SATELLITE REMOTE SENSING - 2024/5

Module code: EEEM033

Module Overview

Expected prior learning: None specifically advised.

Module purpose: Earth and planetary observation with remote sensing data is playing a key role in the present understanding of natural phenomena, prevention of disasters, resources monitoring, comprehension of origins of life.

Through a series of lectures, seminars, open discussions and “thinking breaks” in class, the module aims to give an introduction to the scientific principles of remote sensing – both passive and active – as carried out by spacecraft. Remote sensing is discussed in terms of instrumentation, missions, products and applications.

IMPORTANT: The Second assessment pattern (Written Exam) is only applicable to the MSc Short Course Students.

Module provider

Computer Science and Electronic Eng

Module Leader

GUIDA Raffaella (Maths & Phys)

Number of Credits: 15

ECTS Credits: 7.5

Framework: FHEQ Level 7

Module cap (Maximum number of students): 90

Overall student workload

Independent Learning Hours: 94

Lecture Hours: 11

Tutorial Hours: 11

Laboratory Hours: 4

Guided Learning: 15

Captured Content: 15

Module Availability

Semester 1

Prerequisites / Co-requisites

None.

Module content

Indicative content includes the following.

Section 1 - INTERACTIONS, SENSORS & PLATFORMS

Introduction to Remote Sensing: Radiometry, Electromagnetic Spectrum, Radiant and Spectral quantities, Blackbodies, Planck law, Stefan-Boltzmann law, Wien displacement law.

Energy Interactions: Physics of interactions, interactions in the atmosphere (influence factors, mechanisms, effects), interactions at the Earth's surface (the energy balance, different kinds of reflectors). Mechanisms of reflection, transmission, absorbance, scattering (Rayleigh, Mie, Non-selective).

Data acquisition and interpretation: Data acquisition, data analysis, reference data, calibration.

Sensors and Platforms: Active and Passive systems, Spatial, Spectral, Radiometric and Temporal Resolution, Swath Width, Coverage (Along-track scanner, Across-track scanner), Nadir, Signal to Noise Ratio (SNR), Payload design considerations,. Examples of some multispectral missions: LANDSAT program, SPOT program, NOAA program.

Section 2 - RADAR REMOTE SENSING

Radar Remote Sensing: Viewing geometry, Antenna Beam. Signal properties in Time Domain (Continuous wave CW and Pulsed wave PW) and Frequency domains, (Spectrum for CW and PW). Linear Frequency Modulation. Range and Doppler discrimination. Geometric distortions (Foreshortening, Layover, Shadow). Real Aperture Radar (RAR), Radar Equation (Bistatic and Monostatic), Swath width, Range resolution, Azimuth resolution, Signal Fading (speckle).

Synthetic Aperture Radar (SAR): Synthetic-Array approach, Doppler-Synthesis approach, lower and upper bounds for PRF. Configurations: stripmap, spotlight, hybrid, scansar. SAR Missions and Applications. SAR Interferometry. SAR Polarimetry. Scatterometer: basic principles. Altimeter: basic principles. Examples of SAR missions.

Section 3 - DATA QUALITY & IMAGE PROCESSING

Image Processing: Image rectification and restoration (Geometric correction, Radiometric correction, Noise removal); Image enhancement (Contrast manipulation, Spatial feature manipulation, Multi-image manipulation). Image classification (supervised and unsupervised), classifiers. Data merging: principles.

Assessment pattern

Assessment type	Unit of assessment	Weighting
Examination	2 HOUR (OPEN BOOK) EXAM	100

Alternative Assessment

N/A

Assessment Strategy

The assessment strategy for this module is designed to provide students with the opportunity to demonstrate the following:

- a basic knowledge of remote sensing principles and instrumentation and a good understanding of the interactions of radiation with the earth's surface and atmosphere, assessed through coursework and examination;

- a good understanding of Synthetic Aperture Radar principles and applications, assessed through coursework and examination;

- a good capability of analysing end-users requirements for specific remote sensing application and converting them in technical specifications for the design of remote sensing instrumentation, assessed through coursework;

- a good knowledge of basic image processing and interpretation skills of remote sensing products, assessed through examination.

Thus, the summative assessment for this module consists of the following.

· Open book examination.

- These deadlines are indicative. For confirmation of exact date and time, please check the Departmental assessment calendar issued to you.

Formative assessment and feedback

For the module, students will receive formative assessment/feedback in the following ways.

