UNIVERSITY of BRADFORD

Module Descriptor

Module Details	
Module Title	Space Dynamics and Systems Design
Module Code	ELE7033-B
Academic Year	2024/5
Credits	20
School	School of Computer Science, AI and Electronics
FHEQ Level	FHEQ Level 7

Contact Hours	
Type	Hours
Tutorials	6
Tutorials	This module aims to provide basic tools and professional knowledge of satellite systems engineering based on consolidated industrial experience. This will allow students to gain broad, top-level insight, which will support their learning in the other modules of the MSc programme. This module will introduce the principles of satellite orbits, dynamics, and manoeuvres to provide a fundamental background to understanding spacecraft capabilities, performance, and behaviour. Certain satellite subsystems will also be covered in greater depth. This module will provide a comprehensive overview of how space projects are conceived, developed, and managed. There will be an emphasis on how space projects have improved the quality of life in a global context, especially in developing countries. This module will include technical engineering discussions where students will gain understanding of key elements of satellite systems architectures, design drivers, and criticalities. Several use cases for LEO and GEO systems will be used to highlight the application of such concepts to provide the students a view into industry operations. This module will give students the opportunity to apply and demonstrate their new understanding and skills through group project work.
Tutorials	Learning and Teaching will be directed, supported, and reinforced through a combination of face-to-face or online lectures, practical tutorials, as well as through directed and self-directed study supported by learning materials available on Canvas. Face-to-face or online drop-in sessions will be scheduled to assist students who required extra support. Tutorials will include using the industry-standard software package Ansys STK to illustrate various concepts introduced in lectures, and to demonstrate the use of digital tools in modern satellite mission design. Revision sessions and additional tutorial sessions will be arranged upon request by students. The module will be wholly delivered during Semester 1 and assessed through a combination of a Group Project, Presentation, and an Open Book exam. Students will be briefed on their Group Project assignment at the beginning of the Semester and can start work on it straight away. The Open Book exam will be scheduled during the January examination period, giving students time to properly prepare for it. Lectures and tutorials will be recorded for students who may not be able to attend the face-to-face sessions. In the event of face-to-face delivery not being possible, recorded synchronous online or pre-recorded lectures will be delivered and uploaded to Canvas to support students learning. Synchronous online tutorials will be scheduled for the work involving STK. The Group Project will consist of a feasibility study for a specific use-case, with students working in groups of 4 or 5. This activity is intended to strengthen the knowledge base acquired in the lectures and tutorials, encourage teamwork, and practise higher-order technical and soft skills. This teamwork will be assessed through a group presentation, where each member of a group will present their individual contribution. Finally, an open book written examination will be used to assess students technical understanding of the module. This module satisfies the below Learning Outcomes as specified by the Accreditation of Higher Education Programmes: Fourth Edition (AHEP4) as published by The Engineering Council in line with the UK Standard for Professional Engineering Competence (UK-SPEC). These outcomes specify five key areas of learning at Masters level: Science and Mathematics (SM), Engineering Analysis (EA), Design and Innovation (DI), The Engineer and Society (ES), and Engineering Practice (EP). SM-M1; EA-M2, M4; ES-M7; EP-M16, M17 This module also equips the students with the following Competencies defined in the Space Competencies Recognition and Assessment Framework Tool, published by the Space Skills Alliance: SCF-2, SCF-8, SCF-10, SCF-11, SCF-12, SCF-27, SCF-48, SCF-50, SCF-52, SCF-54, SCF-55, SCF-56. Summative Assessment - A timed examination that takes place on-campus, with all students sitting the exam in the same place and at the same time. Students may bring specified books/other resources into the exam. Supplementary - A timed examination that takes place on-campus, with all students sitting the exam in the same place and at the same time. Students may bring specified books/other resources into the exam.
Tutorials	Spacecraft dynamics and space environment: concepts of orbital and attitude dynamics, including multibody dynamics and Earth-Space environment effects. Space missions: typical lifecycle processes for space projects with highlights on applicable space standards such as ECSS and CCSDS. Spacecraft systems architectures: typical GEO/MEO/LEO satellite systems architecture definitions including an overview of main subsystems, such as avionics, on-board data handling, thermal, mechanical, electrical, propulsion, etc. Spacecraft systems design: typical design drivers and trade-offs. Spacecraft avionics: main functions and design drivers, typical solutions. Space

Type	Hours
	technologies: overview of state-of-the-art technologies and comparison between Old Space and New Space approaches.
Directed Study	160
Project Supervision	6
Seminars	6
Lectures	22

Availability	
Occurrence	Location / Period
BDA	University of Bradford / Semester 1

Module Aims

This module aims to provide basic tools and professional knowledge of satellite systems engineering based on consolidated industrial experience. This will allow students to gain broad, top-level insight, which will support their learning in the other modules of the MSc programme.

