# Annexe A: New/Revised Course Content in OBTL+ Format

## Course Overview

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| Expected Implementation in Academic Year (New format) | AY2024-2025 |
| Semester/Trimester/Others (specify approx. Start/End date) | Semester 1 |
| Course Author<br>* Faculty proposing/revising the course | Assoc Prof Sang-Ho YUN |
| Course Author Email | sangho.yun@ntu.edu.sg |
| Course Title | Eyes on Earth – Satellite Remote Sensing |
| Course Code | ES4304 |
| Academic Units | 3 |
| Contact Hours | 39 |
| Research Experience Components | Research Defined Course (at least 50% of deliverables involve practical research activities: problem identification, hypothesis forming, data collection/analysis/interpretation, result communication) |

## Course Requisites (if applicable)

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| Pre-requisites | N/A |
| Co-requisites | N/A |
| Pre-requisite to | N/A |
| Mutually exclusive to | N/A |
| Replacement course to | N/A |
| Remarks (if any) | |

## Course Aims

This course aims to cultivate students' satellite remote sensing literacy – ability to analyse, interpret, and communicate satellite remote sensing products. By the end of the course, students will become experienced in handling these products and in communicating their findings to stakeholders and policymakers.

We will delve into the physical principles underlying various remote sensing techniques through a balanced combination of lectures and tutorials. While a basic understanding of electromagnetic waves will be beneficial, it is not a prerequisite.

Throughout the course, we will explore key methods of remote sensing, including optical, multi/hyper-spectral, and microwave sensing. Students will gain hands-on experience in identifying and measuring geometrical, physical, and chemical parameters of the Earth's surface. These skills are invaluable for applications such as environmental monitoring, hazard assessment, and addressing the impacts of climate change.

## Course's Intended Learning Outcomes (ILOs)

Upon the successful completion of this course, you (student) would be able to:

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| ILO 1 | Describe major satellite sensors used for Earth observations. |
| ILO 2 | Identify appropriate satellite remote sensing products for specific challenges. |
| ILO 3 | Evaluate the advantages and disadvantages of various satellite remote sensing data. |
| ILO 4 | Conduct basic analyses on remote sensing data. |
| ILO 5 | Interpret and communicate the results of analyses both orally and in written format. |
| ILO 6 | Apply remote sensing techniques to real-world scenarios. |

## Course Content

This course is designed to foster students' literacy in satellite remote sensing, focusing on the analysis, interpretation, and communication of satellite remote sensing products. The curriculum provides a balance of lectures and tutorials, covering the fundamental principles of various remote sensing techniques. Students will be introduced to key methods such as optical, multi/hyper-spectral, and microwave sensing and will acquire practical skills in identifying and measuring the Earth's surface parameters, which have applications in environmental monitoring and climate change assessment. Assessment will comprise quizzes, assignments, and a term project, aimed at reinforcing the application of learned concepts.

## Reading and References (if applicable)

Recommended reading for this class:

"Remote Sensing and Image Interpretation", Thomas Lillesand (Author), Ralph W. Kiefer (Author), Jonathan Chipman (Author), ISBN: 978-1118343289, John Wiley, 2015.

"Introduction to the Physics and Technologies of Remote Sensing", Charles Elachi (Author), Jakob van Zyl (Author), ISBN: 978-1119523017, John Wiley, 2006.

"Introduction to Microwave Remote Sensing", Iain Woodhouse (Author), Speckled Press; 1st edition (February 27, 2015)

## Planned Schedule

| Week or Session | Topics or Themes | ILO | Delivery Mode | Activities | Readings |
|---|---|---|---|---|---|
| 1 | Satellite missions and sensors Electromagnetic waves Remote sensing image primary | 1 | In-person | | N/A |
| 2 | Optical, multi/hyper-spectral sensors, radiometers | 1, 2, 3 | In-person | Quiz on EM waves & imagery | N/A |
| 3 | Optical, multi/hyper-spectral sensors, radiometers | 1, 2, 3 | In-person | Tutorial | N/A |
| 4 | Altimetry, GEDI, SWOT missions | 1, 2, 3 | In-person | Quiz on passive sensors (optical, multi-spectral) | N/A |
| 5 | Altimetry, GEDI, SWOT missions | 1, 2, 3 | In-person | Tutorial | N/A |
| 6 | Synthetic Aperture Radar | 1, 2, 3 | In-person | Quiz on altimetry, LiDAR | N/A |
| 7 | Interferometric Synthetic Aperture Radar | 1, 2, 3 | In-person | Team formation | N/A |
| 8 | Synthetic Aperture Radar | 1, 2, 3 | In-person | | N/A |
| 9 | Interferometric Synthetic Aperture Radar | 1, 2, 3 | In-person | Tutorial | N/A |
| 10 | Google Earth Engine Term project check & discussion | 1, 2, 3 | In-person | Quiz on SAR, InSAR | N/A |
| 11 | Google Earth Engine | 1, 2, 3 | In-person | Tutorial | N/A |

| Week or Session | Topics or Themes | ILO | Delivery Mode | Activities | Readings |
|---|---|---|---|---|---|
| 12 | Entire course review | 1, 2, 3, 4, 5, 6 | In-person | | N/A |
| 13 | Presentation of term projects | 1, 2, 3, 4, 5, 6 | In-person | Term project report due | N/A |

