UNIVERSITY of BRADFORD

Module Descriptor

Module Details	
Module Title	Navigation Satellite Systems
Module Code	ELE7034-B
Academic Year	2022/3
Credits	20
School	Department of Biomedical and Electronics Engineering
FHEQ Level	FHEQ Level 7

Contact Hours	
Type	Hours
External Visits	8
Lectures	16
Project Supervision	6
Seminars	2
Supervised time in studio/workshop	8
Directed Study	160

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

Module Aims

This course is for students who have an interest in the development of satellite navigation technologies (e.g., receivers, signal processing or software), as well as for students willing to apply satellite navigation methods to problems in their own fields. The module aims to provide theoretical and practical basics of satellite based positioning and timing using global navigation satellite systems (GNSS): GPS, GLONASS, Galileo and Beidou, as well as augmentation systems such as EGNOS and WAAS. Applications and services based on GNSS in different fields (transportation, energy distribution, telecommunications, finance, land surveying and mapping, precision agriculture, emergency response and disaster recovery, scientific research) are covered in detail. The regulatory aspects and the ethical use of navigation satellite systems will also be covered.

Outline Syllabus
- Overview of key concepts of space dynamics and orbits, evolution of navigation techniques and time measurement techniques. - Key concepts of GNSS: triangulation and trilateration; ranging. - GNSS system architecture: space, ground and user segments. - Present multi-constellation scenarios: GPS, GLONASS, Galileo, Beidou. - Regional and global augmentation systems: WAAS, EGNOS, QZSS. - Representation of satellite orbits; geodetic reference systems and time systems. - GNSS satellite signals and error sources. - Space Weather and its effects on telecommunications and radio navigation. - Modelling and estimation of atmospheric effects on GNSS satellite signals. - Differential and assisted GNSS positioning; precise positioning techniques. - Carrier-phase positioning and estimation of ambiguities. - User segment: receiver technologies. - Relativistic effects in GNSS systems. - Timing, time scale generation, synchronization techniques. - Applications of GNSS. - GNSS threats and vulnerabilities; security aspects. - GNSS and critical infrastructures. - GNSS regulatory and ethical aspects.

Learning Outcomes	
Outcome Number	Description
LO1	Critically evaluate the evolution of navigation and timing techniques using presently available Global Navigation Satellite Systems (such as GPS, Beidou, GLONASS, Galileo, etc.) as examples.
LO2	Demonstrate a comprehensive understanding and critically apply the principles of GNSS based positioning methods, the main components in a satellite navigation system and their functions as well as the core concepts of accuracy, precision, dilution of position (DOP), multipath errors, and clock errors.
LO3	Implement algorithms for estimation of GNSS positions and plan, perform and process precise GNSS measurements, taking in account the influence of different error sources on the positioning precision and the specific influence of space weather on GNSS performance.
LO4	Critically analyse the role of GNSS or GNSS based products and services as an essential component in the critical infrastructures of our society considering the ethics, threats and vulnerabilities of GNSS and their effectiveness, affordability and sustainability in the global context and responsible use of satellite systems for the good of humanity.
LO5	Demonstrate a comprehensive understanding, through the group project, 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 and seminars as well as through directed and self-directed study supported by learning materials available in CANVAS. Face-to-face or online drop-in sessions will be scheduled to assist students who required extra support.

The module will be delivered and assessed over four consecutive weeks, with lectures and seminars delivered within the first two weeks and the rest will be dedicated to the assessed group project. Extra tutorials or laboratory sessions can be arranged upon request by students to ensure that every student understands the theory and knows how to use the software tools.

Lectures and laboratories will be recorded live to cater for students who may not be able to attend face-to-face lectures due to extenuation circumstances In the event of face-to-face delivery not being possible, recorded synchronous online or pre-recorded lectures and laboratories will be delivered and uploaded to CANVAS to enable students watch the presentations, videos at their own time. Utilising current research and case studies on the topic of Satellite Navigation Systems, the students will participate in lectures, workshops, seminars from external speakers and independent study to explore concepts and solve real-world problems.

Lectures will provide key concepts about Positioning, Navigation, and Timing (PNT) techniques, including terrestrial systems. A broad review of applications of GNSS positioning and timing will also be provided. One external visit to either the Greenwich Astronomical Observatory or to an industry will be organized.

Assessment will be based on a group project, specific for the topic, organized in Work Packages. The group project will be student-led. Students will assign work packages among themselves based on mutual agreement. The outcomes of the Group Project will become an asset of a future Navigation Lab. Upon completion of the project, each student will need to submit a project report on his/her assigned workpackage,that constitutes a part of the group project report. In addition to the individual report, each student will be assessed through an oral presentation about their own work packages. They are also required to show a thorough understanding of the relationship between different workpackages, thus enabling the assessment of students? understanding of LOs, teamwork, project management skills, presentation skills. Individual contributions to the project report and oral presentations weighs 50% each towards the module grade. Appropriate feedback, formative and summative, will be given on the assessment.

Mode of Assessment

Type	Method	Description	Weighting
Summative	Examination - oral/viva voce	Oral viva voce exam of group proj (d>	50%
Summative	Coursework - Written	Project report (min. 2000 words) detailing individual contribution to group project inc. research analysis & reflection	50%

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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