This module will introduce the principles of satellite orbits, dynamics, and manoeuvres to provide a fundamental background to understanding spacecraft capabilities, performance, and behaviour. Certain satellite subsystems will also be covered in greater depth.

This module will provide a comprehensive overview of how space projects are conceived, developed, and managed. There will be an emphasis on how space projects have improved the quality of life in a global context, especially in developing countries.

This module will include technical engineering discussions where students will gain understanding of key elements of satellite systems architectures, design drivers, and criticalities. Several use cases for LEO and GEO systems will be used to highlight the application of such concepts to provide the students a view into industry operations.

This module will give students the opportunity to apply and demonstrate their new understanding and skills through group project work.

Outline Syllabus

Spacecraft dynamics and space environment: concepts of orbital and attitude dynamics, including multibody dynamics and Earth-Space environment effects.

Space missions: typical lifecycle processes for space projects with highlights on applicable space standards such as ECSS and CCSDS.

Spacecraft systems architectures: typical GEO/MEO/LEO satellite systems architecture definitions including an overview of main subsystems, such as avionics, on-board data handling, thermal, mechanical, electrical, propulsion, etc.

Spacecraft systems design: typical design drivers and trade-offs.

Spacecraft avionics: main functions and design drivers, typical solutions.

Space technologies: overview of state-of-the-art technologies and comparison between Old Space and New Space approaches.

Learning Outcomes

Outcome Number	Description
01	Demonstrate a comprehensive understanding of, and apply the principles, of spacecraft mission design, including orbit and attitude dynamics
02	Demonstrate a critical awareness of, and apply, the life cycle of a satellite system including industry-standard phases, referencing appropriate processes and standards
03	Critically apply key principles and concepts of satellite system engineering
04	Critically evaluate the main design drivers of spacecraft architectures (typical LEO, MEO, and GEO missions)
05	Critically evaluate current space technologies for the avionics and attitude control subsystems
06	Demonstrate a comprehensive understanding, group project work, on collaborative working, proposal writing, project management, and the ability to present findings in a commercial context.

Learning, Teaching and Assessment Strategy

Learning and Teaching will be directed, supported, and reinforced through a combination of face-to-face or online lectures, practical tutorials, as well as through directed and self-directed study supported by learning materials available on Canvas. Face-to-face or online drop-in sessions will be scheduled to assist students who required extra support.

Tutorials will include using the industry-standard software package Ansys STK to illustrate various concepts introduced in lectures, and to demonstrate the use of digital tools in modern satellite mission design.

Revision sessions and additional tutorial sessions will be arranged upon request by students.

The module will be wholly delivered during Semester 1 and assessed through a combination of a Group Project, Presentation, and an Open Book exam. Students will be briefed on their Group Project assignment at the beginning of the Semester and can start work on it straight away. The Open Book exam will be scheduled during the January examination period, giving students time to properly prepare for it.

Lectures and tutorials will be recorded for students who may not be able to attend the face-to-face sessions. In the event of face-to-face delivery not being possible, recorded synchronous online or pre-recorded lectures will be delivered and uploaded to Canvas to support students learning. Synchronous online tutorials will be scheduled for the work involving STK.

The Group Project will consist of a feasibility study for a specific use-case, with students working in groups of 4 or 5. This activity is intended to strengthen the knowledge base acquired in the lectures and tutorials, encourage teamwork, and practise higher-order technical and soft skills.

This teamwork will be assessed through a group presentation, where each member of a group will present their individual contribution.

Finally, an open book written examination will be used to assess students technical understanding of the module.

This module satisfies the below Learning Outcomes as specified by the Accreditation of Higher Education Programmes: Fourth Edition (AHEP4) as published by The Engineering Council in line with the UK Standard for Professional Engineering Competence (UK-SPEC). These outcomes specify five key areas of learning at Masters level: Science and Mathematics (SM), Engineering Analysis (EA), Design and Innovation (DI), The Engineer and Society (ES), and Engineering Practice (EP). SM-M1; EA-M2, M4; ES-M7; EP-M16, M17

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Summative Assessment - A timed examination that takes place on-campus, with all students sitting the exam in the same place and at the same time. Students may bring specified books/other resources into the exam.

Supplementary - A timed examination that takes place on-campus, with all students sitting the exam in the same place and at the same time. Students may bring specified books/other resources into the exam.

Mode of Assessment

Type	Method	Description	Weighting
Summative	Presentation	In-person group oral presentation by each project group.	30%
Summative	Computerised examination	Timed Examination open book	70%
Referral	Computerised examination	Timed examination open book	100%

Reading List
To access the reading list for this module, please visit https://bradford.rl.talis.com/index.html

Please note:
This module descriptor 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 minor changes may occur given the interval between publishing and commencement of teaching. Upon commencement of the module, students will receive a handbook with further detail about the module and any changes will be discussed and/or communicated at this point.

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