- During lectures, by question and answer sessions and discussions
- During tutorial classes
- By means of unassessed tutorial problem sheets (with answers/model solutions)
- By means of quizzes set in SurreyLearn
- During meetings with the module coordinator

Module aims

- Introduce the student to remote sensing principles, the physical interactions of radiation with atmosphere and Earth's features;
- Introduce the student to the processing of remotely sensed data and the development of applications for Earth's resources management and monitoring for the achievement of Sustainable Development Goals (SDGs)

Learning outcomes

Ref		Attributes Developed	
001	Have a good understanding of the interactions of radiation with the earth's surface and atmosphere and be able to use this knowledge to approach the design of new sensors and address specific problems	KCPT	M2, M5
002	Have a good knowledge of remote sensing instrumentation, and radar in particular	KC	M1, M6
003	Have a good understanding and basic interpretation skills of remote sensing products	KCPT	M3, M4, M13
004	Be capable of analysing the requirements for some relevant application in remote sensing	CPT	M5, M7

Attributes Developed

C - Cognitive/analytical

K - Subject knowledge

T - Transferable skills

P - Professional/Practical skills

Methods of Teaching / Learning

The learning and teaching strategy is designed to achieve the following aims:

1. Through the introduction of the key concepts, representative examples and selected case studies of the use of satellite remote sensing technology.

2. Through the use of revision questions with full solutions, allow the student will be able to pace their own learning in parallel with the lecture course.

Learning and teaching methods include the following.

1. Lectures where key concepts will be introduced, and students will learn about the key conceptions and applications of satellite remote sensing.

2. Problem classes with full sample solutions to allow the students to pace their learning at the pace they are comfortable with.

3. Lab sessions allow students to gain experience of analysis of satellite remote sensing data.

4. Revision sessions of past examination papers; students will be encouraged to attempt the examination papers in advance and to compare their answers with the model solution

Indicated Lecture Hours (which may also include seminars, tutorials, workshops and other contact time) are approximate and may include in-class tests where one or more of these are an assessment on the module. In-class tests are scheduled/organised separately to taught content and will be published on to student personal timetables, where they apply to taken modules, as soon as they are finalised by central administration. This will usually be after the initial publication of the teaching timetable for the relevant semester.

Reading list

https://readinglists.surrey.ac.uk
Upon accessing the reading list, please search for the module using the module code: EEEM033

Other information

This module has a capped number and may not be available to exchange students. Please check with the International Engagement Office email: ieo.incoming@surrey.ac.uk

Digital Capabilities: In this module students will be required to master specific digital resources and online platforms related to the development of Earth Observation (EO) applications. These include the Sentinel Tool Box and the Sentinel Data Hub through which they will learn about satellite data acquisition plans, data order and processing.

Employability: The module learning outcomes and the formative assessments are designed to provide students with the analytical and design skills required for an EO and image analyst expert thus developing leaders in a fast growing market, that of EO applications and services, as also prioritized by many national space strategies, included the UK one.

Global and Cultural Capabilities: through exercises of formative assessment, students will be introduced to the real world task of designing an EO application for a group of stakeholders of different background (can be cultural, societal, educational, geographical etc.) with the challenge to understand their *end-users* requirements and translate them in technical specifications for the EO application to develop. The challenge of dealing with a large heterogeneity in the groups of customers considered, from a specific Ministry in a Small Island Development State (SIDS) to group of farmers till defence agencies, will equip the students with the necessary global and cultural capabilities to address the same in a real work environment.

Sustainability: Earth Observation with satellite data is considered today one of the most efficient way to accelerate the achievement of the UN Sustainable Development Goals (SDGs). During the different forms of formative assessment, the design of an EO applications for a specific group of stakeholders identified, is accomplished by the students by first identifying the UN SDGs involved and then considering the indicators defined by the UN to measure the achievement of those SDGs. Students are required to specify how the use of satellite data can facilitate the tracking of the indicators involved.

Programmes this module appears in

Programme	Semester	Classification	Qualifying conditions
Computer Vision, Robotics and Machine Learning MSc	1	Optional	A weighted aggregate mark of 50% is required to pass the module
Electronic Engineering MEng	1	Optional	A weighted aggregate mark of 50% is required to pass the module
Electronic Engineering with Computer Systems MEng	1	Optional	A weighted aggregate mark of 50% is required to pass the module
Electronic Engineering with Space Systems MEng	1	Optional	A weighted aggregate mark of 50% is required to pass the module
Satellite Communications Engineering MSc	1	Optional	A weighted aggregate mark of 50% is required to pass the module

Programme	Semester	Classification	Qualifying conditions
Space Engineering MSc	1	Optional	A weighted aggregate mark of 50% is required to pass the module