involved in the application of satellite and/or AI technologies.
9. Integrate engineering knowledge and insight to make system trade-offs to determine payload architecture.
10. Critically evaluate current problems, synthesise knowledge of engineering design principles and techniques, formulate and implement a programme of work to tackle the problem and allocate different roles within an engineering team.

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

11. Plan, implement, monitor, and adjust on an on-going basis, a self-directed individual research programme of work, demonstrating skills in information or data collection and critical analysis of research data, use or adaptation of appropriate analysis tools

to tackle unfamiliar problems (e.g. those with uncertain or incomplete data or specification), innovation, and application of relevant skills, reflection, and research methodologies in the production of an advanced technical report.

Curriculum

Autumn Semester

FHEQ Level	Module Title	Core/ Option/ Elective	Credits	Study Period	Module Code
7	Space Dynamics & System Design	C	20	1	ELE7033-B
7	RF and Wireless Systems	C	20	1	ELE7039-B
7	Communication Satellite Systems	C	20	1	ELE7035-B

Spring Semester

FHEQ Level	Module Title	Core/ Option/ Elective	Credits	Study Period	Module Code
7	Earth Observation Satellite Systems	C	20	2	**ELE7036-B**
7	Ground Satellite Systems	O	20	2	**ELE7037-B**
7	Digital Signal Processing Systems	O	20	2	**ELE7040-B**
7	**Industrial Big Data Analysis and Mining**	**C**	**20**	**2**	**COS7050-B**

Summer Semester

FHEQ Level	Module Title	Core/ Option/ Elective	Credits	Study Period	Module Code
7	**MSc Project**	**C**	**60**	**1,2,3**	**ENG7002-E**

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 180 credits and achieved the award learning outcomes.

THESE AWARDS DO NOT AUTOMATICALLY CONFER ELIGIBILITY TO REGISTER WITH THE INSTITUTE OF ENGINEERING AND TECHNOLOGY OR PROVIDE CHARTERED ENGINEER STATUS.

Learning and Teaching Strategy

The proposed MSc programme is designed in line with the University's Learning, Teaching and Student Experience Strategy (LTSES), which is committed to equality and diversity, inclusion, and social mobility, and to empower students to realise their potentials, fulfil their ambitions and make a positive impact in the world. This is achieved through the highest level of inclusivity in curriculum design, learning experience activity and learning community environment.

The programme is delivered by university academics with significant support from external experts, who have ample research and industrial experience in this field to ensure that the curriculum is led by research and engaged with the latest research outcomes in this area. The modules follow the latest research and industrial trends. Research elements are integrated into each module through which students will be assessed on their research, technical and professional skills (team work, report writing, presentation, etc.) through group projects.

Students will benefit from a suite of digital teaching and collaborative platforms supported by the University including CANVAS, Horizon, Teams. They will also benefit from hands-on hardware-based laboratories in the RF & Wireless Systems, and Digital Signal Processing Systems modules. Student experience will be further enhanced by facilities provided in the state-of-the-art teaching laboratory, where a cleanroom for the construction of cubesat/pocketqube and a small-scale Telemetry, Tracking and Command system will be developed. Group projects will be created in various modules to consolidate understanding of how technologies have evolved and contributed to the next generation of satellite systems.

Assessment Strategy

Our assessment strategy is inclusive and aligned with the University's LTSES. Assessment is a key part of the student learning process and is designed to incorporate a wide range of different methods to meet the needs of students and industry as well as the accrediting bodies. Our diverse assessment prepares students for work in a professional and industrial environment, academic research, or entrepreneurship.

There are two forms of assessment: formative and summative. Formative assessment provides an opportunity for students to receive feedback during their learning. This promotes reflective thinking leading towards an enhanced knowledge. All the modules have some formative assessment, and this may take different forms such as discussions or questioning from their tutors, class tests, presentations, and practical activities. These formative activities are crucial if students are to make best use of their learning experience and they are designed to prepare students for their summative assessment. Summative assessment is how we grade the work on a module and the details of this assessment are available from the beginning of the module so that students understand how their grade is determined.

Summative assessment is mostly through a combination of formal individual/group report for group projects, presentations, and written examinations depending on the module. For group projects, peer assessment will be applied. These methods of assessment not only assess subject-specific knowledge and skills, but also a suite of transferable skills that provide students with a competitive edge when they graduate. Because of the nature of the module delivery, the final assessments for the modules may not necessarily be at the end of the semester.

Assessment Regulations

This Programme conforms to the standard University Taught Postgraduate Regulations, which are available at the link: www.bradford.ac.uk/regulations with the following exceptions to these regulations as listed below:

1. To gain an accredited MSc award, students must achieve 30% or more in assessment components worth above 30%. Students who achieve a mark of 40% or more for a module, but fail to achieve 30% in a qualifying component, will be permitted supplementary assessment in line with the University Postgraduate Assessment Regulations.

2. Students must achieve 180 credits in total, comprising 160 credits at 50% or above and 20 credits at 40% or above.

3. Students who achieve a mark between 40%-49% in up to 60 credits worth of modules will be permitted one supplementary assessment attempt to support them to remain on the accredited MSc with no more than 2 attempts in any module.

If the above requirements are not met, but the University's taught postgraduate regulations are complied with, then a non-accredited MSc will be awarded, MSc Engineering (Satellite Systems).

Admission Requirements

The University welcomes applications from all potential students and most important in the decision to offer a place is our assessment of a candidate's potential to benefit from their studies and of their ability to succeed on this particular programme. Consideration of applications will be based on a combination of formal academic qualifications and other relevant experience.

The standard entry requirements for the programme are as follows:

1. At least a lower second class (2:2) degree or equivalent in electrical & electronics engineering, telecommunications engineering, computer science, physics, mechanical engineering, or mathematics from an approved degree-awarding body.
2. Candidates who do not fulfil the normal entry requirements but have extensive industrial experience in a related area, for example communications and RF engineers, satellite engineers, computer scientists/software programmers, are considered on an individual basis.
3. International students must have a 6.0 overall score on IELTS test of English (with no sub-test less than 5.5) or an equivalent score on another recognized test.

Recognition of Prior Learning

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.

Minor Modification Schedule

Version Number	Brief description of Modification	Date of Approval (Faculty Board)
2	Updated for delivery in 23-24, including two new modules.	