## Learning and Teaching Approach

| Approach | How does this approach support you in achieving the learning outcomes? |
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| Active Learning | Students will engage in active learning techniques periodically throughout lectures, and during tutorial sessions. |
| Independent Learning | Students are required to show self-motivation and initiative in your learning process, such as preparation for tutorials and teamwork opportunities. |

## Assessment Structure

Assessment Components (includes both continuous and summative assessment)

| No. | Component | ILO | Related PLO or Accreditation | Weightage | Description of Assessment Component | Team/Individual | Rubrics | Level of Understanding |
|---|---|---|---|---|---|---|---|---|
| 1 | Continuous Assessment (CA): Others(Tutorial Exercises: analysing satellite data using matlab/python/R, based on real world examples, and producing a report based on the findings) | 1, 2, 3 | 1, 2, 3 | 35 | | Individual | Analytic | Multistructural |
| 2 | Continuous Assessment (CA): Test/Quiz(Short Online Quizzes will be administered to help frequent retrieval of what students learn.) | 1, 2, 3 | 1, 3 | 35 | | Individual | Analytic | Relational |
| 3 | Continuous Assessment (CA): Report/Case study(Final Project Report: team report on their final project of their choice using publicly available satellite remote sensing Earth observation data) | 1, 2, 3, 4 | 1, 2, 3, 4, 5, 6 | 15 | | Team | Analytic | Multistructural |
| 4 | Continuous Assessment (CA): Presentation(Final Project Presentation: team presents to the class about the findings from their final project ) | 1, 2, 3, 4 | 1, 2, 3, 4, 5, 6 | 15 | | Team | Analytic | Multistructural |

Description of Assessment Components (if applicable)

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| Group formation - We will randomly assign students to form groups for the final project. (Please see instructors if you have any concerns). |

Formative Feedback

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| The class will be given feedback after each assignment. You will receive feedback during tutorial. |

## NTU Graduate Attributes/Competency Mapping

This course intends to develop the following graduate attributes and competencies (maximum 5 most relevant)

| Attributes/Competency | Level |
|---|---|
| Care for Environment | Advanced |
| Collaboration | Advanced |
| Curiosity | Intermediate |
| Digital Fluency | Advanced |
| Problem Solving | Advanced |

# Course Policy

Policy (Academic Integrity)

Good academic work depends on honesty and ethical behaviour. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honour Code, a set of values shared by the whole university community. Truth, Trust and Justice are at the core of NTU's shared values. As a student, it is important that you recognize your responsibilities in understanding and applying the principles of academic integrity in all the work you do at NTU. Not knowing what is involved in maintaining academic integrity does not excuse academic dishonesty. You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion and cheating. If you are uncertain of the definitions of any of these terms, you should go to the academic integrity website for more information. On the use of technological tools (such as Generative AI tools), different courses / assignments have different intended learning outcomes. Students should refer to the specific assignment instructions on their use and requirements and/or consult your instructors on how you can use these tools to help your learning. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Policy (General)

Students are expected to complete all assigned pre-class readings and activities, attend all classes punctually and take all scheduled assignments and tests by due dates. Students are expected to take responsibility to follow up with course notes, assignments and course related announcements. Students are expected to participate in discussions and activities.

Policy (Absenteeism)

Absence from class without a valid reason will affect your overall course grade. Valid reasons include falling sick supported by a medical certificate and participation in NTU's approved activities supported by an excuse letter from the relevant bodies.

Policy (Others, if applicable)

Label everything
There should be no plots without labels, legend, title, etc. Any missing labels or missing units will result in points deducted on assignments.

Pay attention to units
Everything should be labelled with the correct units. Make sure you know what units you are working in. All units should be SI standard.

Group work
It's ok to help each other, and good to discuss your work together. Just make sure that you fully understand all your calculations by the time you turn them in. This is to your own benefit.

Compulsory Assignments
You are required to submit compulsory assignments on due dates through the online system. The latest attempt will be the one graded.

Diversity and inclusion policy
Integrating a diverse set of experiences is important for a more comprehensive understanding of science.
It is our goal to create an inclusive and collaborative learning environment that supports a diversity of perspectives and learning experiences, and that honours your identities; including ethnicity, gender, socioeconomic status, sexual orientation, religion or ability.
To help accomplish this:

- If you are neuroatypical or neurodiverse, have dyslexia or ADHD (for example), or have a social anxiety disorder or social phobia;
- If you feel like your performance in the class is being impacted by your experiences outside of class;
- If something was said in class (by anyone, including the instructor) that made you feel uncomfortable;

Please speak to your teaching team, our school pastoral officer, Ms Christina Tee, or a peer or senior (either in-person or via email) about how we can help facilitate your learning experience.
As a participant in course discussions, you should also strive to honour the diversity of your classmates. You can do this by: using preferred pronouns and names; being respectful of others opinions and actively making sure all voices are being heard; and refraining from the use of derogatory or demeaning speech or actions.
All members of the class are expected to adhere to the NTU anti-harassment policy. if you witness something that goes against this or have any other concerns, please speak to your instructors or a faculty member.

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Last Updated By: Siti Nur Amirah Binte Suhari